普通高等教育“十二五”规划教材
食品科学与工程系列教材

食品专业英语

主　编　吴　澎　王　超　朱法荣
副主编　路　飞　李　峰　王世卓　李法德

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内 容 简 介

本书分为5章，主要内容包括：营养与健康、食品化学、食品技术、食品安全管理与食品专业科技论文写作。以独具特色的记忆窍门教学生学习专业词汇分析，课文配以翻译，阅读链接、难句分析，并穿插作业、阅读文选。

本书可作为食品科学与工程、食品质量与安全专业本科生、研究生专业英语教材，对相关领域的科研、生产单位从业人员具有重要的参考价值。

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前　言

目前，工科专业的英语教材大多选自各专业英文经典论著，这种教材虽有较好的系统性，但题材单一、缺乏时代感，很难吸引学生，同时整本教材保持一个较高的难度，不适合学生循序渐进的知识接受过程。要解决这些问题，应从选材和编排两方面着手。对教材的结构与特色进行探索，通过对专业外语内容的研究，使学生能够掌握专业外语词汇、看懂专业外文书籍及有关资料、获取国内外专业信息、更好地把专业知识运用到实践中去。

在长期的教学过程中我们发现，需要做好以下几个方面：搜集本专业的基本词汇、短小精悍的论文配以热门电影、视频等教学手段，提高学生听力和阅读的学习兴趣；翻译方面侧重于授之以渔，讲技巧，布置作业课下完成；写作方面面临着的真实状况是让本科生直接写科技论文不太现实，只有少数优秀学生才能在老师的指导下做到，大部分学生需要做到的是掌握基本的表达方式，熟练掌握科技论文题目、摘要的英语写作，以备毕业论文写作及为研究生阶段的科技论文写作打下基础。盲目的好高骛远并不能让学生学好专业英语，应该本着由浅入深、循序渐进的原则让学生愉快地接受专业英语。现实效果表明，这种教学方法得到了广大学生的认可和欢迎。

在这样的工作经验基础上，山东农业大学和全国其他开设了相关专业课程的高校，从学生实际需要出发，编写能够体现以上教学目的的教材。

本书由山东农业大学（吴澎、王超、朱法荣、李法德、李峰、单长松、崔婷婷、王荣）、沈阳师范大学（路飞、李苏红）、福建农林大学（庞杰）、哈尔滨师范大学（王世卓）、甘肃农大食品学院（丁若珺）、内蒙古农业大学（陈霞）、辽宁大学轻型产业学院（薛友林）、淮阴工学院生化学院（赵希荣）、淮海工学院（舒留泉）、河南科技大学（陈秀金）、齐齐哈尔大学（田英华）、渤海大学（邵俊花）、中国海洋大学（赵雪）、泰安市委党校（齐丽）、成都大学（张珏）及英国皇家农业大学（Michelle R. Tutty 和 Douglas L. Hinkley）十六所高等院校联合编写，作者均为从事相关课程教学与研究的教师与专家。

本书在各编写老师多年授课经验基础上形成，编写时力求内容新颖，突出实用性。突破了以往专业英语的撰写模式，分为五个单元：营养与健康、食品化学、食品技术、食品安全管理与食品专业科技论文写作，以独具特色的记忆窍门教学生学习专业词汇分析，课文配以翻译、阅读链接、难句分析，并穿插作业、阅读文选。本书可作为食品科学与工程、食品质量与安全专业本科生、研究生专业英语教材和相关科研人员参考书。本书为立体化教材，

出版社网站备有与教材配套的多媒体软件。学生可以结合教材在课下利用网站资源进行自学、预习与复习。

在本书编书过程中，各位老师和专家们同心协力，参阅了国内外有关专家学者的论著，认真细致地完成了编写工作。但由于内容庞杂，编者水平有限，书中难免存在不足或问题，敬请读者批评指正，以便进一步修改、补充和完善。

编者 2013 年 9 月
于英国皇家农业大学

目　录

Chapter 1　Nutrition and Health

Unit 1　Carbohydrate

1　专业词汇分析

（1）carbohydrate　n. 碳水化合物

［记忆窍门］将该词分解成“carbo”和“hydrate”两个组合，词义分别为“碳”和“水”，合起来就是碳水化合物。

（2）bagel　n. 硬面包圈

［记忆窍门］“bagel”是马蹬（beugal）形的圈饼；和单词“bagel”的外形很像。

（3）starch　n. 淀粉，浆粉

［记忆窍门］由“starch”联想到“start”（开始），“ch”即“吃”，合起来就是“开始吃”，吃什么呢？中国人当然是吃米饭，而米饭里不是有很多淀粉吗？

（4）oatmeal　n. 燕麦片

［记忆窍门］该词可以分解为“oat”和“meal”，其中“oat”是“燕麦”；“meal”是“饭”的意思；由饭可以联想到吃，可以吃的燕麦就是燕麦片。

（5）pasta　n. 面团（用以制意大利通心粉，细面条等）

［记忆窍门］由单词 pasta 可以联想到“paste”，为“粘贴”的意思，而粘东西用的糊状物通常用面粉做成，由此很容易记住“pasta”为“面团”。

（6）peas　n. 豌豆（pea 的名词复数）

［记忆窍门］单词“bean”是“豆”，而单词“peas”中含有“ea”，由此联想到该词一定是一种豆类。

（7）legumes　n. 豆科植物，豆类蔬菜（legume 的名词复数）

［记忆窍门］单词“Legumes”可以被分解为“leg”和“ume”，其中“leg”是“腿”，联想到豆荚通常是长长的，和“腿”有相似之处；同时“ume”为“梅花”之意，因二者都有香味而联系在一起。

（9）lentils　n. 小扁豆（lentil 的名词复数）；小扁豆植株

［记忆窍门］该词和“little”相似，由此联想到“小”；由“en”联系到“bean”（豆）；将二者合起来就是小扁豆了。

（10）broccoli　n. 花椰菜；西兰花

［记忆窍门］单词“broccoli”中“occo”为“对称”之意；而西兰花拥有许多密实的绿色花苞束，形状规则且对称。

（11）insulin n. 胰岛素

［记忆窍门］单词“insulin”分解为“insu”和“lin”。前一部分和单词“insufficient”（不足）有相似之处，从而想到体内葡萄糖不足时，需要注射胰岛素。

（12）monosaccharides n. 单糖

［记忆窍门］该词可以被分解为“mono”和“saccharide”，分别为“单”和“糖”的意思，加起来就是单糖。

（13）glucose n. 葡萄糖

［记忆窍门］通常用该词的首字母大写“G”来表示葡萄糖，词中“ose”是糖的后缀。

（14）fructose n. 果糖

［记忆窍门］通常用该词的首字母大写“F”来表示果糖，而“ose”是糖的后缀。

（15）galactose n. 半乳糖

［记忆窍门］该词可以分为“ga”和“lactose”两部分，“lactose”是“乳糖”的意思；乳糖是由葡萄糖和半乳糖构成的双糖，所以一个乳糖分子去掉一个葡萄糖“G”，剩下的就是一个半乳糖了。

（16）disaccharides n. 双糖

［记忆窍门］该词可以被分解为“di”和“saccharide”，分别为“二”和“糖”的意思，加起来就是双糖。

（17）sucrose n. 蔗糖

［记忆窍门］其中“ose”为糖的后缀。

（18）lactose n. 乳糖

［记忆窍门］其中“ose”为糖的后缀。

（19）maltose n. 麦芽糖；饴糖

［记忆窍门］该词可以分解为“malt”和“ose”，“malt”意为“麦芽”；“ose”为糖的后缀；加起来就是麦芽糖。

（20）sedentary adj. 坐着的；（指工作等）坐着干的；案头的；（指人）不爱活动的

［记忆窍门］由该单词中“se”使人联想到座位“seat”，再加上“ary”是形容词的词缀，加起来就是“坐着的；（指工作等）坐着干的”；引申意为“（指人）不爱活动的”。

（21）polysaccharides n. 多糖

［记忆窍门］该词可以分解为“poly”和“saccharide”，分别为“多”和“糖”的意思，加起来就是多糖。

（22）glycogen n. 糖原

［记忆窍门］该词中“glyco”为“糖基”，由此联想到和糖有关。

(23) maltodextrin n. 麦芽糊精

[记忆窍门] 该词可以分解为“malt”和“dextrin”两部分，分别为“麦芽”和“糊精”的意思，合起来就是麦芽糊精。

(24) amylase n. 淀粉酶

[记忆窍门]“ase”为酶的后缀。

(25) intestine n. [解] 肠

[记忆窍门]“in”表示“在里面”，“est”和消化“digest”形似，因为体内最重要的消化发生在肠道，联想到体内最重要的消化器官肠。

(26) villi n. 长茸毛（villus 的名词复数）；绒毛

[记忆窍门] [v] 的发音类似于中文的“微”，而肠粘膜的绒毛非常的细小，从而将二者联系起来。

(27) feces n. 粪便；屎；渣滓

[记忆窍门] 由发音 [f] [s] 联想到汉语的发音“粪便”或“屎”

(28) cramp n. 痛性痉挛，抽筋；（腹部）绞痛

[记忆窍门] 该词和爬“crawl”很相近，由此联想到抽筋，易于记忆。

(29) diarrhea n. 腹泻；adj. 腹泻的

[记忆窍门] 该词的前一部分“dia”和“disease”（疾病）相似，由此想到是一种疾病。

2 课文

2.1 原文

Carbohydrate

Carbohydrates are the main source of energy in most human diets, constituting from less than 40% to 80% of the calories. Current dietary guidelines recommend that the fat intake in Western countries should be decreased from around 40% at present to not more than 30% of the energy intake. The protein should be kept at about the present level, corresponding to 10% ~15% of the energy. Thus, the carbohydrate intake has to be increased to at least 55% ~60% of the energy.

Originally, the recommendation to increase the carbohydrate intake came as a consequence of the fat and protein recommendations. In recent years, however, the specific nutritional importance of the carbohydrates as such has been more and more emphasized, and new developments call for a more specific nutritional classification of the different food carbohydrates as a basis for more specific recommendations. Labeling of foods regarding carbohydrate content is a separate, but closely related issue. The 'carbohydrate by difference' figure, which is still prevailing on food packages, needs to be replaced by a number of different nutritionally relevant carbohydrate fractions.

1 Dietary Sources of Carbohydrates

Carbohydrates, an economical and plentiful source of calories, can be found in varying amounts in a wide variety of foods. The basic diet should be consistent with the recommendations for chronic disease prevention and long-term health promotion. Such a diet is high in carbohydrate (>55% of total calories), low in fat (≤30% of total calories), and places a significant emphasis on a wide variety of foods.

The various recommendations made in this chapter regarding carbohydrate intake can be satisfied via consumption of a wide range of carbohydrates, depending on personal and cultural preference. Although structure and consistency are important aspects of an athlete's daily routine, consumption of the same carbohydrate containing foods day in and day out can lead to a reduction in the joy of eating. Incorporating traditional foods from different ethnic groups can be an excellent way of creating variety in an athlete's diet. For example, although most athletes are familiar with the fact that the main carbohydrate source in Italian food is pasta-based, it should be noted that Asian food is rice- and soybean-based, Mexican food is rice and bean-based, and South American food is tuber-, bean-, and nut-based. Being largely composed of carbohydrates, food types such as these can be incorporated into the diet to promote varied and interesting carbohydrate consumption patterns. A selection of common sources of dietary carbohydrate can be found in Table 1.

Table 1 Common source of dietary carbohydrate

Food Group	Food	Serving Size	Carbohydrate/g
Starches	Bagel	4 * (71 g)	38
	Bread	1 slice(25 g)	14
	Cereal, sweet	1cup(35 g)	29
	Cereal, low sugar	1cup(28 g)	24
	Oatmeal, cooked	1cup(234 g)	25
	Pasta, cooked	0.5cup(70 g)	19
	Potato chips	1 ounce(28 g)	15
	Rice, cooked		
Starchy vegetable	Corn, cooked	0.5cup(97 g)	22
	Green peas, cooked	0.5cup(75 g)	15
	Potatoes, mashed	0.5cup(75 g)	11
	Rice, cooked	0.5cup(140 g)	25
Beans/legumes	Dried beans, cooked	0.5cup(118 g)	20
	Lentils, cooked	0.5cup(141 g)	20
Fruits	Apple, medium	3 * (78 g)	25
	Banana, medium	7 * (72 g)	27
	Orange	2.5" (105 g)	16
Vegetables	Broccoli, cooked	0.5cup(78 g)	6
	Carrot	8 * long(72 g)	6
	Tomato	2.5" (105 g)	5

Continued

Food Group	Food	Serving Size	Carbohydrate/g
Milk	Milk	1cup(245 g)	12
	Chocolate milk	1cup(245 g)	26
	Soy milk	1cup(245 g)	18
	Yogurt, plain	1cup(245 g)	17
	Yogurt, sweetened	1cup(245 g)	26
Sugared beverage	Orange Juice	0.5cup(125 g)	13
	Sports beverage (6%, stand for the sugar content in beverage)	1cup(244 g)	14
	Soft drink	12ounce(368 g)	40
	Pizza, Cheese, Thick Crust	2 slices(142 g)	55
	Pizza, Cheese, Thin Crust	2 slices(166 g)	46
	Cheese Lasagna	1Cup(150 g)	45
	Chili with Beans	1Cup(160 g)	22

* Stand for one unit.

2 Classification of Carbohydrates

Carbohydrates can be classified according to several criteria, including those based on the structure and number of sugar molecules, as well as the degree to which they induce a rise in blood glucose and insulin levels.

Monosaccharides contain only one sugar molecule and include glucose, fructose, and galactose. Disaccharides, which contain two sugar molecules, include sucrose, lactose, and maltose. Disaccharides can be distinguished from each other based on their specific monosaccharide building blocks, with sucrose made up of glucose and fructose, lactose made up of glucose and galactose, and maltose made of two glucose molecules.

Monosaccharides and disaccharides are collectively referred to as simple sugars or carbohydrates. Simple sugars, or food products containing large amounts of simple sugars, have often been referred to as 'bad' carbohydrates, mostly as a method of describing the fact that they contain little additional nutritional value other than the provision of calories. Simple sugars are not inherently bad, but should certainly not make up the bulk of dietary carbohydrate intake. This may be especially true for sedentary or obese individuals, with studies suggesting that consumption of large amounts of rapidly absorbed sugars can predispose such individuals to chronic diseases such as type 2 diabetes.

Polysaccharides, which include starch, fiber, and glycogen, contain many glucose units linked together and are referred to as complex carbohydrates. another type of polysaccharide, are glucose polymers containing no starch or fiber and are subsequently metabolized like simple sugars. Examples of simple and complex carbohydrates and their dietary sources can be found in Table 2.

Table 2 Examples of simple and complex carbohydrates and their dietary sources

Classification of Carbohydrate	Comments
Simple Carbohydrates	
Monosaccharides	
Glucose	Also known as dextrose; found in plant foods, fruits, honey
Fructose	Also known as fruit sugar; found in plant foods, fruits, honey
Galactose	Product of lactose digestion
Disaccharides	
Sucrose	Also known as white or table sugar. composed of glucose and fructose. used as a sweetener
Lactose	Composed of galactose and glucose; found in milk and dairy products
Maltose	Composed of two glucose molecules; product of starch digestion
Complex Carbohydrates	
Polysaccharides	
Amylopectin	Starch; found in plant foods and grains
Amylose	Starch; found in plant foods and grains
Carrageenan	Soluble fiber; found in the extract of seaweed and used as food thickener and stabilize
Cellulose	Insoluble fiber; found in the bran layers of grains, seeds, edible skins, and peels
Corn Syrup	Hydrolyzed starch; found in processed foods
Dextrins	Starch; found in processed foods
Glycogen	Animal starch; found in meat, liver
Hemicellulose	Insoluble fiber; found in the bran layers of grains, seeds, edible skins, and peels
Inulin	Soluble fiber; found in Jerusalem artichokes
Invert Sugar	Hydrolyzed sucrose; found in processed foods
Lignin	Insoluble fiber; found in plant cell walls
Pectin	Soluble fiber; found in apples

3 Digestion and Absorption of Carbohydrate

Digestion of carbohydrates begins to a small degree in the mouth. Enzymes (salivary amylases) begin the process of digestion of complex carbohydrates by initiating the breakdown of starches. Chewing (mastication) is an important part of the digestive process, reducing foods to smaller-sized particles. Continuing this process of size reduction, mechanical action of the stomach increases both the rate of gastric emptying of food from the stomach into the small intestine and the surface area of the food particles made accessible to intestinal enzymes.

The majority of carbohydrate digestion and absorption occurs in the small intestine. After moving into the small intestine, the monosaccharides (glucose, fructose, and galactose) are absorbed directly into the blood via the capillaries within the intestinal villi. Glucose (and galactose) is absorbed via numerous sodium-dependent glucose transporters (SGLT-1), whereas fructose is absorbed via less numerous sodium-independent carriers. Disaccharides (sucrose, lactose, and maltose) are split into their constituent monosaccharides by specific disaccharidases, which are then absorbed directly into the blood. Complex carbohydrates are acted upon by pancreatic amylase and brush border enzymes, splitting polysaccharides to monosaccharides that are then absorbed as described above. The monosaccharides absorbed into the intestinal circulation are transported to the liver via the hepatic portal vein. Ultimately, glucose is the end point of carbohydrate

digestion and absorption regardless of whether the original compound was a polysaccharide, disaccharide, or monosaccharide.

Not all of the carbohydrate content of foods consumed is digested and absorbed. Carbohydrate that is not absorbed may be related to the form of the food, the type of starch, or the amount of fiber present in the food. Undigested and unabsorbed carbohydrates go to the large intestine, where they are acted upon by colonic bacteria or excreted in the feces. Large amounts of indigestible carbohydrates, or excessive amounts of simple sugars consumed rapidly, may result in excessive gas production or gastrointestinal disturbances such as cramping and diarrhea. The fiber content of carbohydrate foods, which is largely indigestible by humans, plays an important role in maintaining appropriate gastric transit, may influence the eventual glycemic response to the foods consumed, and has important long-term health implications.

2.2 参考译文

碳水化合物

在大多数人的饮食中，碳水化合物是主要的能量来源，占热量的 40% ~80%。在西方国家，目前的膳食指南推荐的脂肪摄入量占能量摄入的比例应从现在 40% 左右减少到不足 30%。蛋白质应保持在目前的水平（占总热量的 10% ~15%），因此，碳水化合物摄入量占总热量的比例将增加到不少于 55% ~60%。

最初，碳水化合物摄入推荐量的增加是脂肪和蛋白质膳食推荐量的减少的结果。然而，近年来，随着碳水化合物特定营养的重要性越来越受到重视，以更多具体推荐量为基础，新发展要求更多不同食物碳水化合物更具体的营养分类。关于碳水化合物含量的食品标签仍然是一个独立但又密切相关的问题。在食品包装上仍然是流行“不同碳水化合物”的数字，需要由许多不同营养相关的碳水化合物片段所取代。

1 碳水化合物的食物来源

碳水化合物，是一种即经济又丰富的热量源，发现不同食物中的碳水化合物含量不同。基础饮食应该和预防慢性病和促进长期健康保持一致。这样一来，饮食往往是高碳水化合物（>总热量的 55%），低脂肪（≤总热量的 30%），并非常注重丰富多样的食物。

本章提出关于碳水化合物的不同摄入推荐量可以通过消耗各种各样的碳水化合物得到满足，这取决于个人和文化偏好。虽然碳水化合物的结构和含量是一个运动员日常饮食的重要方面，但每天消费含有相同碳水化合物的食物，将会减少饮食带来的快乐。不同民族的传统食品融合在一起，可能是制作不同运动员饮食的一种好方法。例如，虽然大多数运动员都知道，在意大利食品的主要碳水化合物来源是面食，但是应该指出的是，在亚洲，碳水化合物的来源是大豆和水稻，墨西哥的碳水化合物食物是大米和豆类，南美洲的食物是块茎、豆和坚果。很多由碳水化合物组成的食物类型的并入，以形成多样

和有趣的碳水化合物消费模式。常见碳水化合物的主要来源见表1。

表1 常见食物的碳水化合物种类和热量

碳水化合物	食物来源	食用份量	碳水化合物/g
淀粉	硬面包圈	4*（71 g）	38
	面包	1片（25 g）	14
	麦片，甜	1杯（35 g）	29
	谷物，低糖	1杯（28 g）	24
	燕麦粥，熟	1杯（234 g）	25
	通心粉，煮	0.5杯（70 g）	19
	土豆片	1盎司①（28 g）	15
	大米，煮	0.5杯（97 g）	22
淀粉类的蔬菜	谷物，煮	0.5杯（75 g）	15
	绿豌豆，熟	0.5杯（75 g）	11
	土豆，土豆泥	0.5杯（140 g）	25
豆类	干豆，煮	0.5杯（98 g）	20
	小扁豆，熟	0.5杯（98 g）	20
水果	苹果，伴生熟的	3*（182 g）	25
	香蕉，伴生熟的	7*（118 g）	27
	橘子	2.5”（105 g）	16
	西兰花，熟的	0.5杯（78 g）	6
蔬菜	萝卜	8*长型的（72 g）	6
	西红柿	2.5”（105 g）	5
奶	奶	1杯（245 g）	12
	巧克力奶	1杯（245 g）	26
	大豆奶	1杯（245 g）	18
	酸奶，原味	1杯（245 g）	17
	酸奶，甜味	1杯（245 g）	26
	橘子汁	0.5杯（125 g）	13
含糖饮料	运动饮料（6%，饮料中的含糖量）	1杯（244 g）	14
	软饮料	12盎司（368 g）	40
	披萨，奶酪，厚面包	2片（142 g）	55
	披萨，奶酪，薄面包	2片（166 g）	46
	意大利奶酪千层饼	1杯（250 g）	45
	豆拌红辣椒	1杯（260 g）	22

注：*指一个单位。

2 碳水化合物的分类

碳水化合物可根据不同的标准进行分类，如糖分子的结构和数量，以及它们在何种程度上诱导血液中葡萄糖和胰岛素水平上升。

只含有一个糖分子的碳水化合物称为单糖，包括葡萄糖，果糖，半乳糖。含有两个

① 1盎司≈28.35 g

糖分子的为双糖，包括蔗糖，乳糖，麦芽糖。双糖可以根据组成的单糖种类进行区分，如葡萄糖和果糖构成蔗糖，葡萄糖和半乳糖构成乳糖，由两个葡萄糖构成麦芽糖。

单糖和双糖统称为简单的糖或碳水化合物。简单的糖，或含有大量的单糖的食物，常常被称为“坏”的碳水化合物。事实上，和其他供给热量相比，它们很少有额外的营养价值。其实，简单的糖本身并不差，只是不该通过摄入大量的碳水化合物来弥补营养，特别是对于久坐不动的或肥胖的人。有研究表明，食用大量迅速吸收糖会诱发慢性疾病，如Ⅱ型糖尿病。

多糖包括淀粉、纤维和糖原，由许多葡萄糖单元连接在一起，被称为复杂的碳水化合物。麦芽糊精是另一种多糖，不含淀粉或纤维的葡萄糖聚合物，并可以被代谢为单糖。简单和复杂碳水化合物的膳食来源见表2。

表2 简单和复杂碳水化合物的膳食来源

碳水化合物分类	阐述
简单碳水化合物	
单糖	
葡萄糖	也称右旋糖，存在于植物性食物、水果和蜂蜜
果糖	也称水果糖，存在于植物性食物、水果和蜂蜜
半乳糖	乳糖消化的产物
双糖	
蔗糖	也称白糖或食用糖，由葡萄糖和果糖构成，也称甜味剂
乳糖	由半乳糖和葡萄糖构成，存在于奶及奶制品中
麦芽糖	由两个葡萄糖分子构成，为淀粉的消化产物
复杂碳水化合物	
多糖	
支链淀粉	淀粉，存在于植物性食物和谷物中
直链淀粉	淀粉，存在于植物性食物和谷物中
角叉（菜）胶	可溶性纤维素，为海藻的提取物，用作食品的增稠剂和稳定剂
纤维素	不溶性纤维素，存在于谷物，种子，食用皮和皮中
玉米糖浆	水解淀粉，存在于加工食品
糊精	淀粉，存在于加工食品
糖原	动物淀粉，存在于肉类和肝脏中
半纤维素	不溶性纤维素，存在于谷物，种子，食用皮和皮中
菊粉	可溶性纤维；存在耶路撒冷洋蓟中
反式糖	水解蔗糖，存在于加工食品
木质素	不溶性纤维素，存在于植物细胞壁中
果胶	可溶性纤维素，存在于苹果中

3 碳水化合物的消化和吸收

只有很少的碳水化合物在口腔内消化，复杂碳水化合物的消化过程开始于酶（唾液淀粉酶）的作用，将淀粉分解。咀嚼是消化过程的一个重要部分，减少食物的颗粒大小。胃的机械作用，会继续减小食物颗粒大小，并提高食物从胃进入小肠的排空速度，并使食物颗粒和肠酶充分接触。

大部分碳水化合物的消化和吸收发生在小肠。进入小肠后，单糖（葡萄糖，果糖，

半乳糖）直接通过小肠绒毛内的毛细血管进入血液内被吸收。葡萄糖和半乳糖是通过大量的钠依赖性葡萄糖转运体（SGLT-1），而果糖则不依赖钠离子的载体被吸收。双糖（蔗糖，乳糖，麦芽糖）通过特定的双糖酶分解成单糖，然后直接进入血液被吸收。复杂碳水化合物在胰淀粉酶和刷状缘酶作用下，将多糖分解成单糖，再按照上述的方式被吸收。进入肠循环单糖经肝门静脉输送到肝。不管是哪种碳水化合物（多糖，双糖或单糖），最终都是以葡萄糖形式进行消化和吸收。

并不是食物中所有的碳水化合物都会被消化和吸收。碳水化合物不能被吸收主要和食物形式、淀粉类型和食物中所含纤维素的量有关。没有消化和吸收的碳水化合物会进入大肠，受到肠细菌的作用或通过粪便排出体外。大量未消化碳水化合物或迅速吸收的过量单糖，可能会产生过量的气体或胃肠道疾病（如痉挛和腹泻）的发生。碳水化合物食物中的纤维含量大部分不能被人类消化，但对保持胃进行适当运动起着重要作用，最终可能会影响到摄入食物的血糖反应，长远上对健康具有重要的意义。

3 阅读链接

[1] http://www.nature.com/ejcn/journal/v61/n1s/full/1602936a.html

[2] http://benthamscience.com/open/tonutrj/artilces/V006/21TONUTRJ.pdf

[3] http://onlinelibrary.wiley.com/doi/10.1002/9780470958186.ch7/pdf

[4] http://onlinelibrary.wiley.com/book/10.1002/9780813811048

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[6] http://ajcn.nutrition.org/content/91/3/502.full.pdf+html

[7] http://ac.els-cdn.com/S1874566006800110/1-s2.0-S1874566006800110-main.pdf?_tid=7442b522-e575-11e2-9bae-00000aab0f27&acdnat=1373030520_2fa049dd537ca836e44260f527dc5a60

4 课后作业

4.1 句子翻译

4.1.1 原句

(1) Current dietary guidelines recommend that the fat intake in Western countries should be decreased from around 40% at present to not more than 30% of the energy intake.

(2) In recent years, however, the specific nutritional importance of the carbohydrates as such has been more and more emphasized, and new developments call for a more specific nutritional classification of the different food carbohydrates as a basis for more specific recommendations.

(3) Simple sugars, or food products containing large amounts of simple sugars, have often been referred to as 'bad' carbohydrates, mostly as a method of describing the fact that they con-

tain little additional nutritional value other than the provision of calories.

(4) Continuing this process of size reduction, mechanical action of the stomach increases both the rate of gastric emptying of food from the stomach into the small intestine and the surface area of the food particles made accessible to intestinal enzymes.

4.1.2 参考翻译

(1) 在西方国家，目前的膳食指南推荐的脂肪摄入量占能量摄入的比例应从现在40%左右减少到不足30%。

(2) 然而，近年来，随着碳水化合物特定营养的重要性越来越受到重视，以更多具体推荐量为基础，新发展要求更多不同食物碳水化合物更具体的营养分类。

(3) 简单的糖，或含有大量的单糖的食物，常常被称为“坏”的碳水化合物，事实上，和其他供给热量的物质相比，它们很少有额外的营养价值。

(4) 胃的机械作用，会继续减小食物颗粒大小，并提高食物从胃进入小肠的排空速度，并使食物颗粒和肠酶充分接触。

4.2 科技论文常见句型

4.2.1 摘要

This paper derives the…

This paper puts forward a new method to …

4.2.2 引文

1)研究目的(purpose of the study)

This problem concerned (deals, bears) (briefly, meanly, largely) with …

This is a problem relating to …

Our work is devoted to …

The Primer goal of the present research is …

The work presented in this paper focuses in …

The work presented in this paper focuses on several aspects of …

The chief aim of study is …

The laboratory study demonstrates (suggests, indicates, reveals, establishes) …

Doing this work, we intend (hope, expect, attempt) to …

Carry out (undertaking, performing, initiating) this study, we hope to …

The principal purpose (objective, task) of the present (preliminary, further) work is to investigate the features of (mechanisms involved in, effects produced by) …

2)背景和历史(background and history)

This problem was (first) advanced by …

The Problem under discussion was formulated (raised, posed, brought up, put forward) by …

Since then the problem has attracted (fascinated) many scientists (workers in this field) …

This problem has been clarified (solved) …

The problem as can be seen (is to know) is (still) poorly (inadequately) understood.

Compared with the current research, the previous work was in connection with …

The work we are doing is closely related to the deliberations described in …

The new findings from the experiment agree well with the results obtained in …

Several (numerous, many, few) studies are made (carried out, performed) to elucidate the nature (understand the behavior, reveal the cause) of …

A study of the kind has (never) been made (until now, until a few years ago)

3)问题的难易程度(difficulty of the problem)

It seems (exceedingly, enormously) difficulty to obtain knowledge of the problem …

It proves (totally, quite) impossible (unrealistic) to try …

It is rather difficult to solve the problem …

The problem is rather involved …

The problem involves (certain, tremendous) difficulties.

It is easy to present (reveal, analyze, discuss) the problem in all its complexity (in every detail).

It is no easy task to gain a insight into the intricate detail of …

4)问题的范围(scope of the problem)

The main aspect (core, essence) of problem is …

Studies of these effects cover various aspects of …

Our studies with this technique confine to …

The problem is within the scope of …

Our problem lies beyond the range of …

4.2.3 正文

1)理论说明(theoretical explanations)

Our theory is based on the assumption that …

This theory proceeds from the idea (principle) of …

The underlying concept of the theory is as follows.

There is a similar (alternative, tentative) theory that …

The basic (essential, fundamental) feature of this theory is …

The object of this theory is to …

The newly advanced theory has some advantages (assets, strong points, positive features, deficiencies, drawback, inadequacies, flaws, shortcomings).

The validity of the theory has become obvious in the light of recent findings.

This newly-developed theory finds experimental support . .

The theory received universal recognition (general acceptance).

2)公式推导(formulas derivation)

… is given by:

… as follows:

… as in the following:

… the following equation is obtained.

… this becomes

therefore, we have

… can be expressed as

… can be derived:

… can be written:

… can be described by …

… can be represented as

3)方法介绍(method introduction)

the method of … was first developed by …

the method of … came into use as long ago as

the original proposal of this method was first published in …

the method we used differs from the conventional one.

The newly-elaborated technique is different from the one previously used.

The method is now greatly improved.

The procedure we followed has certain advantages over the existing method.

One of the assets of the technique is its simplicity (reliability, sensitivity).

Another good feature of this method is …

This method allows us to demonstrate …

The above procedure makes it possible to evaluate …

This method is capable of providing …

4)实验描述(experiment description)

We made (carried out, performed, initiated) this experiment to show (demonstrate, elucidate, evaluate) a correlation between (certain phenomena, the mechanism of, the hypothesis of, some features of) …

Experiments on … are made (underway) to …

Earlier (previous) experiments with this technique were intended (designed, designated) to …

The experiments reported here demonstrate a variety of changes in (a correlation between, a much resistance to) …

Our experiment support our assumption (hypothesis, evidence) that …

Recent experiments with … furnish some new information (for the data, new evidence) about the mechanism (the influence) of …

Further experiments in this area lead us to conclude (believe, suggest) that …

From these experiments we can conclude that …

4.2.4 结论

1)结果的意义(meaning of the results)

The results presented in this paper are (seem) …

The findings reported here is (quite) striking (remarkable, fascinating).

These preliminary findings are very reliable (encouraging, promising. Convincing, ambiguous)

The results reported here prove (confirm, support, bear out) the hypothesis (assumption, observation) that …

The above findings can be viewed (approached) as follows (in terms of …, from other standpoint).

We can consider (interpret, look at) these results as fully reliable (consistent with) …

This fruitful work gives explanation to …

2)导致结论(Conclusion deduced)

Our findings suggests that …

These findings lead the other to a conclusion that …

Our data leave open the question of whether …

In the future, we will extend the present studies to …

Our work has contributed to the understanding of …

The research work has brought about a discovery of …

Further progress can be provided by this experiment.

Unit 2 Lipids

1 专业词汇分析

（1）palatability n. 嗜食性，适口性，风味

［记忆窍门］该词可以分成“pala”，“tab”，“ility”三部分，“pala”和“palace”（宫殿）形似；“tab”和“table”（餐桌）相似，这两部分合起来就是宫殿里的餐桌，想像为宫殿里的桌子上一定有很多美味的食物；“ility”是名词的后缀；因此为“适口性”。

（2）triacylglycerols n. ［医］三酰基甘油；甘油三酯

［记忆窍门］该词中“tri”为“三”；“acyl”为“酰基”；“glycerol”为“甘油”；合起来就是三酰基甘油，即甘油三酯。

（3）sterols n. 甾醇类；固醇类

［记忆窍门］单词中“erols”是酯的后缀，再加上“s”为固体的第一个字母；进而联想到为固醇类。

（4）bile n. 胆汁

［记忆窍门］胆汁（bile）为胆囊（bile cyst）中的液体。

（5）diacylglycerols n. 二酰基甘油；甘油二酯

［记忆窍门］该词中该词中“di”为“二”；“acyl”为“酰基”；“glycerol”为“甘油”；合起来就是甘油二酯。

（6）cholesterol n. 胆固醇

［记忆窍门］该词中“chole”为“胆汁”；“sterol”为“固醇类”；合起来就是胆汁中固醇类就是胆固醇。

（7）sitosterol n. 谷甾醇

［记忆窍门］该词中“sito”为“食物”，而中国人以谷物为主；“sterol”为“甾醇类”；合起来就是谷甾醇。

（8）acylglycerol n. 酰基甘油，甘油酯

［记忆窍门］该词中“acyl”为“酰基”；“glycerol”为“甘油”；合起来就是“酰基甘油”。

（9）phospholipids n. ［医］磷脂（类）

［记忆窍门］该词中“phosph”和“phosphate”（磷酸盐）很相似；第二部分“lipid”为“脂类”；将二者合起来就是磷酸脂。

（10）glycolipids n. ［医］糖脂（类），配糖脂

［记忆窍门］该词中“glyco”为糖词根；“lipid”为“脂类”；将二者合起来就是糖脂。

（11）sphingolipids n.（神经）鞘脂类

［记忆窍门］该词的第一部分“sphingo”和“sphingoin”［（神经）鞘氨（基）脂］形似；“lipid”为“脂类”；将二者合起来就是（神经）鞘脂类。

（12）ruminants n. 反刍动物

［记忆窍门］单词可以分解为“rumin”和“ants”，“rumin”和“rumen”（瘤胃）相似，而只有反刍动物有瘤胃，进而联想到反刍动物。

（13）hibernate vi.（某些动物）冬眠，蛰伏

［记忆窍门］该词中“hibe”和“hide”（隐藏）很相似；联想到动物在冬天藏起来，往往是冬眠。

（14）linolenic acid n. 亚麻酸

［记忆窍门］该词中“linolenic”为“亚麻”；“acid”是“酸”；合起来就是亚麻酸。

（15）adipocytes n. 脂肪细胞

［记忆窍门］该词中“adipo”的含义为脂肪；“cyte”为细胞；合起来就是脂肪细胞。

（16）adipose adj. 含动物脂肪的；动物脂肪（似）的；脂肪质的；脂肪多的 n.（储于脂肪组织中的）动物脂肪；肥胖

［记忆窍门］该词为脂肪“adipo”的派生词。

（17）carotenoids n. 类胡萝卜素

［记忆窍门］该词中“carot”是“胡萝卜”，联想到胡萝卜中含有类胡萝卜素。

（18）leptin n. 瘦蛋白

［记忆窍门］由单词中“ptin”联想到“protein”（蛋白质），说明是蛋白质的一种。

（19）homeostasis n. 动态静止；动态平衡

［记忆窍门］该词中“homeo”为“相同或类似”（拉丁语）；而“stasis”和“static”（静止）很相似；合起来就是动态静止。

2 课文

2.1 原文

Lipids

Lipids form a group of compounds, the chemical nature of which is extremely varied. They have physical, chemical, and physiological properties that make them important both in nutrition and in food technology. Lipids make an important contribution to food characteristics, such as texture and palatability. In addition to fats ingested as food, there are specific lipids synthesized by the human body that are essential to life.

Lipids are insoluble in water and this profoundly affects the particular phenomena associated

with their digestion, absorption, transport in the blood, and metabolism at the cellular level. Fat is easily recognized when it accumulates within the body, but the chemical and technical definition of fats and lipids are more difficult. Of nutritional interest are (TAG), phospholipids (PL), sterols, and some derived lipids—results of the hydrolysis or enzymatic breakdown of simple and compound lipids.

TAG represents the bulk of ingested lipids. The second major group of lipids contained in a normal diet, the PL, contributes only an estimated 2% to the total fat intake, but an additional 12 g PL is secreted in the bile every 24 hours. Other lipids are either present in such minute quantities that they do not play a role in digestion and absorption, or they are poorly absorbed (e. g., wax and wax-like compounds).

Fatty acids (FA) are the main constituents of food fats and oils as well as of depot fats in man and animals. Dietary fats contain practically no free FA; instead, these are present in the form of TAG.

Diacylglycerol (DAG) are found naturally as minor components in various dietary lipids. Although human adults ingest 1 to 5 g of DAG every day, little attention has been paid to its nutritional characteristics because DAG have been recognized only as intermediates in the process of TAG digestion and absorption.

Food lipids usually contain small amounts of other fat-soluble substances, including flavor components and some vitamins. Animal fats may contain vitamins A and D, and varying amounts of cholesterol, while vegetable fats may contain carotenes, vitamin E, and sitosterol, but not cholesterol.

1 Lipid Classifications

Classification of lipid structures is possible based on physical properties at room temperature (oils are liquid and fats are solid), their polarity (polar and neutral lipids), their essentiality for humans (essential and nonessential fatty acids), or their structure (simple or complex). Neutral lipids include fatty acids, alcohols, glycerides, and sterols, while polar lipids include glycerophospholipids and glyceroglycolipids. The separation into polarity classes is rather arbitrary, as some short chain fatty acids are very polar. A classification based on structure is, therefore, preferable. Based on structure, lipids can be classified as derived, simple, or complex. The derived lipids include fatty acids and alcohols, which are the building blocks for the simple and complex lipids. Simple lipids, compose of fatty acids and alcohol components, include acylglycerols, ether acylglycerols, sterols, and their esters and wax esters. In general terms, simple lipids can be hydrolyzed to two different components, usually an alcohol and an acid. Complex lipids include glycerophospholipids (phospholipids), glyceroqlycolipids (glycolipids), and sphingolipids. These structures yield three or more different compounds on hydrolysis.

2 Source of Lipids in The Diet

In plants, fats are formed from carbohydrates. Thus, when seeds such as sunflower or soybean ripen, their starch content decreases as the fat content increases. The proportion of FA in fat varies from plant to plant, and is also quite variable within a species. Fats from vegetable seeds are among the principal sources of essential FA (EFA), especially of linoleic acid (LA). Vegetable oil obtained from corn, soybean, and sunflower seeds contains less than 15% saturated FA and more than 55% polyunsaturated FA (PUFA). However, not all vegetable oils contain such large amounts of PUFA; for example, the fat contained in olive oil and coconut is less than 10% PUFA.

Animals, including humans, store excess energy almost entirely in deposits of fat, the amount of which is very variable. As in plants, this fat can be made from carbohydrate, but the dietary carbohydrates can be starch, sugar, or cellulose (in ruminants). Animals and humans also lay down fat from their dietary fat. The FA composition in this case reflects that of the diet, except for ruminants whose digestive process normally makes the FA more saturated and/or by isomerization with lower melting point. Animal fats have a high percentage of saturated FA with chain lengths of 14 to 18 carbon atoms. Milk fat contains about 20% 4 ~ 14 carbon FA. This short-chain FA (SCFA) and medium-chain FA (MCFA) content is specific milk fat and is partly responsible for physical properties of butter such as melting point and for its pleasant taste. Beef and pork fats contain about 40% or more of long-chain FA (LCFA) and saturated MCFA. The PUFA content of animal fats, including fish oils, is generally between 4.0% and 30%. But, contrary to other land animals, the storage fat of hibernating animals (e.g., brown or black bear) is rich in PUFA and contains much of linolenic acid (LNA). Differences between the animal and vegetable lipids in relation to composition, digestion, absorption, and in the composition and concentration of sterols incorporated in ingested fat affect the metabolism and composition of fat depots.

3 Lipid Functions

1) Energy Reserve

As humans grow, mature, and age, characteristic changes in body composition occur. These changes are influenced by gender, heredity, stature, and of course, food supply in relation to need. One of these changes involves deposition of fat in adipocytes (fat cells), producing substantial deposits of body fat that can insulate against body heat loss and serve as an energy reserve. Various procedures have been used to measure the size of these adipose deposits, and about 59 million adult Americans have fat stores so large as to be classified as obese. In these individuals, consumption of energy far exceeds their energy expenditure. Fat is an efficient energy storage form because every gram of fat can provide more than twice as much energy in support of body metabolism as can carbohydrate or protein. However, excess body fat is often accompanied by health problems-a serious consequence of too much food and too little exercise. Unfortunately, too little food charac-

terizes the lives of much of the world's population, and the benefits of a substantial body fat store to buffer short periods of food scarcity are not available to them.

2) Thermogenesis

Specialized body fat deposits, with an unusually rich blood vessel supply, have been designated brown adipose tissue. They are characterized by the ability to generate heat in response to food intake or to prolonged cold exposure by a process called nonshivering thermogenesis. Although present in newborns, particularly between the shoulder blades (interscapular area) and useful in elevating body temperature after birth, brown adipose tissue appears to play little role in maintaining the body temperature of human adults.

3) Cell Membrane Structure and Function

Particular fatty acids are found in phospholipids that are critical for cell membrane structure and function. They provide physical support to the membranes, serve as a source of physiologically active compounds, and modulate cross-membrane movement of metabolically active substances.

4) Nutrient Transport

In addition to serving as a source of essential fatty acids, lipids are involved in transport of the lipid-soluble vitamins A, D, E, and K and provitamin A carotenoids.

5) Hormonal Activity

No longer is body fat considered just a source of stored energy. In recent years, white adipose tissue has been shown to secrete over ten peptide hormones-compounds that contain two or more amino acids. By means of these hormones (such as leptin, which affects appetite and the immune system), fat serves also as an endocrine organ, sustaining energy homeostasis through regulation of glucose and lipid metabolism, modulating the immune response, and influencing reproduction.

2.2 参考译文

脂 类

脂类构成了一大类化合物，其化学性质差别很大。脂类所具有的物理、化学和生理特性，使其在营养和食品加工中显得十分重要。脂类对于食品特性具有重要贡献如质感和口感。除了作为食物被消化的脂肪外，还有一些人体自身合成的对生命十分必需的特定脂类。

脂类不溶于水，这很大程度上影响了它们的消化、吸收、在血液中的转运以及在细胞层面的代谢。当脂肪在体内累积时很容易被识别，但给脂肪和脂类进行化学定义是比较难的。和营养相关的有甘油三酯（TAG）、磷脂（PL）、甾醇和一些衍生脂类（指的是通过水解或酶解得到的简单类脂化合物）。

甘油三酯是消化大量脂类的指标。正常的饮食中的第二大脂类（PL），仅占脂肪总摄入量约2%，但每增加12g的PL，会导致24小时的胆汁分泌。其他脂类物质要么含量

非常少对消化和吸收不起作用，或者吸收非常差（例如，蜡和蜡类化合物）。故脂肪酸（FA）是食品脂肪和油、以及贮存在人和动物体内脂肪的主要成分。膳食脂肪中几乎不含有自由 FA；相反，主要以甘油三酯的形式存在。

甘油二酯（DAG）是存在于各种膳食脂肪中次要成分。如果成人每天摄入 1 至 5 克的 DAG，几乎观察不到其营养特征的变化，因为 DAG 仅作为甘油三酯消化和吸收的中间产物被识别。

脂类食品通常含有少量其他脂溶性物质，包括风味成分和一些维生素。动物脂肪可能含有维生素 A 和 D、不同量的胆固醇，而植物脂可能有胡萝卜素、维生素 E 和谷甾醇，但不含胆固醇。

1 脂分类

脂结构的分类根据常温下其物理性能（油是液体和脂肪是固体）、极性（极性脂肪和中性脂肪）、对人类的重要性（必需脂肪酸和非必需脂肪酸）或结构（简单或复杂的）来进行。其中中性脂类包括脂肪酸、醇、酯、甾醇，而极性脂质包括磷脂和甘油糖脂。脂类被分成极性是相当随意的，一些短链脂肪酸是极性的。因此，基于结构的分类是比较好的。根据结构可以将脂类分为派生的、简单的和复杂的。衍生脂类包括脂肪酸和醇，这是简单脂和复杂脂的组成部分。简单脂由脂肪酸和醇组成，包括甘油酯、醚甘油酯、甾醇、甾醇酯和蜡酯。一般来说，简单脂可以水解为两个不同组分，通常是一个醇和一个酸。复杂脂类包括磷脂（磷脂）、甘油糖脂（糖脂和鞘脂）和（神经）鞘脂类，这些结构的脂水解会产生三个或更多种化合物。

2 脂类的食物来源

对于植物而言，脂肪是由碳水化合物转化而来的。因此，当种子（如向日葵和大豆）成熟时，其淀粉含量下降，而伴随着脂肪含量增加。对于同一种植物的不同植株，脂肪中脂肪酸的比例变化也是非常大的。源于蔬菜种子中的脂肪是必需脂肪酸的主要来源之一，特别是亚油酸（LA）。源于玉米、大豆和葵花籽中的植物油包含少于 15% 的饱和脂肪酸以及超过 55% 的多不饱和脂肪酸（PUFA）。然而，并不是所有的植物油中都含有大量多不饱和脂肪酸；例如，橄榄油和椰子所含的脂肪酸小于 10%。

动物（包括人类），多余的能量几乎全部以脂肪的形式储存。脂肪含量是易变的。像植物中，这种脂肪是由碳水化合物转化而来，而膳食碳水化合物可能是淀粉、糖、或纤维素（反刍动物）。动物和人类利用膳食中的脂肪合成脂肪。在这种情况下，FA 组成反映的饮食中的脂肪酸，除了反刍动物的消化过程通常使脂肪酸更饱和/或低熔点脂肪酸异构化。动物脂肪中 14 ~ 18 个碳链长饱和脂肪酸的含量高。乳脂肪中含有的 4 ~ 14 碳原子脂肪酸约 20%。这种短链 FA（SCFA）和中链 FA（MCFA）的含量是牛奶脂肪中特有的，部分程度上影响了黄油的物理性质，例如熔点以及令人愉悦的味道。牛肉和猪肉脂肪中，含有 40% 甚至更多的中长链脂肪酸。动物脂肪（包括鱼油）PUFA 含量，通常是 4.0% 到 30%。但是，和其他陆地动物相比，冬眠的动物储存脂肪（例如棕熊或黑熊）

富含大量 PUFA 和 γ-亚麻酸（LNA）。动物脂和植物脂在组成、消化和吸收方面的存在差异；脂肪消化产物（甾醇）影响储存脂的代谢和组成。

3 脂类功能

1）能量储备

随着人类的生长、成熟和老化，身体组成的特征发生变化。这些变化受遗传、性别、身高和需求的食品供应影响，这些变化涉及脂肪细胞中的脂肪沉积，产生了大量的身体脂肪贮备，这些脂肪可以防止身体散热或作为一个能源储备。各种方法可以用来测量这些脂肪沉积粒的大小。大约 5900 万美国成年人因储存脂肪过多而被列为肥胖。在这些人中，消化吸收的能量远远超过他们的能量开支。脂肪是一种高效的能量存储形式。因为每克脂肪给身体代谢提供的能量相当于碳水化合物或者蛋白质的两倍多。然而，体内多余的脂肪往往会伴随产生健康问题，这就是过多食物和太少锻炼的严重后果。不幸的是，世界上很多人仍过着食物缺乏的生活，对于他们来说，储备大量的脂肪以缓冲短期食品缺乏是不可能的。

2）产热

具有异常丰富的血液供应的特定的体脂肪沉积，被命名为棕色脂肪组织。它们的特点是对于食物摄入后能够产生热量或通过一种叫非颤抖产热来延长冷暴露过程。尽管棕色脂肪组织存在于新生儿（尤其是肩胛骨之间）体内，并且对于提高出生后的身体温度有重要作用，但是它在维持成人体温方面几乎没有什么作用。

3）细胞膜的结构和功能

特定脂肪酸存在于对于细胞膜的结构和功能都重要的磷脂中。特定脂肪酸能够对膜提供物理支持；作为生理活性物的来源；调节的代谢活性物质跨膜运动。

4）营养物质的运输

除了作为一种必需脂肪酸的来源，脂质参与了脂溶性维生素 A，D，E，K 和维生素 A 原类胡萝卜素的运输。

5）激素活性

身体脂肪不再只被当做能量源。近年来，白色脂肪组织已被证明分泌十肽激素，其含有两种或更多的氨基酸。由于这些激素（如影响食欲和免疫系统的瘦蛋白）的存在，脂肪被认为是一种内分泌器官，通过葡萄糖和脂质代谢的调节来维持能量平衡、调节免疫反应以及影响生殖。

3 阅读链接

[1] http://ac.els-cdn.com/B9780123747181100148/

[2] http://www.crcnetbase.com/doi/pdf/10.1201/b10272-12

[3] http://www.crcnetbase.com/doi/pdf/10.1201/b11210-5

[4] http://www.crcnetbase.com/doi/pdf/10.1201/b10501-30

[5] http://www.crcnetbase.com/doi/abs/10.1201/9781420066029.ch3? prevSearch =%255BTitle%253A%2Blipids%255D&searchHistoryKey=

[6] http://www.crcnetbase.com/doi/abs/10.1201/b10272-17? prevSearch=%255BTitle%253A%2Blipids%255D&searchHistoryKey=

[7] http://www.crcnetbase.com/doi/abs/10.1201/b10272-16? prevSearch=%255BTitle%253A%2Blipids%255D&searchHistoryKey=

[8] http://www.crcnetbase.com/doi/pdf/10.1201/b10272-12

4 课后作业

4.1 句子翻译

4.1.1 原句

(1) Lipids are insoluble in water and this profoundly affects the particular phenomena associated with their digestion, absorption, transport in the blood, and metabolism at the cellular level.

(2) Vegetable oils obtained from corn, soybean, and sunflower seed contain less than 15% saturated FA and more than 55% polyunsaturated FA (PUFA).

(3) This short-chain FA (SCFA) and medium-chain FA (MCFA) content is specific for milk fat and is partly responsible for physical properties of butter such as melting point and for its pleasant taste.

(4) Fat is an efficient energy storage form because every gram of fat can provide more than twice as much energy in support of body metabolism as can carbohydrate or protein.

(5) Although present in newborns, particularly between the shoulder blades (interscapular area) and useful in elevating body temperature after birth, brown adipose tissue appears to play little role in maintaining the body temperature of human adults.

(6) By means of these hormones (such as leptin, which affects appetite and the immune system), fat serves also as an endocrine organ, sustaining energy homeostasis through regulation of glucose and lipid metabolism, modulating the immune response, and influencing reproduction.

4.1.2 参考翻译

(1) 脂类不溶于水，这很大程度上影响了它们的消化、吸收、在血液中的转运以及在细胞层面的代谢。

(2) 源于玉米、大豆和葵花籽中的植物油包含少于15%的饱和脂肪酸以及超过55%的多不饱和脂肪酸（PUFA）。

(3) 这种短链FA（SCFA）和中链FA（MCFA）的含量是牛奶脂肪中特有的，部分

程度上影响了黄油的物理性质，例如熔点以及令人愉悦的味道。

（4）脂肪是一种高效的能量存储形式。因为每克脂肪给身体代谢提供的能量相当于碳水化合物或者蛋白质的两倍多。

（5）尽管棕色脂肪组织存在于新生儿（尤其是肩胛骨之间）体内，并且对于提高出生后的身体温度有重要作用，但是它在维持成人体温方面几乎没有什么作用。

（6）由于这些激素（如影响食欲和免疫系统的瘦蛋白）的存在，脂肪被认为是一种内分泌器官，通过葡萄糖和脂质代谢的调节来维持能量平衡、调节免疫反应以及影响生殖。

4.2 科技论文常见句型

(1) The specific nutritional importance of the carbohydrates has been more and more emphasized…

(2) Carbohydrates can be found in …

(3) Carbohydrates can be classified according to several criteria, including those based on the structure and number of sugar molecules, as well as …

(4) The fiber content of carbohydrate foods, which is largely indigestible by humans, plays an important role in …

(5) Lipids form a group of compounds, the chemical nature of which is extremely varied.

(6) TAG represent the bulk of ingested lipids.

(7) Based on structure, lipids can be classified as derived, simple, or complex.

(8) when seeds such as sunflower or soybean ripen, their starch content decreases as the fat content increases.

(9) Vegetable oils obtained from corn, soybean, and sunflower seed contain less than 15% saturated FA and more than 55% polyunsaturated FA (PUFA).

(10) As humans grow, mature, and age, characteristic changes in body composition occur.

(11) Particular fatty acids are found in phospholipids that are critical for cell membrane structure and function.

Unit 3 Vitamins and Minerals

1 专业词汇分析

(1) vitamin n. [生化] 维生素

[记忆窍门] "vita-" 微量的。

(2) mineral n. 矿物质

[记忆窍门] "mine" (矿) + "ral" (名词词尾)。

(3) nutrient n. 营养物，滋养物

[记忆窍门] "nutri" (营养) + "ent" (名词词尾)。

(4) nerve signal n. 神经信号

[记忆窍门] "nerve" 神经；"signal" 信号。

(5) formulate vt. 用公式表示，明确表达

[记忆窍门] "formula" n. 公式；"formu" (公式) + "late" (动词词缀)。

(6) shore up v. 支撑

[记忆窍门] "Shore" n. 海岸，河岸；"shore up" 象河岸一样支撑。

(7) bolster vt. 支撑，支持

(8) interplay vi. 相互影响，相互作用

[记忆窍门] "inter" (相互的) + "play" (起作用)。

(9) micronutrient n. [生化] 微量营养物

[记忆窍门] "micro" (微小的) + "nutri" (营养) + "ent" (名词后缀)。

(10) scurvy n. [内科] 坏血病

(11) blindness n. 失明

[记忆窍门] "blind" adj. 瞎的；"-ness" 名词后缀。

(12) deficiency n. 缺陷、缺点

[拓展] "de" (不足的) + "ficien" (充足的) + "cy" (名词后缀)，efficient adj. 充足的。

(13) rickets n. [内科] 佝偻病

(14) fortified milk n. 强化奶

[拓展] fortify vt. 加强，增强

(15) block vt. 阻止，阻塞

(16) assimilate vt. 吸收，使同化

[记忆窍门] similar adj. 相似的；"as similar" (相似的) + "late" (动词后缀)。

(17) copper n. 铜

(18) minor adj. 次要的，微量的

(19) overload n. 超载 过量

[记忆窍门] 复合词，词头“over-”越过，在…之上，load v. 负载，装载量。

(20) manganese n. [化学] 锰

[拓展] iron 铁；potassium 钾；sulfur 硫

(21) worsen vi. 恶化

[记忆窍门] worse adj. 更坏的，更差的；“-n”使成为动词。

(22) skeletal deformities 骨头畸形

[记忆窍门] 词头“skele-”骨头；skeleton 为 n. 骨头之意，其中“-ton”是名词词尾；“-tal”是形容词词尾；deform adj. 畸形的。

(23) water-soluble vitamins n. 水溶性维生素

(24) packed into 充满

(25) bloodstream n. [生理] 血流，血液的流动

[记忆窍门] “blood”（血液）+“stream”（溪流）。

(26) digestion n. 消化

[记忆窍门] digest vt. 消化；“tion”是名词词尾。

(27) shunt vt. 使分流，使转轨

(28) urine n. 尿，kidney；n. [器官] 肾

(29) regulate vt. 调节，规定

(30) biotin n. [生化] 生物素；riboflavin n. [生化] 核黄素；folic acid n. [生化] 叶酸；thiamin n. [生化] 硫胺；niacin n. [生化] 烟酸；pantothenic acid n. [生化] 泛酸

(31) coenzyme n. [生化] 辅酶

[记忆窍门] “co-”（辅助的）+“enzyme”（酶）。

(32) blood vessel walls n. 血管壁

[记忆窍门] “blood”（血液）+“vessel”（脉管）+“wall”（墙壁，似墙之物）。

(33) metabolise vt. 使新陈代谢

[记忆窍门] “metabo-”是新陈代谢的词头，+“lise”成为动词；“metabo”（新陈代谢）+“lism”（名词后缀）= n. [生理] 代谢；“Metabo”+“lic”（形容词后缀）= adj. 新陈代谢的，变化的。

(34) multiply vi. 增殖，繁殖

[记忆窍门] 词缀“Multi”，表示多。

(35) Replenish vt. 补充，再装满

[记忆窍门] 词头“re”（重新）+“plenish”（给装备）。

(36) lymph channels 淋巴管道

［记忆窍门］lymph n. ［解剖］淋巴；channel n. 通道，管路。

（37）intestinal adj. 肠的

［记忆窍门］intestine n. ［解剖］肠；intestin+“al”（形容词词缀，为“肠的”之意。

（38）escort vt. 护送，携带

（39）reservoir n. 水库，储藏

［记忆窍门］reserve n. 保存，vt. 储备。“reserv”+“oir”（后缀，为“储存的容器”之意）。

（40）gastrointestinal adj. 胃肠道的

［记忆窍门］“gastro-” adj. 胃的；intestinal n. 肠。

（41）vision n. 视力

［记忆窍门］“vis-”（前缀，为“视觉的”之意）+“ion”（名词后缀）。

（42）major mineral n. 常量矿物质；minor mineral n. 微量矿物质

［记忆窍门］“major”主要的；“minor”次要的，较小的。

（43）hamper vt. 妨碍

（44）excrete vt. 排泄 分泌

［记忆窍门］“ex-”排出；“crete-”产生。

（45）thimble n. 套管

（46）immune response n. ［生理］免疫反应

［记忆窍门］“immu-”（免疫单位）+“une”；“re”（相互）+“-sponse”（有反应）。

（47）hemoglobin n. ［生理］血红蛋白

［记忆窍门］“hemo”（出血）+“glo”（球）+“bin”（球蛋白）。

（48）ferry vi. 渡运

（49）decay vi. 腐烂 腐坏

［记忆窍门］“de”（降解）+“cay”。

（50）exacerbate vt. 使加剧，使恶化

［记忆窍门］“acerbate” vt. 使发怒，使烦恼；“ex”（超过）+“acerbate”，更加加剧、恶化。

（51）thyroid n. 甲状腺；adj. 甲状腺的

（52）hormone n. 激素

［记忆窍门］“hormon-”荷尔蒙。“hormon”+“al”（形容词后缀） adj. 荷尔蒙的。

（53）sluggishness n. 迟缓，惰性

［记忆窍门］“slug” vi. 偷懒，动作迟缓；“-ness”名词后缀。

2 课文

2.1 原文

Vitamins and Minerals

1 Key Points

(1) Vitamins and minerals are essential nutrients because they perform hundreds of roles in the body.

(2) There is a fine line between getting enough of these nutrients (which is healthy) and getting too much (which can end up harming you).

(3) Eating a healthy diet remains the best way to get sufficient amounts of the vitamins and minerals you need.

2 Essential Nutrients for Your Body

Every day, your body produces skin, muscle, and bone. It churns out rich red blood that carries nutrients and oxygen to remote outposts, and it sends nerve signals skipping along thousands of miles of brain and body pathways. It also formulates chemical messengers that shuttle from one organ to another, issuing the instructions that help sustain your life.

But to do all this, your body requires some raw materials. These include at least 30 vitamins, minerals, and dietary components that your body needs but cannot manufacture on its own in sufficient amounts.

Vitamins and minerals are considered essential nutrients—because acting in concert, they perform hundreds of roles in the body. They help shore up bones, heal wounds, and bolster your immune system. They also convert food into energy, and repair cellular damage.

But trying to keep track of what all these vitamins and minerals do can be confusing. Read enough articles on the topic, and your eyes may swim with the alphabet-soup references to these nutrients, which are known mainly be their initials (such as vitamins A, B, C, D, E and K to name just a few).

3 Micronutrients with a Big Role in the Body

Vitamins and minerals are often called micronutrients because your body needs only tiny amounts of them. Yet failing to get even those small quantities virtually guarantees disease. Here are a few examples of diseases that can result from vitamin deficiencies:

(1) Scurvy: Old-time sailors learned that living for months without fresh fruits or vegetables-the main sources of vitamin C-causes the bleeding gums and listlessness of scurvy.

(2) Blindness: In some developing countries, people still become blind from vitamin A deficiency.

(3) Rickets: A deficiency in vitamin D can cause rickets, a condition marked by soft, weak

bones that can lead to skeletal deformities such as bowed legs. Partly to combat rickets, the U. S. has fortified milk with vitamin D since the 1930s.

1) The Difference between Vitamins and Minerals

Although they are all considered micronutrients, vitamins and minerals differ in basic ways. Vitamins are organic and can be broken down by heat, air, or acid. Minerals are inorganic and hold on to their chemical structure.

So why does this matter? It means the minerals in soil and water easily find their way into your body through the plants, fish, animals, and fluids you consume. But it's tougher to shuttle vitamins from food and other sources into your body because cooking, storage, and simple exposure to air can inactivate these more fragile compounds.

2) Interacting—In Good Ways and Bad

Many micronutrients interact. Vitamin D enables your body to pluck calcium from food sources passing through your digestive tract rather than harvesting it from your bones. Vitamin C helps you absorb iron.

The interplay of micronutrients isn't always cooperative, however. For example, vitamin C blocks your body's ability to assimilate the essential mineral copper. And even a minor overload of the mineral manganese can worsen iron deficiency.

3) A Closer Look at Water-Soluble Vitamins

(1) Water-soluble vitamins are packed into the watery portions of the foods you eat. They are absorbed directly into the bloodstream as food is broken down during digestion or as a supplement dissolves. Because much of your body consists of water, many of the water-soluble vitamins circulate easily in your body. Your kidneys continuously regulate levels of water-soluble vitamins, shunting excesses out of the body in your urine. Water-soluble vitamins including B vitamins: Biotin (vitamin B_7) Riboflavin (vitamin B_2) Folic acid (folate, vitamin B_9) Thiamin (vitamin B_1) Niacin (vitamin B_3) Vitamin B6 Pantothenic acid (vitamin B_5); Vitamin B_{12}; Vitamin C.

(2) What they do. Although water-soluble vitamins have many tasks in the body, one of the most important is helping to free the energy found in the food you eat. Others help keep tissues healthy.

(3) Words to the wise. Contrary to popular belief, some water-soluble vitamins can stay in the body for long periods of time. You probably have several years'supply of vitamin B_{12} in your liver. And even folic acid and vitamin C stores can last more than a couple of days.

Generally, though, water-soluble vitamins should be replenished every few days. Just be aware that there is a small risk that consuming large amounts of some of these micronutrients through supplements may be quite harmful. For example, very high doses of B_6—many times the recommended amount of 1.3 milligrams (mg) per day for adults—can damage nerves, causing

numbness and muscle weakness.

4) A Closer Look at Fat-soluble Vitamins

(1) Rather than slipping easily into the bloodstream like most water-soluble vitamins, fat-soluble vitamins gain entry to the blood via lymph channels in the intestinal wall. Many fat-soluble vitamins travel through the body only under escort by proteins that act as carriers. Fatty foods and oils are reservoirs for the four fat-soluble vitamins. Within your body, fat tissues and the liver act as the main holding pens for these vitamins and release them as needed.

To some extent, you can think of these vitamins as time-release micronutrients. It's possible to consume them every now and again, perhaps in doses weeks or months apart rather than daily, and still get your fill. Your body squirrels away the excess and doles it out gradually to meet your needs. Fat-soluble: Vitamin A, vitamins D, Vitamin E, Vitamin K

(2) What they do. Together this vitamin quartet helps keep your eyes, skin, lungs, gastrointestinal tract, and nervous system in good repair. Here are some of the other essential roles these vitamins play: ①Build bones. Bone formation would be impossible without vitamins A, D, and K. ②Protect vision. Vitamin A also helps keep cells healthy and protects your vision. ③Interact favorably. Without vitamin E, your body would have difficulty absorbing and storing vitamin A. ④Protect the body. Vitamin E also acts as an antioxidant (a compound that helps protect the body against damage from unstable molecules).

3) Words to the Wise

Because fat-soluble vitamins are stored in your body for long periods, toxic levels can build up. This is most likely to happen if you take supplements. It's very rare to get too much of a vitamin just from food.

5) A closer look at major minerals

(1) The body needs, and stores, fairly large amounts of the major minerals. These minerals are no more important to your health than the trace minerals; they're just present in your body in greater amounts. Major minerals travel through the body in various ways. Potassium, for example, is quickly absorbed into the bloodstream, where it circulates freely and is excreted by the kidneys, much like a water-soluble vitamin. Calcium is more like a fat-soluble vitamin because it requires a carrier for absorption and transport. Major minerals including phosphorus, sulfur, magnesium, sodium, potassium, chloride, calcium

(2) What they do. One of the key tasks of major minerals is to maintain the proper balance of water in the body. Sodium, chloride, and potassium take the lead in doing this. Three other major minerals-calcium, phosphorus, and magnesium-are important for healthy bones. Sulfur helps stabilize protein structures, including some of those that make up hair, skin, and nails.

(3) Words to the wise. Having too much of one major mineral can result in a deficiency of

another. These sorts of imbalances are usually caused by overloads from supplements, not food sources. Here are two examples: ①Salt overload. Calcium binds with excess sodium in the body and is excreted when the body senses that sodium levels must be lowered. That means that if you ingest too much sodium through table salt or processed foods, you could end up losing needed calcium as your body rids itself of the surplus sodium. ②Excess phosphorus. Likewise, too much phosphorus can hamper your ability to absorb magnesium.

6) A Closer Look at Trace Minerals

(1) A thimble could easily contain the distillation of all the trace minerals normally found in your body. Yet their contributions are just as essential as those of major minerals such as calcium and phosphorus, which each account for more than a pound of your body weight. Trace minerals: Chromium, Manganese, Copper, Molybdenum, Fluoride, Iodine, Zinc, Selenium, Iron.

(2) What They Do. Trace minerals carry out a diverse set of tasks. Here are a few examples: ①Iron is best known for ferrying oxygen throughout the body. ②Fluoride strengthens bones and wards off tooth decay. ③Zinc helps blood clot, is essential for taste and smell, and bolsters the immune response. ④Copper helps form several enzymes, one of which assists with iron metabolism and the creation of hemoglobin, which carries oxygen in the blood.

The other trace minerals perform equally vital jobs, such as helping to block damage to body cells and forming parts of key enzymes or enhancing their activity.

(3) Words To The Wise

Trace minerals interact with one another, sometimes in ways that can trigger imbalances. Too much of one can cause or contribute to a deficiency of another. Here are some example: ①A minor overload of manganese can exacerbate iron deficiency. Having too little can also cause problems. ②When the body has too little iodine, thyroid hormone production slows, causing sluggishness and weight gain as well as other health concerns. The problem worsens if the body also has too little selenium.

The difference between 'just enough' and 'too much' of the trace minerals is often tiny. Generally, food is a safe source of trace minerals, but if you take supplements, it's important to make sure you're not exceeding safe levels.

2.2 参考译文

维生素与矿物质

1 文章要点

(1) 维生素和矿物质是必不可少的营养素，因为它们在人体内起着各种各样的作用。

(2) 获得到足够的营养物质（这是健康的），还是吃得太多（这可能最终伤害你），有明确的界限。

（3）吃健康的饮食仍然是获得足够的维生素和矿物质的最好方式。

2 身体中重要的营养素

每天，你身体的皮肤、肌肉和骨骼都在生长。产生丰富的红色血液，把营养物质和氧气输送到较远的部位。它沿着数千英里的大脑和身体的途径发送神经信号。它还能产生化学信号，信号从一个器官输送到另有一个器官，发出的指令帮助你维持生命活动。

但要做到这一切，你的身体需要一些原料。这些包括至少 30 种维生素、矿物质和膳食组件。你的身体需要这些物质，但不能自行制造足够的数量。

维生素和矿物质被认为是必不可少的营养素。通过协调行动，它们在体内执行着数百个重要的功能。它们帮助支撑骨骼、愈合伤口，并增强你的免疫系统。它们还将食物转化为能量，修复细胞损伤。

试图跟踪所有的维生素和矿物质是如何起作用是很复杂的事情。当你阅读相关的文章时，你会发现这些物质经常出现在你的眼前，并且总是以它们的首字母出现（比如，维生素 A、B、C、D、E、K 等，这仅仅是一小部分）。

3 体内重要的微量元素

维生素和矿物质通常被称为微量元素，因为你的身体对它们的需求量很小。但是如果未能摄取这微量的成分，也肯定会导致疾病。这里有几个维生素缺乏造成疾病的例子。

（1）坏血病：古代的水手们在海上生活几个月，因为没有新鲜水果或蔬菜，会因为缺乏维生素 C 而导致坏血病，出现牙龈出血和无精打采的症状。

（2）失明：在一些发展中国家，仍然有人们因为维生素 A 缺乏导致失明。

（3）佝偻病：缺乏维生素 D 会导致佝偻病。这一种疾病的特点是骨头又软又脆弱，会导致骨骼发育畸形，比如出现弓形弯曲的腿。为了对抗佝偻病，美国自 19 世纪 30 年代就使用维生素 D 营养强化奶。

1）维生素和矿物质之间的区别

虽然维生素和矿物质都被认为是微量元素，但是它们有着本质的不同。维生素是有机物，可以被高温、空气或酸分解。矿物质是无机物，化学结构非常稳定。这些有什么关系呢？这表明矿物质很容易从你吃的植物、鱼其他动物和液体中进入到身体里的。但是很难把维生素从你吃的食物或者其他来源运送到你的身体里。因为烹饪、存储和单纯的暴露在空气中就可使这些脆弱的化合物失去活性。

2）好的和坏的反应

许多微量元素进行交互反应。维生素 D 可以将经过消化道的食物中的钙抽提出来，而不是从骨头中获得。维生素 C 可以帮助你吸收铁。然而微量元素之间并不总是合作的。例如维生素 C 会阻碍你的身体吸收铜这种重要的矿物质。只是微量的锰过量就会加重铁的缺乏。

3）水溶性维生素

（1）你所吃的食物的水溶性部分有大量的水溶性维生素。在消化或补充溶解时，食

物被分解，水溶性维生素直接被吸收进入血液。因为你身体的大部分是由水组成，许多水溶性维生素很容易在你的身体中流通。你的肾脏不断调节水溶性维生素水平，多余的部分从尿液中被排出体外。水溶性维生素包括：B 族维生素有：生物素、核黄素、叶酸（维生素 B_9）、硫胺（维生素 B_1）、烟酸（维生素 B_3）、维生素 B_6、泛酸（维生素 B_5）；维生素 B_{12}；维生素 C。

（2）水溶性维生素的作用。虽然水溶性维生素在身体中有很多任务，最重要任务之一是把你吃的食物中的能量释放出来，还包括帮助保持组织健康。

（3）建议。与大众的看法相反，一些水溶性维生素在体内能保持很长一段时间。你肝脏中的维生素 B_{12}可以维持数年之久。甚至是叶酸和维生素 C 的储存也可以持续超过数日。

一般来说，水溶性维生素应该每隔几天补充一下。只是要注意一个小的风险，通过食用补养品摄入大量的微量营养素是相当有害的。例如，成人每天建议食用量维生素 B_6 为 1.3 mg，如果服用非常高剂量的维生素 B_6——数倍于推荐量，会损伤神经，导致麻木和肌肉无力。

4）脂溶性维生素

（1）与很容易进入血流中的水溶性维生素不同，脂溶性维生素必须通过肠壁的淋巴通道才能进入血液中。许多脂溶性维生素只有在载体蛋白质的携带下才能进入人体。脂肪和食用油是脂溶性维生素的四个水库。在你的身体中，脂肪组织和肝脏是这些维生素主要储存处，需要时会释放出来。

在某种程度上，你可以认为这些维生素是定时释放的微量营养素。可以经常补充维生素，不必要每天都补充，可以每隔几周或几个月，仍然可以得到补充。你的身体会排除掉多余的部分来满足身体的需求。脂溶性维生素是指：维生素 A、D、E 和 K。

（2）所起的作用。这些维生素综合在一起有助于保持你的眼睛、皮肤、肺、胃肠道和神经系统的良好修复，以下是这些维生素其他的重要作用：①构建骨骼。如果没有维生素 A、D、K，骨骼形成是不可能的。②保护视力。维生素 A 也有助于保持健康，保护你的视觉细胞。③顺利地反应。没有维生素 E，你的身体很难吸收和储存维生素 A。④保护身体。维生素 E 可以作为抗氧化剂（帮助身体减少不稳定分子带来的损伤）。

（3）建议。因为脂溶性维生素可以在你的身体是储存很长一段时间，所以产生的毒素数量也会增大。这种情况最有可能发生在你食用了营养补品之后，仅从食品中获取维生素一般不会出现过量的情况。

5）常量矿物质

（1）身体需要和储存了相当大量的常量矿物质。这些矿物质对你的健康并不比微量矿物质更重要，它们只是大量的存在于你的身体里。常量矿物质以不同的方式在身体中运行。例如钾很像水溶性维生素一样，被迅速地吸收进入血液，在那里自由地流通，然后从肾脏排出。钙更像脂溶性维生素，因为它的吸收和运输需要载体。常量矿物质：磷、

硫、镁、钠、钾、氯化物、钙。

（2）所起作用。常量矿物质维持体内水的平衡。钠、氯和钾带头起作用，其他三个种常量矿物质-钙、磷、镁对骨骼的健康非常重要。硫帮助稳定蛋白质的结构，其中的部分蛋白质组成了头发、皮肤和指甲。

（3）建议。某种常量矿物质摄入太多，会导致另一种矿物质缺乏。这类失衡通常是因为食用了营养补品，而不是因为食物。这里有两个例子：①盐过量。身体感觉到钠的水平需要降低的时候，钙可以和体内多余的钠结合，结合物被排出。这意味着如果你从食盐或加工的食物中摄入过多的钠，在排除过多的钠的过程中，你的身体会同时失去所需要的钙。②过量磷。同样，磷过多会阻碍你吸收镁的能力。

6）微量矿物质

（1）虽然每种常量矿物质如钙和磷会占你体重的一磅，并且一个套管便可以容纳下你身体中所含的微量矿物质，然而它们的贡献与常量矿物质一样重要。微量元素：铬、锰、铜、钼、氟、碘、锌、硒、铁。

（2）所起的作用。微量元素担任不同类型的任务。以下是几个例子：①铁的功能是运送氧气到全身。②氟化物可以增强骨骼，避免牙齿腐蚀。③锌有助于血液凝结，对味觉和嗅觉很重要，支持免疫反应。④铜有助于几种酶的形成，其中一种酶协助铁代谢，生成血液中携带氧的血红蛋白。

其他微量元素执行同样重要的工作，比如有助于保护身体细胞免受破坏，形成关键酶的组成部分或提高它们的活性。

（3）建议。微量元素相互作用，有时候有些方式可以触发失衡。某一种太多会引起或导致另一个的缺乏。下面是一些例子：①轻微镁过量会导致缺铁，而镁太少也会导致问题。②当身体有太少的碘，甲状腺激素生产放缓，导致行动迟缓，体重增加以及其他健康问题。缺硒会使这种情况更加恶化。

“足够的”和“太多”的微量矿物质的区别很小。一般来说，食物是安全的微量矿物质来源，但如果你吃补品，确保不超过安全水平就至关重要了。

3 阅读链接

[1] http://ods.od.nih.gov/factsheets/list-Vitamins Minerals/

[2] http://www.who.int/nutrition/publications/micronutrients/9241546123/en/

[3] http://www.webmd.com/food-recipes/guide/vitamins-and-minerals-good-food-sources

4 课后作业

4.1 句子翻译

4.1.1 原文

(1) Vitamins and minerals are often called micronutrients because your body needs only tiny amounts of them. Yet failing to get even those small quantities virtually guarantees disease.

(2) The interplay of micronutrients isn't always cooperative, however. For example, vitamin C blocks your body's ability to assimilate the essential mineral copper.

(3) Although water-soluble vitamins have many tasks in the body, one of the most important is helping to free the energy found in the food you eat. Others help keep tissues healthy.

(4) Rather than slipping easily into the bloodstream like most water-soluble vitamins, fat-soluble vitamins gain entry to the blood via lymph channels in the intestinal wall

(5) Calcium is more like a fat-soluble vitamin because it requires a carrier for absorption and transport.

4.1.2 参考翻译

(1) 维生素和矿物质通常被称为微量元素，因为身体对它们的需求量很小。但是如果未能摄取这微量的成分，肯定会导致疾病。

(2) 例如维生素 C 会阻碍你的身体吸收铜这种重要的矿物质。只是微量的锰过量就会加重铁的缺乏。

(3) 虽然水溶性维生素在身体中有很多任务，最重要任务之一是把你吃的食物中的能量释放出来，还包括帮助保持组织健康。

(4) 与很容易进入血流中的水溶维生素不同，脂溶性维生素必须通过肠壁的淋巴通道才能进入血液中。

(5) 钙更像脂溶性维生素，因为它的吸收和运输需要载体。

4.2 科技论文常见句型

4.2.1 研究现状

People have reported a variety of …

Nevertheless, … remains unclear.

4.2.2 研究目的

We used data from … to …

4.2.3 定义概念

Sth is defined as …

The poverty-income ratio (PIR) was defined as …

4.2.4 实验分组

Sth was categorized as follows …

Sth were divided into …, as seen in the following tabulation …

4.2.5 数量描述

This number is equivalent to …

4.2.6 表格结果描述

Table 1 and Table 2 show(that)…

4.2.7 结果描述(experiment description)

Of those taking vitamin and mineral supplements, 43% were male and 57% were female; the mean age of those taking vitamin and mineral supplements was 37 years …

From these experiments we can conclude that …

We found that 62.1% of all folic acid users …

4.2.8 结果的意义

These results suggests that …

4.2.9 导致结论

Further study to … could prove valuable.

Chapter 2　Food Chemistry

Unit 1　Food Additives

1　专业词汇分析

（1）acidulant　n. 酸化剂

［记忆窍门］“acid”，酸，酸的；“lant”，陈化尿液（用于清洁地板）。

（2）additive　n. 添加剂

［记忆窍门］“add”，添加，增加；“-ive”，构成形容词的后缀。该词有形容词和名词两个词性，此处是名词。

（3）anti-browning agent　抗褐变剂

［记忆窍门］“anti-”，表示“反”、“抗”意思的词前缀；“brown”，褐色，变成褐色；“agent”，药剂。

（4）antifoaming agent　消泡剂

［记忆窍门］“anti-”，表示“反”、“抗”意思的词前缀；“foam”，泡沫，起泡；“agent”，药剂。

（5）antimicrobial　n. 抗微生物剂

［记忆窍门］“anti-”，表示“反”、“抗”意思的词前缀；“micro”，微小，微米；“microbial”，微生物的。

（6）metallic aftertaste　金属后味

［记忆窍门］“metal”，金属，金属的，以金属覆盖；“-lic”，构成形容词的后缀；“after”，在…之后；“taste”，味道，品尝。

（7）aspartame　n. 阿斯巴甜，又名天冬甜素

［记忆窍门］“aspart”，天冬胰岛素，诺和锐；“tame”，驯服，使具有。

（8）mono and diglyceride　甘油单脂和甘油二脂物

［记忆窍门］“mono-”，单个，单一；“di-”，双的，两个；“glycine”，甘氨酸；“glyceride”，甘油脂。

（9）aspartic acid　天门冬氨酸

［记忆窍门］“aspart”，天冬胰岛素，诺和锐；“-ic”，构成形容词的后缀；“acid”，酸，酸的。

（10）monosodium glutamate　n. 谷氨酸钠，味精

［记忆窍门］“mono-”，单个，单一；“sodium”，钠；“gluta”，戊二醛；“mate”，结

伴，伙伴。

（11）autoxidation n. 自动氧化

［记忆窍门］“auto-”，汽车，自动；“oxid”，氧化，氧化物；“-ation”，构成名词的后缀。

（12）neotame n. 纽甜

［记忆窍门］“neo”，“new”的变形；“-tame”，驯服，使具有。

（13）coagulant-bittern n. 盐卤凝固剂

［记忆窍门］“coagu”，凝结；“coagu lation”，混凝；“lant”，陈化尿液；“bitter”，苦味，苦啤酒；“bittern”，盐卤。

（14）non-caloric adj. 无热值的

［记忆窍门］“non”，非，无；“calorie”，卡路里；“-c”，构成形容词的后缀。

（15）bulking agent 填充剂

［记忆窍门］“bulk”，体积，使变大；“-ing”，构成名词的后缀；“agent”，药剂。

（16）non-enzymatic adj. 非酶的

［记忆窍门］“non-”，非，无；“enzy”，酶；“-matic”，以…方式，构成形容词的后缀。

（17）chelating agent 螯合剂

［记忆窍门］“chelate”，螯合物，使结合成螯合物；“-ing”，构成名词的后缀；“agent”，药剂。

（18）nucleotide n. 核苷酸

［记忆窍门］“nucleus”，核；“nucleo”，核苷酸钠；“-tide”，具备…方式，构成名词的后缀。

（19）nitrite n. 亚硝酸盐

［记忆窍门］“nitro”，硝基；“nitri”，硝酸。

（20）nutraceutical adj. 保健品

［记忆窍门］“nutrition”，营养品；“nutra”，保健品；“ceutical”，药剂，凝露。

（21）coloring agent n. 着色剂

［记忆窍门］“color”，颜色，着色；“-ing”，构成名词的后缀；“agent”，药剂。

（22）nutritional deficiency 营养缺乏

［记忆窍门］“nutri”，营养，喂养；“-tion”，构成名词的后缀；“-al”，构成形容词的后缀；“de-”，构成反义词的前缀；“ficient”，吸收。

（23）phosphate n. 磷酸盐

［记忆窍门］“phos”，无机磷；磷酸盐；“phate”，酸式硫酸盐。

（24）dipeptide n. 二肽

［记忆窍门］“di-”，双，二；“pepsin”，胃蛋白酶；“peptide”，缩氨酸，肽。

（25）processing aid　n. 加工助剂

［记忆窍门］“pro-”，支持的，词的前缀；“process”，过程，加工；“-ing”，构成名词的后缀；“aid”，援助，帮助。

（26）propellant　n. 推进剂

［记忆窍门］“propel”，推进，驱使；“lant”，陈化尿液（用于清洁地板）。

（27）dough conditioner　面团改良剂

［记忆窍门］“dough”，生面团；“condition”，条件，使适应，使健康；“-er”，构成名词的后缀。

（28）proteinaceous material　蛋白质类物质

［记忆窍门］“protein”，朊，蛋白质；“-aceous”，具有，构成形容词的后缀；“material”，材料，原料，物质。

（29）fermentation　n. 发酵

［记忆窍门］“ferment”，酵素，使发酵；“-ation”，构成名词的词尾。

（30）rancidity　n. 酸败，腐败，臭败

［记忆窍门］“free radicals”，“radicals”，根基，自由基。

（31）emulsifier　n. 乳化剂

［记忆窍门］“emulsum”，拉丁文“乳剂”；“-sion”，构成名词的后缀；“emulsion”，乳剂，乳液；“-ify”，构成动词的后缀；“-er”，构成名词的后缀，再变成名词。

（32）rhizome　n. 根茎

（33）fat replacer　脂肪替代物

［记忆窍门］“fat”，脂肪，肥肉；“replace”，代替，取代；“-r（-er）”，构成名词的后缀。

（34）saccharin　n. 糖精

［记忆窍门］“sac”，囊，液囊；“charin”，糖精。

（35）flavor enhancer　风味增强剂

［记忆窍门］“flav”，黄色的，黄素；“-or”，构成名词的后缀；“flavor”，风味，滋味；“en-”，使成为，构成动词的前缀；“hance”，拥有；“-er”，构成名词的后缀。

（36）snack　n. 点心，小吃，快餐

［记忆窍门］“snack”，拉丁文“部分、片”。

（37）flavor agent　风味剂

［记忆窍门］“flavor”，风味，滋味；“agent”，药剂。

（38）sodium nitrite　亚硝酸盐

［记忆窍门］“sodium”，钠；“nitri”，硝酸。

（39）frozen food　冷冻食品

［记忆窍门］“froz”，速冻；“-en”，构成形容词的后缀；“frozen”，冷冻的，结冰。

(40) sodium silicoaluminate 铝硅酸钠

[记忆窍门] "sodium", 钠; "silico", 硅胶, 硅橡胶; "alumi", 铝; "-nate", 使具有; "silicoaluminate", 硅铝化合物。

(41) fructans n. 果聚糖

[记忆窍门] "fruit", 水果, 产物; "fruct", 使结果; "tans", 褐色, 使变成褐色, 鞣革。

(42) sodium sulfite 亚硫酸钠

[记忆窍门] "sodium", 钠; "sulfit", 硫化物; "sulfite", 亚硫酸盐。

(43) humectant n. 湿润剂

[记忆窍门] "humid", 潮湿的, 湿润的; "ctant", 常量。

(44) soya protein 大豆蛋白

[记忆窍门] "soya", 大豆, 黄豆; "protein", 蛋白质。

(45) ice cream 冰激凌

[记忆窍门] "ice", 冰; "cream", 奶油, 乳酪。

(46) stabilizer n. 稳定剂

[记忆窍门] "stable", 马厩, 稳定的; "-iz", 构成动词的后缀; "-er", 构成名词的后缀。

(47) non-toxic n. adj. 无, 无毒的

[记忆窍门] "non-", 非, 不, 词的前缀; "tox", 毒药; "-ic", 构成形容词的词尾; "toxic", 有毒的。

(48) steroyl-2-lactylate n. 硬脂酰-2-乳酸盐

[记忆窍门] "steroyl", 硬脂酰, 十八烷酰; "lactate", 乳酸钠。

(49) iodine n. 碘

[记忆窍门] "dine", 宴请, 进餐。

(50) surface finishing agent 表面光滑剂

[记忆窍门] "face", 面, 面对; "surface", 表面; "finishing", 完成, 最终; "agent", 药剂。

(51) lecithin n. 卵磷脂

[记忆窍门] "lecithic", 有卵黄的。

(52) texturizing agent n. 增稠剂

[记忆窍门] "textur", 组织, 纹理; "-ize" (-iz), 构成动词的后缀; "-ing", 构成名词的后缀; "agent", 药剂。

(53) low-calorie adj. 低热量的

[记忆窍门] "low", 低的; "calorie", 卡路里, 热量。

(54) volatile flavor oil 挥发性风味油

［记忆窍门］“volat”，变异性；“tile”，瓦片，瓦片式显示；“volatile”，易挥发的，不稳定的；“flavor”，滋味，味道；“oil”，油，油脂。

（55）lubricant n. 润滑剂

［记忆窍门］“lubricate”，润滑，涂油；“cant”，去掉棱角。

（56）water-holding capacity 持水性，持水能力

［记忆窍门］“water”，水；“holding”，保持，支持；“capable”，有能力的；“capacity”，能力。

（57）meat product 肉制品

［记忆窍门］“meat”，肉，肉类；“product”，产品，结果。

（58）metabolism n. 新陈代谢

［记忆窍门］“metabolite”，代谢物；“-ism”，构成名词的词尾。

2 课文

2.1 原文

Food Additives

Food additives may be defined as a class of substances that are used in food production, processing, storage and packaging to extend shelf-life of purpose and to meet the processing needs for improving quality, color, flavor and taste. It is of significance to use food additives correctly to improve food quality, prevent food spoilage.

It's a long history of human use of food additives. The ancient Chinese had fruit and vegetable juice colored rice cake. In 1500B. C, Egypt's tombstone depicted the candy colored. Chinese began to use food coagulant-bittern to make bean curd from the Eastern Han Dynasty and the method is still in use today. Nitrite was used as the meat preservation and color development for bacon production in the Southern Song Dynasty and the way came to Europe in 13th Century. With the development of science and technology, especially the chemical industry technology progress, many chemical additives are produced, which are far better than those of natural substances, such as preservative, antioxidant, various synthetic perfume and edible pigment etc. Variety, scope and content of the use of food additives all increased rapidly. Food additives has become an indispensable part of modern food industrial production, even it has developed into an independent industry. There are more than 14000 kinds of food additives used in the world. Among them, there are more than 4000 kinds for directly using, about 80% are spices. The FAO/WHO has published more than 700 kinds of food additives. The number is more than 400 by EEC while 700 by U. S. In our country, there are 1460 kinds that can fit into the international standard and 936 of them are spices, accounting for 64.1%.

1 Classification

1) More Classification Methods

Natural food additives and artificial chemical synthesis products create two categories. Natural food additives are two types, one is made of animal and plant extract and the other by the method of biotechnology by fermentation or by enzyme. Artificial chemical additives might be divided into two kinds too, general synthetic chemicals and artificial synthesis of natural equivalent such as natural equivalent spices, natural equivalent pigment, etc.

Food additives can be classified into twenty-one kinds according to their major functions. They are acidity regulator, anti caking agent, defoaming agent, antioxidant, bleach, raising agent, gum base agent, colorant, color retention agent, emulsifiers, enzymes, flavor enhancer, flour treatment agent, film agent, water retention agent, nutrition enhancer, preservatives, stability and curing agent, sweetener and thickener, etc. We will introduce seven major categories following.

2) Preservative

There are basically three types of preservatives used in foods: antimicrobials, antioxidants, and all anti-browning agents. These additives are used to check or prevent the growth of microorganisms. Antimicrobials play a major role in extending the shelf-life of numerous snack an convenience foods and have come into even greater use in recent years as microbial food safety concerns have increased.

The antioxidants are used to prevent lipid and vitamin oxidation in food products. They are used primarily to prevent oxidation and subsequent development of rancidity and off-flavor. They vary from natural substances such as vitamins C and E to synthetic chemicals such as butylated hdroxyanisole(BHA) and butylated hydroxytoluene(BTH). The antioxidants are especially useful in preserving dry and frozen foods for an extended period of time.

Anti-browning agents are chemicals used to prevent both enzymatic and non-enzymatic browning in food products, especially dried fruits or vegetables. Vitamin C, citric acid, sodium sulfite are the most commonly used additives in the category.

3) Nutrition Additives

Nutritional additives have increased in use in recent years as consumers have become more concerned about and interested in nutrition. Vitamins, which are also used in some cases as preservatives, are commonly added to cereals and cereal products to restore nutrients lost in processing or to enhance the overall nutritive value of the food. The addition of vitamin D to milk and of B vitamin to bread has been associated with the prevention of major nutritional deficiencies in the United States. Minerals such as iron and iodine have also been of extreme value in preventing nutritional deficiencies. Like vitamins, the primary use of minerals is in cereal products.

Amino acids and other proteinaceous are not commonly used in foods. However, lysine is

sometimes added to cereals to enhance protein quality. Proteins or proteinaceous materials such as soya protein are also sometimes as nutritional additives, although they are most commonly used as texturizing agents.

Fiber additives have seen increased popularity in recent years with the increase in consumer interest in dietary fiber. Various cellulose, pectin, and starch derivatives have been used for this purpose. Recently, naturally derived fiber from apples and other fruits as well as sugar beets has been introduced as a fiber additive. Fiber additives are not well defined and in reality have little or no direct nutritional value, although they do have indirect nutritional benefits.

The number of food additives used for special dietary purposes has increased significantly in recent years with an emphasis on the replacement of fat to reduce calories. Fat replacers include many texturizing agents and include carbohydrate, protein, and fat-based systems.

The increased interest in nutrition has also led to the rapid growth of the functional food or nutraceutical industry with the development of several additives for the purpose of enhancing overall health.

4) Sweetener

Sweetener refers to the substances can give food to sweet. It can be classified into natural sweetener and artificial sweetener according to the source. Natural sweetener refers to be the material of carbohydrate sweetener which has a certain sweetness found in natural plants, such as sucrose, glucose, fructose, fructose syrup, etc. They are called as sugar and seen as food in our country. Only sugar alcohols or non-sugar sweeteners can be supervised in China. Sugar alcohols used in food mainly include xylitol, sorbitol, mannitol and maltitol etc. Some of their sweetness is the same as sucrose, others maybe hundreds times of sucrose. In addition, liquorice is another kind of sweetener. It's a sort of traditional Chinese medicine which has been widely used and used unlimited. It is mainly used in cans, seasoning, candies and cookies while its production depends on the usage.

Artificial sweetener refers to those non-carbohydrate compounds taste sweet. Generally, their sweetness is several times to several hundreds times of sucrose but without any nutritional value. Artificial sweetener has a great variety of categories. The most common used one is saccharin and its salts which sweetness equals to 300 ~ 500 times of sucrose. Due to the low water solubility, it is used by sodium salt (sodium) based on Food Additives Standards of our country. Besides saccharin and its salts, there are other artificial sweeteners such as Sodium cyclamate (sodium cyclamate), acesulfame potassium and aspartame (nutrasweet).

5) Colorant

Most coloring agents are used to improve the overall attractiveness of the food. A number of natural and synthetic additives are used to color foods. In addition, sodium nitrite is used not only as an antimicrobial, but also to fix the color of meat by interaction with meat pigment. There has

been much controversy regarding their use. Although synthetic coloring agents continue to be used extensively, there has been significant increased interest in natural colorants.

6) Flavoring Agent

Flavoring agents comprise the greatest number of additives used in foods. There are three major types of flavoring additives: sweeteners, natural and synthetic flavors, and flavor enhancers.

The most commonly used sweeteners are sucrose, glucose, fructose, and lactose, with sucrose being the most popular. These substances, however, are commonly classified as foods rather than as additives. The most common additives used as sweeteners are low-calorie or non caloric sweeteners such as saccharin and aspartame. These sweeteners have had a major impact on the development of new foods.

In addition to sweeteners, there are more than 1700 natural and synthetic substances used to flavor foods. These additives are, in most cases, mixtures of several chemicals and are used to substitute for natural flavors. In most cases, flavoring agents are the same chemical mixtures that would naturally provide the flavor. The acidulants, which add a sour taste, often serve other purposes, including preservation.

Flavor enhancers magnify or modify the flavor of foods and do not contribute any flavor of their own. Flavor enhancers, which include chemicals such as monosodium glutamate and various nucleotides, are often used in Asian foods or in soups to enhance the perception of other tastes.

7) Texturizer

Although flavoring agents comprise the greatest number of chemicals, texturizing agents are used in the greatest total quantity. These agents are used to add to or modify the overall texture or mouth feel of food products. Emulsifiers and stabilizers are the primary additives in this category. Phosphantes and dough conditioners are other chemicals that play a major role in modifying food texture. Phosphates are some of the most widely used and serve a number of functions in foods.

Emulsifiers include natural substances such as lecithin and mono-and diglycerides as well as several synthetic derivatives. The primary role of these agents is to allow flavors and oils to be dispersed throughout a food product.

Stabilizers include several natural gums such as carrageenan as well as natural and modified starches. These additives have been used for several years to provide the desired texture in products such as ice cream and are now also finding use in both dry and liquid products. They also are used to prevent evaporation and deterioration of volatile flavor oils.

Phosphates are often used to modify the texture of foods containing protein or starch. These chemicals are especially useful in stabilizing various dairy and meat peoducts. The phosphates apparently react with protein and starch and modify the water-holding capacity of these natural food components.

Dough conditioners such as steroyl-2-lactylate and various humectants such as sodium silicoaluminate are also used as texturizing agents under very specific conditions.

8) Food Processing Aids

Food processing aids are those kinds of auxiliary materials to the needs of food processing, including solvent, adsorption agent, filter aid, purifying agent, etc. Processing aids themselves must comply with the food grade and remove from the products finally that are provided for their residues. The most common solvent are propylene glycol, glycerin, acetone, ethyl acetate, hexane, etc. Others are ion exchange resin, active carbon, diatomite, talc, kaolin, paraffin, stearic acid and D-mannitol which is dedicated to anti sticky candy.

2 Using Principles of Food Additives

(1) Food additives should be non-toxic harmless All kinds of food additives should be tested long-term use of harmless to human security in the use of limited range, strictly according to Evaluation Procedures and Methods on Food Safety Toxicology (GB15193-94). Or it must be fully proved its non-toxic harmless by using the foreign basis. Nor there should be toxic impurities.

Non-toxic harmless also means it can be broken down into non-toxic substances, or to participate in the normal metabolism of human body after processing and cooking. Nor it does produce harmful substances or directly discharged in vitro.

(2) Food additives should destroy the nutritional content of food, not affect the sensory properties of food or no adverse effect on the quality and flavor of food.

(3) Food additives be used at the lowest dose while its significant effect is improving the food quality.

(4) Food additives hall not be used to cover up the food defect or as forged means, crudely made, deceive consumers. The peculiar smell of cake: It is known as the peculiar smell of cake because of yellow pigment instead of eggs, saccharin instead of sugar, fertilizer (ammonium carbonate, ammonium sulfate) instead of baking soda, thus the prepared cake ammonia rich. Sanjing soda (saccharin, essence, pigment flavor) and other simulation of food ingredients product fake food.

(5) Food additives should be identified after analysis after added to food. It'll be conducive to supervise.

(6) Apart from the food nutrition enhancer permitted by regulations, artificial sweetener, pigment, essence, monosodium glutamate and other inappropriate food additives can't be added to principal and supplementary food for babies.

(7) Production or use of new food additives shall provide in advance the hygiene evaluation data and the actual use basis, approved by the relevant department after a step by step review.

2.2 参考译文

食品添加剂

食品添加剂可以定义为：为改善食品品质和色、香、味，满足加工需要，延长保质期等目的，在食品生产、加工、贮藏或者包装过程中所用到的一类物质。正确使用食品添加剂对提高食品质量、防止食品变质具有一定的意义。

人类使用食品添加剂的历史悠久。中国古代就已用果蔬汁液着色糕团。公元前1500年，埃及墓碑上就描绘了糖果的着色。中国从东汉时期就开始应用食品凝固剂——盐卤来做豆腐，并沿用至今。南宋时作为肉制品防腐和发色的亚硝酸盐用于腊肉生产，并于13世纪传至欧洲。随着科学技术，特别是化学工业技术的进步，出现了许多性能远优于天然物质的化学合成添加剂，如防腐剂、抗氧化剂、各种合成香料和食用色素等，食品添加剂的使用品种、范围和用量均在迅速增加。食品添加剂已成为现代食品工业生产中不可缺少的组成部分，其生产已发展为独立的行业。目前国际上使用的食品添加剂种类已达14000多种，其中直接使用的有4000多种，仅香料约占80%，FAO/WHO已公布700多种，欧共体400多种，美国2700多种，我国纳入国标的有1460种，其中香料936种，占64.1%.

1 分类

1）食品添加剂的分类方法有多种

有天然食品添加剂和人工化学合成品两大类。天然食品添加剂又分为由动植物提取制得和由生物技术方法由发酵或酶法制得两种；化工合成法又可分为一般化学合成品与人工合成，如人工合成香料、人工合成色素等。

食品添加剂按其主要功能的不同分为21种，包括酸度调节剂、抗结剂、消泡剂、抗氧化剂、漂白剂、膨松剂、胶姆糖基础剂、着色剂、护色剂、乳化剂、酶制剂、增味剂、面粉处理剂、被膜剂、水分保持剂、营养强化剂、防腐剂、稳定和凝固剂、甜味剂和增稠剂。以下我们将介绍七类重要的食品添加剂。

2）防腐剂

食品中使用的防腐剂大概有三类：抗微生物剂、抗氧化剂和所有抗褐变剂，用于限制或防止微生物的生长。抗微生物剂在延长许多快餐和方便食品的货架寿命方面起着重要作用，随着食品微生物安全问题的增加，抗微生物剂使用更加广泛。

抗氧化剂用于防止食品中的脂质和维生素氧化，他们主要防治氧化以及酸败和异味的发展。抗氧化剂包括了维生素C、维生素E之类的天然物质和丁基羟基茴香醚（BHA）、二丁基羟基甲苯（BHT）之类的合成化学剂。抗氧化剂在延长干制和冷冻食品保藏期方面特别有效。

抗褐变剂是用于防止食品酶化和非酶褐变的化学剂，特别适用于干制果蔬制品。维生素C、柠檬酸和亚硝酸钠是使用最普遍的此类添加剂。

3）营养添加剂

随着消费者对营养的日益关心，近年来营养添加剂使用量已经日益增加。维生素有时可用作防腐剂，更多的是加到谷物或者谷物制品中补充加工过程中损失的营养素，或者用来强化食品的整体营养价值。在美国，向乳中添加维生素 D 以及向面包中添加 B 类维生素已经被用来防止主要营养的缺失。诸如铁、碘之类的矿物质在防止营养缺失方面也有极大的价值。与维生素一样，矿物质也主要用于谷物制品。

食品中通常不使用氨基酸和其他蛋白质类物质。但是，赖氨酸有时加到谷物中，以强化蛋白质品质。尽管蛋白质或大豆蛋白之类的蛋白质类材料大多被当成调制剂使用，但有时也当做营养添加剂使用。

随着消费者对膳食纤维关注的增加，纤维添加剂近年来的流行性有所增加。各种纤维素、果胶和淀粉衍生物已经用于这一目的。最近，从苹果和其它水果以及甜菜中分离出来的天然衍生纤维已经被当做纤维添加剂使用。对纤维添加剂不太好界定，并且实际上它们只能提供很少甚至不能直接提供营养，但是，其确实具有间接的营养好处。用于特殊膳食目的的食品添加剂数量近年来明显增加，且重点在于替代脂肪以降低热量方面。脂肪替代物包括很多调制剂，也包括碳水化合物、蛋白质和脂肪类。对于营养兴趣的增加也导致了功能性食品或保健品产业的迅速成长，结果使一些总体起健康强化作用的添加剂得到发展。

4）甜味剂

甜味剂是指能给食品以甜味的物质。甜味剂按来源可分为天然甜味剂和人工合成甜味剂。天然甜味剂系指天然植物中含有的具有一定甜味的物质，如蔗糖、葡萄糖、果糖、果葡糖浆等，在我国通常称为糖，并视为食品，仅糖醇类和非糖甜味剂才作为食品添加剂管理。食品中使用的糖醇类，主要有木糖醇、山梨糖醇、甘露糖醇、异麦芽糖醇等，其甜度有的与蔗糖相当，有的是蔗糖的几百倍。另外还有甘草，这是我国传统的中草药，使用较为广泛，没有限制，生产量依使用量而定，主要用于罐头、调味料、糖果及饼干中。

人工合成甜味剂系指一些具有甜味的非糖类化合物，其甜度一般较蔗糖高几十倍至几百倍，没有任何营养价值。人工合成甜味剂种类很多，但使用最多的是糖精及其钠盐，其甜度相当于蔗糖的 300 ~ 500 倍。由于糖精的水溶性低，故在我国食品添加剂标准中规定使用钠盐（糖精钠）。人工合成的甜味剂除糖精及其钠盐外，还有环己基氨基磺酸钠（甜蜜素）、乙酰磺胺酸钾、天门冬酰苯丙氨酸甲酯（阿斯巴甜）。

5）着色剂

大多数着色剂用于改善食品的整体外观。一些天然和合成的添加剂用于食品着色。此外，亚硝酸钠不但作为抗微生物剂使用，而且也通过与肉色素反应使肉的颜色固定。对于它们的使用有许多不同的看法。虽然合成色素仍然大量使用，但对于天然色素的关注已经明显增加。

6）风味剂

风味剂是用于食品数量最多的添加剂。风味剂主要有三类：甜味剂、天然和合成风味剂以及风味增强剂。

最为常用的甜味剂是蔗糖、葡萄糖、果糖和乳糖，其中蔗糖用的最多。然而，这些物质通常被归类为食品，而不是添加剂。最普通的作为甜味剂使用的添加剂是低热值或无热值甜味剂，例如糖精和阿斯巴甜。这些甜味剂是促使食品新种类发展的主要推手。

除了甜味剂以外，还有1700多种天然和合成风味剂在食品中使用。多数情况下，这些添加剂是由若干化合物混合而成，常用作天然风味替代剂。风味剂一般是一些与天然风味物质的化学成分相同，能提供同样风味的化学混合物。提供酸味的酸化剂常用于其他目的，包括防腐。

风味增强剂使食品风味增强或改善，而其自身没有任何风味。由诸如谷氨酸钠和各种核苷酸在内的化学剂构成的风味强化剂，通常用于亚洲食品或汤料中以强化其它口味。

7）调质剂

虽然风味剂是数量最多的化学剂，但调质剂却是用量最多的添加剂。调质剂用于改善食品的整体肌质或口感。这类添加剂主要有乳化剂和稳定剂。磷酸盐和面团改良剂是另一类在改善食品肌质方面起主要作用的化学剂。磷酸盐属于使用最广的添加剂，并且在食品中能够起多种作用。

乳化剂包括天然物质，如卵磷脂、甘油单酯和甘油二酯，以及若干合成添加剂。这类添加剂的主要作用是允许风味剂和油能够均匀地分布于食品。

稳定剂包括了若干诸如卡拉胶之类的胶质，以及天然和改性淀粉。这些添加剂已经在冰激凌之类产品中应用了几年，以提供所需质地，现在也用在了干制和液体产品中。他们也用于防止挥发性风味油的蒸发和变质。

磷酸盐常用于含蛋白质或淀粉食品的质地改良。这些化学剂特别适用于各种乳制品和肉制品的稳定。磷酸盐表面与蛋白质或淀粉反应，从而可以改善这些天然食品组成的持水能力。

面团改良剂，如乳酰化硬脂酸钠，以及各种润湿剂，如硅铝酸钠，在非常特殊的条件下也当做调质剂使用。

8）食品加工助剂

因食品加工需要而使用的一类辅助物质，包括溶剂、吸附剂、助滤剂、净化剂等。助剂本身必须符合食品级，最后应从成品中除去，对其残留量也有所规定。常用的溶剂有丙二醇、甘油、丙酮、醋酸乙酯、己烷等，其他如离子交换树脂、活性炭、硅藻土、滑石粉、白陶土、石蜡、硬脂酸及专用于糖果防粘的D-甘露糖醇等。

2 食品添加剂的使用原则

（1）食品添加剂应该是无毒无害的。各种食品添加剂必须严格按《食品安全性毒理学评价程序与方法》（GB 15193-94），证明其在使用限量范围内长期使用对人体安全无

害，或国外使用的依据充分证明其无毒无害，也不应有其他有毒杂质。无毒无害亦是指经加工、烹调后，可被破坏、分解成无毒的物质或参加机体正常代谢，但不产生有害的物质或直接排出体外。

（2）不破坏食品的营养成分，不影响食品的感官性状，对食品的质量及风味不发生不良影响。

（3）使用最低剂量，达到提高食品质量的显著效果。

（4）不得用来掩盖食品的缺陷或作为伪造手段，粗制滥造，欺骗消费者。异味蛋糕：以黄色素代替鸡蛋，糖精代替沙糖，化肥（碳酸铵、硫酸铵）代替小苏打，所制蛋糕氨味浓，故称为异味蛋糕。三精汽水（糖精、色素精、香精），以及其他一些模拟食品成分的假冒伪劣食品。

（5）加到食品中以后应能被分析鉴定出来，有利于监督。

（6）专供婴儿食用的主、辅食品除按规定可加入食品营养强化剂外，不得添加人工甜味剂、色素、香精、谷氨酸钠及其他不适宜的食品添加剂。

（7）生产或使用新的食品添加剂时，应事先提出卫生评价资料和实际使用依据，逐级审议后经有关部门批准。

3 阅读链接

[1] http://down.foodmate.net/standard/sort/3/28220.html

[2] http://db.foodmate.net/2760-2011/

[3] http://zstj.cbpt.cnki.net/EditorB3N/WebPublication/index.aspx?mid=zstj

[4] http://www.eufic.org/article/en/food-safety-quality/food-additives/expid/basics-food-additives/

[5] http://www.foodadditivesbook.com/

4 课后作业

4.1 句子翻译

4.1.1 原句

(1) Additives may be defined as a class of substances that are used in food production, processing, storage and packaging to extend shelf-life of purpose and to meet the processing needs for improving quality, color, flavor and taste.

(2) Chinese began to use food coagulant-bittern to make bean curd from the Eastern Han Dynasty and the method is still in use today.

(3) With the development of science and technology, especially the chemical industry tech-

nology progress, many chemical additives are produced, which are far better than those of natural substances, such as preservative, antioxidant, various synthetic perfume and edible pigment etc.

(4) Antimicrobials play a major role in extending the shelf-life of numerous snack an convenience foods and have come into even greater use in recent years as microbial food safety concerns have increased.

(5) They vary from natural substances such as vitamins C and E to synthetic chemicals such as butylated hdroxyanisole(BHA) and butylated hydroxytoluene(BTH)

(6) Proteins or proteinaceous materials such as soya protein are also sometimes as nutritional additives, although they are most commonly used as texturizing agents.

(7) Vitamins, which are also used in some cases as preservatives, are commonly added to cereals and cereal products to restore nutrients lost in processing or to enhance the overall nutritive value of the food.

(8) The increased interest in nutrition has also led to the rapid growth of the functional food or nutraceutical industry with the development of several additives for the purpose of enhancing overall health.

(9) Flavor enhancers, which include chemicals such as monosodium glutamate and various nucleotides, are often used in Asian foods or in soups to enhance the perception of other tastes.

(10) All kinds of food additives should be tested long-term use of harmless to human security in the use of limited range, strictly according to 'Evaluation Procedures and Methods on Food Safety Toxicology' (GB15193-94).

4.1.2 参考翻译

(1) 食品添加剂可以定义为：为改善食品品质和色、香、味，满足加工需要，延长保质期等目的，在食品生产、加工、贮藏或者包装过程中所用到的一类物质。

(2) 中国从东汉时期就开始应用食品凝固剂——盐卤来做豆腐，并沿用至今。

(3) 随着科学技术、特别是化学工业技术的进步，出现了许多性能远优于天然物质的化学合成添加剂，如防腐剂、抗氧化剂、各种合成香料和食用色素等。

(4) 抗微生物剂在延长许多快餐和方便食品的货架寿命方面起着重要作用，随着食品微生物安全问题的增加，抗微生物剂使用更加广泛。

(5) 抗氧化剂包括了维生素 C、维生素 E 之类的天然物质和丁基羟基茴香醚(BHA)、二丁基羟基甲苯 (BTH) 之类的合成化学剂。

(6) 尽管蛋白质或大豆蛋白之类的蛋白质类材料大多被当成调质剂使用，但有时也当做营养添加剂使用。

(7) 维生素有时可用作防腐剂，但是更多的是加到谷物或者谷物制品中补充加工过程中损失的营养素，或者用来强化食品的整体营养价值。

（8）对于营养问题的关注也导致了功能性食品或保健品产业的迅速成长，结果使一些总体起健康强化作用的添加剂得到发展。

（9）由诸如谷氨酸钠和各种核苷酸在内的化学剂构成的风味强化剂，通常用于亚洲食品或汤料中以强化其他口味。

（10）各种食品添加剂必须严格按《食品安全性毒理学评价程序与方法》（GB 15193-94），证明其在使用限量范围内长期使用对人体安全无害。

Unit 2 Enzymes in food

1 专业词汇分析

(1) rennet n. 凝乳酶

(2) amylase n. 淀粉酶

(3) starch n. 淀粉

(4) maltose n. 麦芽糖

(5) dextrin n. 糊精；葡聚糖

(6) lactose n. 乳糖

(7) cereal n. 谷类，谷物；谷类食品；谷类植物

(8) substrate n. 酶作用物，培养基

(9) thermostability n. 热稳定性；耐热性

[记忆窍门] “thermo” 热的，稳定性。

(10) catalyst n. 催化剂

(11) arabanase n. 阿拉伯聚糖酶

[记忆窍门] “arab” 阿拉伯的，“-ase” 表示 “…酶”。

(12) araban n. 聚阿拉伯糖

(13) maceration n. 泡软；浸渍作用

(14) lager n. (美) 贮藏啤酒 (等于 lager beer)

(15) dessert n. 餐后甜点；甜点心

(16) clot vt. 使凝结成块

(17) coagulate vt. 使…凝结

(18) whey n. 乳清；乳清蛋白；酪蛋白

(19) galactosidase n. 半乳糖苷酶

[记忆窍门] “galact-” [用于元音字母前] 表示 “乳”，“乳的”，“-ase” 表示 “…酶”。

(20) lactase n. 乳糖酶

(21) galactose n. 半乳糖

[记忆窍门] “galact-”，[用于元音字母前] 表示 “乳”，“乳的”。

(22) bloating n. 腹胀

[记忆窍门] “bloat”，使膨胀。

(23) diarrhea n. 腹泻，痢疾

(24) flatulence n. 肠胃气胀

2 课文

2.1 原文

Application of enzymes in food

1 Introduction

The use of enzymes such as rennet in cheese making and barley amylases in brewing is as old as the food and beverage industry itself. However, the production of the amylase represents the first example of the industrial production of an enzyme for use in the food industry. The quantity and variety of enzymes used in the food and beverage industry has increased dramatically in the past two decade. More than 20 different enzymes are regularly used in the food and beverage industry at the present time. The conversion of starch to different commercial products, such as glucose and maltose syrups and dextrin preparations, represents the major application of food enzymes. The use of enzymes in the dairy industry for cheese making and for the production of low lactose dairy products is the second largest market.

2 Enzymes in Baking

Bread and baked products are among the main nutritional sources today. Over 600×10^6 t of wheat are grown in the world each year, making it the single most important crop. Europeans are estimated to obtain approximately half their required carbohydrates and about one-third of their protein from bread. Throughout the history of bread making, enzymes have always played an important role. Even the ancient Egyptians made use of enzymes present endogenously in the flour, although they may not have been aware of the effect. However, not until the 20th century were enzymes used as flour improvers. The first application of enzymes in baked goods was supplementation of α-amylase by addition of malt to correct the concentration of endogenous α-amylase in the flour. Later malt was substituted by microbial α-amylases having a more suitable thermostability for baking. This was the first enzyme industrially produced as a tool to compensate for variations in natural flour. Today, a whole range of enzymes is available for end users of flour. These make it possible to correct suboptimal concentrations of endogenous flour enzymes. Further-more, these biological catalysts are able to produce value-adding ingredients in situ from compounds present in the flour, and thus it is possible to upgrade lower grades of flour.

In many cases the beneficial effects of using enzymes in the baking industry are also obtainable by using chemical agents such as sodium metabisulfite, cysteine, azodicarbonamide (ADA), potassium bromate, etc. However, the food market today shows a clear trend towards more 'green' products, and this has clearly favored the use of the biological catalysts enzymes.

3 Enzymes in Fruit Juice Production and Fruit Processing

The first application of enzymes in the fruit juice industry was the use of pectinases for apple juice clarification in the 1930s. The fast clarification of juice after breakdown of pectin by pectinases and the decrease in juice viscosity resulted in a shorter process and greatly improved the quality of industrial apple juice. Later, pectinases were applied to depectinization of red-berry juice. The use of pectinases and amylases to degrade apple pectin and starch during the hot clarification stage prevents post-bottling haze formation, and thus concentration of the juice by a factor of six has become possible. This results in a smaller storage volume, cheaper transportation, and better concentrate stability without spoilage. Treatment of apple pulp with pectinases and hemicellulases was introduced later: by lowering the viscosity of the pulp, the press capacity and the yield were significantly improved. Depectinization of juice with pectinases with high arabanase activity improved product quality further by preventing araban haze formation after concentration of the juice. In the production of clear and stable red-berry juice or concentrate, hot maceration with enzymes ensures a higher juice yield and a better color extraction. Nowadays, enzyme suppliers provide fruit juice producers with tailor-made enzyme preparations optimally blended on the basis of fruit composition for improved quality and stability of finished products, together with shorter process duration and larger plant capacity. In association with new equipment and processing technologies, industrial enzymes allow processors to add value to raw material for food and feed and to reduce waste quantity.

Nowadays, enzyme producers provide a wide range of pectinases for processing of fruit to give various products such as puree, cloudy juice, clear juice, and concentrate. The evolution of technology and processes including enzymes allow processors to obtain higher juice yield (productivity) together with higher quality of finished products. The use of specific pectinases adapted to the fruit process improves the shelf life of juices and concentrates (stability of color and freedom from turbidity). Apart from juice processing, the wide range and the high specificity of commercial enzymes open the way to new processes and new types of fruit-derived products. The trend is to process fruit under milder and more strictly controlled conditions to obtain new fruit products with sensory characteristics closer to those of fresh fruit.

However, because processing technology evolves faster than regulation, it is necessary to define food standard values and process references. In Europe, a Code of Practice has been developed to maintain quality and authenticity standards. Members of Association of the Industry of Juices and Nectars from fruits and vegetables (AIJN) in parallel with the Association of Microbial Food Enzyme Producers (AMFEP) have established references for fruit juice composition and enzyme specifications, in line with commercial standards and regulations of different countries.

4 Enzymes in Brewing

Brewing is an old and traditional process that uses a variety of raw materials; in centuries past, many brewing processes have evolved, and they show the versatility and craftmanship of historic brewmasters. By far the most important brewing style is the 'lager' type, characterized by the use of very pure water, low-temperature fermentation, and a long maturation period. Even in this relatively young beer style, many variations have developed. The common denominator in the brewing of beer is that part of the starch of a cereal is converted into alcohol. In the first stage enzymes hydrolyze starch into fermentable sugars. In a second process stage, these sugars are converted to alcohol and carbon dioxide by yeast (Not all beers use yeast for fermentation; e. g. , in the case of gueuze beers and weissen, bacteria are involved).

The traditional source of enzymes used for the conversion of cereals into beer is malted grain, and malted barley is a key ingredient in brewing. Malting depends on many factors, including the barley variety and quality, the malt kilning regime and the skill of the malter. The extent and success of the malting process depends on the development, distribution, and survival of indigenous barley enzymes, and in the case of the notoriously heat labile malt enzymes, quality varies from season to season and from region to region.

5 Enzymes in Dairy Applications

Dairy products are among the classic examples of fermentation-derived foodstuffs, and their history of development goes back several millennia. Through the ages a huge variety of dairy products has been developed based on empirical experimentation. Profound understanding of biochemical, microbiological, and physicochemical processes has mainly been achieved during the second half of the 1900s. Economical interest and scientific progress have led to the development of dairy food science as a special branch within food science, and it is the basis of control in manufacturing a huge variety of dairy products. Emphasis on understanding and controlling taste and texture development has led to a still growing assortment of cheeses and desserts. Enzymes originating from raw materials, microbial starter cultures, or other sources are prime tools in improving existing and creating novel dairy products.

A basic element in the process of cheese making is the clotting of the milk. Milk turns into a gel structure through the action of coagulating enzymes, briefly called coagulants. The casein proteins in milk lose their colloidal stability and aggregate to form a gel structure. After cutting of the gel, the liquid whey fraction, containing whey proteins, minerals, and lactose, separates from the casein chunks. The casein material, the curd, is collected in molds. After pressing and brining, the cheese is kept under conditioned storage for ripening. Storage time may last from weeks to months, even years, depending on the type of cheese.

β-Galactosidase (E. C. 3. 2. 1. 23) or lactase is an enzyme that has found ample application

in the hydrolysis of lactose, a disaccharide consisting of a glucose and a galactose moiety, in cow's milk. The consumption of milk is hampered for some people due to a deficiency of lactase in the digestive system. Lactose intolerance in these people, predominantly in Asian countries but also in Africa and South and Middle America, results in symptoms such as bloating, diarrhea, and flatulence. In many cases these symptoms occur after consumption of 200-300 mL of milk.

6 Other Food Applications

The use of enzymes for food applications has increased steadily over the past two decades, not only in traditional application areas such as starch processing, brewing, fruit processing, and dairies. In applications such as baking, the use of enzymes has grown even more.

The appearance of new enzyme applications is due to the increasing diversity of the enzymes available, the majority based on GM technology. In future new enzymes for food applications are expected to lead to major developments in the use of industrially produced enzymes.

2.2 参考译文

生物酶在食品工业中的应用

1 引言

在奶酪加工中添加凝乳酶，在酿酒中添加大麦淀粉酶，正如食品加工工业以及酿酒业同样古老。淀粉酶的使用首次标志着食品加工业中生物酶的工业化生产的出现。在过去二十年里食品加工和酿酒工业中生物酶使用的数量和种类有了极大的增长。目前有超过 20 种不同的生物酶在使用。对淀粉进行的各种商业产品的生产，比如，葡萄糖、麦芽糖和糊精，都标志着生物酶用途之广泛。酶在日常食品中，比如奶酪和低糖食品中的使用是其第二大市场。

2 生物酶在焙烤中的应用

面包和焙烤食品是当今主要的营养食品。全世界每年种植小麦的产量超过 6 亿吨，小麦成为最主要的作物。据估计欧洲人摄入的碳水化合物中有一半、蛋白质有三分之一来自于面包。在制作面包的历史中，酶一直发挥着主要作用。甚至古埃及人都使用存在于面粉内部的酶，尽管他们对于其功效并不知晓。然而，到了 20 世纪，酶用来做发酵粉。酶在焙烤食品中的首要应用是通过添加麦芽的方式补充 α-淀粉酶，以改善面粉中内含的 α-淀粉酶的浓度。后来麦芽由微生 α-淀粉酶替代，因其有适宜焙烤的耐热度。这是工业上第一次将酶在不含任何添加剂的面粉中使用。如今，面粉的消费者可以使用各种酶。这些酶可以改善面粉内含酶浓度偏低的问题（亚适浓度）。而且，这些生物催化剂能够从面粉中的复合物中生成含附加值的原位成分，有可能改善等级较低的面粉。

在焙烤产业许多实例中使用酶所带来的益处，也能通过使用例如焦亚硫酸钠、半胱氨酸、偶氮二甲胺酸、溴酸钾等化学添加剂的方式取得。然而，当代的食品产业显现出清晰地“绿色食品”的潮流，所以，使用酶明显地受到青睐。

3 生物酶在果汁生产与水果加工中的应用

在果汁行业中首次使用酶是在20世纪30年代在苹果汁的生产中使用果胶酶。果胶酶将果胶转化，以更短的工艺将果汁迅速澄清以及使得粘稠度降低，并使得苹果汁的品质大大提高。后来，果胶酶应用于红莓果汁的脱胶化。在热澄清阶段使用果胶酶和淀粉酶能够分解苹果胶和淀粉，能够防止在灌装时形成雾，从而使得果汁的浓度提高6倍有可能实现。其结果是减少存储量，降低运输成本以及在避免腐败的情况下增加浓度稳定性。后来又引进了以果胶酶和半纤维素酶处理苹果果浆的方式：通过降低果浆浓度的方式，使加压能力和产量都显著提高。富含阿拉伯聚糖酶的果胶酶对果汁的去胶化进一步在果汁浓缩后防止雾的形成，提高了产品质量。澄清、稳定的红莓果汁的生产或浓缩中，以酶进行热浸皮保证了更高的产量和更好的色素提取。现在，生产酶的企业按照果汁生产商所需要的酶，为其量身打造，恰到好处地与水果的成分一起提高产品的质量和稳定性，同时缩短生产周期，提高生产能力。与新设备和加工科技一道，工业用酶使得制造企业增加食品原料的价值并减少浪费的数量。

如今，生物酶的制造企业提供大批量的果胶酶对水果进行加工，生产出各种产品，例如果泥、混汁、清汁，并对其进行浓缩。包括生物酶在内的科技和工艺的进展可以使加工方获得更高的产量，同时质量更好。使用特定的果胶酶能够增加果汁的保存期限并提高浓度（颜色稳定、浓而不混）。除了加工果汁之外，商业用酶的多样性和专用性为开发新的水果制品开辟了道路。这种趋势是在更加严格的监管下，以更加贴近新鲜水果的口味特点，开发出新的果类产品。

但是，由于监管跟不上制造科技的进步，所以有必要定义食品标准价值和加工文献。欧洲已经开发出一部操作规则以保持质量和可靠性标准。欧盟果蔬汁饮料协会的成员国与微生物食物酶制造商协会一同为果汁成分和酶的规格、不同国家的商业标准和规范出台了参考标准。

4 生物酶在酿酒业中的使用

酿酒业的工艺古老而传统，酿酒过程中使用各种原料；在过去的几个世纪，许多酿酒工艺已经改善，展现出历史上酿酒大师们非凡的才华和高超的技能。迄今为止最重要的酿酒方法就是“更大”法，特点是使用十分纯净的水，经过低温发酵以及长时间的酿造。即使是在这相对年轻的酿酒法中，也有许多不同的变化。啤酒的酿制中普遍的标准是谷物中多少淀粉转化为酒精。在第一阶段，酶将淀粉水解为可发酵的糖分。在第二阶段，这些糖分被酵母转化为酒精和二氧化碳（不是所有啤酒都使用酵母进行发酵；例如，Gueuze啤酒和Weissen啤酒中使用细菌）。

将谷物转化成啤酒的酶的传统来源是麦芽谷物，大麦就是酿酒中的主要成分。麦芽糖化依赖于很多因素，包括大麦的种类和质量、麦芽入炉干燥和掌控该过程的人员的技巧。麦芽化的过程的程度与成功依赖于大麦中内含酶的发展、分布和存留，以及出现不耐热麦芽酶的情况，季节与季节、地区与地区之间的对质量影响的差别很大。

5 生物酶在乳业中的应用

发酵类产品的历史已有千年，奶类产品是其中的典型。大量的奶制产品在实证实验的基础上被开发出来。二十世纪中叶有关大量对生化、微生物和物理生物的方式的描述。经济利益和科学进展使得奶类食品科学发展成为食品科学下独特的分支，奶类食品科学是加工大量奶类制品的基础。对口味和质感发展的强调使得奶酪和甜点不断细化分类。来自于原材料和人工合成以及其他来源的酶是提高现有以及创新奶制品的主要途径。

在奶酪制作的过程中的一个基本方面是牛奶的凝固。牛奶通过凝固酶的作用转化成胶状结构，这些凝固酶被简称为凝固剂。牛奶中含有酪蛋白的蛋白质失去了胶状稳固性后，聚集成一种胶状结构。经过对胶的切割后，包含乳清蛋白、矿物质和乳糖的液体乳清块从大块的酪蛋白中分离出来。酪蛋白原料——凝乳被收集在塑模中。经过挤压和煮沸，在适宜的状况下进行储存，直至可以食用。根据奶酪的类型，存储的时间从几周到数月不等，甚至可以储存几年。

β-半乳糖苷酶或乳糖分解酵素是能够在乳糖水解中广泛应用的酶，乳糖是存在于牛奶中由葡萄糖和半乳糖形成的一种双糖。有些人的消化系统不能消化乳糖，使得牛奶的消费受到影响。乳糖不耐受人群主要集中在亚洲，但在非洲和南、中美洲也有分布，主要表现是腹胀、腹泻和胀气等。在很多实例中，饮用 200 ~ 300 mL 牛奶后会出现以上症状。

6 生物酶在其他食品中的应用

在过去的二十年里，酶在食品中的应用大幅增长，不仅是在包括淀粉加工、酿酒、水果加工和奶业等传统行业。酶在例如焙烤业中的应用也大幅增加。

新型生物酶应用的出现是由于酶的种类不断增加，而种类的增加主要在于 GM 科技，未来应用于食品的新型酶将引领工业用酶的主要发展。

3 阅读链接

[1] http://www.sciencedirect.com/science/article/pii/S0260877400001278

4 课后作业

4.1 句子翻译

4.1.1 原句

(1) However, for the food industry, the prime goal is to obtain an enzyme which offers a high performance for the applications in question at an economic price.

(2) Further-more, these biological catalysts are able to produce value-adding ingredients in situ from compounds present in the flour, and thus it is possible to upgrade lower grades of flour.

(3) The use of specific pectinases adapted to the fruit process improves the shelf life of juices and concentrates (stability of color and freedom from turbidity).

(4) Treatment of apple pulp with pectinases and hemicellulases was introduced later; by lowering the viscosity of the pulp, the press capacity and the yield were significantly improved.

(5) In the first stage enzymes hydrolyze starch into fermentable sugars.

(6) In a second process stage, these sugars are converted to alcohol and carbon dioxide by yeast. (Not all beers use yeast for fermentation; e. g., in the case of gueuze beers and weissen, bacteria are involved.)

(7) Dairy products are among the classic examples of fermentation-derived foodstuffs, and their history of development goes back several millennia.

(8) Enzymes originating from raw materials, microbial starter cultures, or other sources are prime tools in improving existing and creating novel dairy products.

(9) The casein proteins in milk lose their colloidal stability and aggregate to form a gel structure.

(10) β-Galactosidase (E. C. 3. 2. 1. 23) or lactase is an enzyme that has found ample application in the hydrolysis of lactose, a disaccharide consisting of a glucose and a galactose moiety, in cow's milk.

4.1.2 参考翻译

(1) 但是，对于食品工业，主要的目标是获得一种在应用中具有较高活性并且价格经济的酶。

(2) 此外，这些生物催化剂能够利用面粉中的现有物质产生具有高附加值的成分。因此，可提升低等淀粉的等级。

(3) 在水果处理过程中应用的特定果胶酶可提高果汁的保质期及浓度（保持颜色和避免浑浊）。

(4) 后来，采用了果胶酶和半纤维素酶处理苹果原浆的办法：通过降低果浆的黏度，其榨汁量和产量都得到了显著的提高。

(5) 在第一阶段，酶水解淀粉为可发酵性糖。

(6) 在第二处理阶段，酵母将这些糖转变为酒精和二氧化碳（不是所有的啤酒都采用酵母菌进行发酵；例如，Gueuze 啤酒和 Weissen 啤酒中都加入了细菌）。

(7) 乳制品是发酵衍生食品的经典例子之一，其历史可追溯至几千年前。

(8) 源于原料、微生物发酵培养物或其他来源的酶类是改进现有的和创造新型乳制品的主要工具。

(9) 牛奶中酪蛋白的胶体稳定性被破坏，并且聚集形成了胶体结构。

(10) β-半乳糖苷酶（E. C. 3. 2. 1. 23）或乳糖酶是一类广泛应用于牛乳中乳糖水解的酶类，乳糖是存在于牛奶中由葡萄糖和半乳糖形成的二糖。

Unit 3 Food Fermentation

1 专业词汇分析

(1) chopping n. 斩拌

(2) stuffing n. 填料，灌肠

(3) acidulation n. 酸化；酸化作用

[记忆窍门] “acid”，酸；“acidulate”，使酸化；“-tion” 动词转化成的名词尾。

(4) lactic acid n. 乳酸

(5) simultaneous adj. 同时的；联立的；同时发生的

(6) fermentation n. 发酵

(7) availability n. 可用性；有效性；实用性

[记忆窍门] “avail”，有利，有用；“-able” 形容词后缀 “可…的”；“-(i)ty” 名词词尾，表示性、度。

(8) denaturation n. 使变性；改变本性

[记忆窍门] “natura”，自然；“de-” 前缀，除去，去掉。

(9) shelf-life n. 货架期，贮藏寿命

(10) interrelated adj. 相关的，互相联系的；v. 使相互联系（interrelate 的过去式）

[记忆窍门] “inter-” 前缀，…之间，相互；“related”，有关系的，有关联的。

(11) microbiological adj. 微生物学的

[记忆窍门] “micro-” 前缀，微；“biological”，生物的，生物学的。

(12) biochemical adj. 生物化学的

[记忆窍门] “bio-” 前缀，生物的；“chemical”，化学的。

(13) starter bacteria n. 发酵剂

(14) antioxidant n. 抗氧化剂

[记忆窍门] “anti-”，前缀，反，防；“oxidant”，氧化剂。

(15) proteolytic adj. 蛋白水解的，解蛋白的

[记忆窍门] “proteo-”，蛋白；“-lytic”，分解的。

(16) lipolytic adj. 分解脂肪的，脂解的

[记忆窍门] “lipo”，脂肪；“-lytic”，分解的。

(17) metabolism n. 新陈代谢

(18) ripening n. 成熟

(19) in relation to prep. 关于，涉及

(20) bacteriological adj. 细菌学的，细菌学上的

［记忆窍门］“bacteria”，细菌；“-ology”，学（科）；“-（c）al”，的。

（21）polyunsaturated adj. 多不饱和的

［记忆窍门］“poly-”，多，聚；“un-”不；“saturate” adj. 饱和的。

（22）sodium ascorbate n. 抗坏血酸钠

（23）semisynthetic adj. 半合成的

［记忆窍门］“semi-”，半；“synthetic”，综合的，合成的，人造的。

（24）permeable adj. 能透过的，有渗透性的

（25）case hardening n. 表面硬化

（26）combustion n. 燃烧，氧化

（27）polycyclic hydrocarbons n. 多环烃

［记忆窍门］“poly-”，多，聚；“cyclic”，环的，循环的，周期的；“hydro-”，氢或水；“carbon”，碳。

（28）inoculation n. 接种

（29）lactobacilli n. 乳酸杆菌

［记忆窍门］“lacto-”，乳酸，乳糖；“bacilli”，杆菌，细菌。

（30）Micrococcaceae n. 微球菌科

［记忆窍门］“micro-”，微；“coccaceae”，球菌。

（31）probiotic n. 益生菌，益生素

2 课文

2.1 原文

Meat Fermentation①

1 Introduction

The chopping or mincing of meat and fat with curing salt and/or sugar together with spices, herbs and other plant material, followed by the stuffing of such mixture to form a ‘sausage’ that is left to dry is a practice dating back to centuries before the Common Era. Since these early beginnings, variations in ‘meat’ species, subjected to various degrees of mixing with other ingredients or additives and subjected to various temperature and humidity conditions have yielded at least 56 different ‘fermented meat products’. The shelf-life and safety, as well as the specific flavour, texture and colour of these products are determined by combinations, varying in relative importance, of acidulation brought about by lactic acid production and the lowering of water activity (A_w) by the addition of salt (curing) and by drying.

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① 选自：Encyclopedia of Meat Sciences. 作者：D Demeyer, Ghent University, Melle, Belgium F Toldrá, Instituto de Agroquímica y Tecnología de Alimentos (CSIC), Burjassot, Valencia, Spain

The simultaneous or successive combination of these processes is generally referred to as 'fermentation'. The presence of salt, the lowering of aw by both addition of salt and drying, and the limited availability of oxygen, intensified in most industrial productions by vacuum stuffing, selects salt-tolerant bacteria from the contaminating and/or added flora, producing lactic acid from carbohydrates added to or naturally present in the mix. This 'fermentation' lowers the pH to final values between 4.5 and 5.5, inducing the denaturation of salt-solubilized protein to a gel that can be sliced. The adequate (rapid) reduction of pH and the lowered A_w are the major factors determining both shelf-life and safety.

Considerable recent research efforts have generated more detailed knowledge of the interrelated microbiological, biochemical, chemical and physical changes taking place during 'meat fermentation', emphasizing two major and apparently contrasting developments: ① The need for 'starter bacteria', well-characterized for acidifying, antioxidant and amino acid degrading acidities. ②The importance of both proteolytic and lipolytic enzymes, present in the meat and/or fat raw materials used.

The many intricate interactions between microorganisms, meat and fat enzymes and processing conditions determining sausage quality encompass more than the concept of fermentation and are therefore better referred to as 'metabolism'.

2 The Processing of Fermented Sausages

Industrial production, mainly in continental Europe, from where the technology was transferred to the United States and Australia, has narrowed down the many types of fermented meat products. These are classified in several ways, based on moisture content, moisture/protein ratio, weight loss, water activities, surface treatment, texture, fat particle size, and other parameters.

The industrial production period, referred to as 'ripening', is separated into two consecutive periods: fermentation followed by drying. Technologies differ mainly in the length of the total ripening period in relation to that of the fermentation period. High initial rates of lactic acid production resulting from the use of lactic acid-producing 'starters' and/or high temperatures during fermentation are associated with short drying periods. The drying period may even be omitted, as in 'summer sausage', prevalent in parts of the United States and fermented at 38℃. In Europe, a major distinction can be made between so-called Northern type and Mediterranean type sausages. Northern type sausages (NS) contain both beef and pork as raw meats, are ripened for short periods (up to 3 weeks) and are usually subjected to smoking. In these sausages, shelf-life and safety are mainly due to the fast drop to acid pH (<5.0 after 3 days) at temperatures >20℃ and to smoking rather than to drying. Mediterranean sausages (MS) mostly use only pork and are ripened for longer periods (several weeks or even months) and smoke is not so typically applied. Acidulation is slower, takes place at lower temperatures (<20℃) and ends at higher pH values (>5 after

3 days). Shelf-life is mostly due to drying and reduced water activity.

3 Raw Materials and Additives

Chilled meats (frozen meat tempered to ca. −4℃) and frozen (≤18℃) porcine fats after removal of rind (e. g. lard) are most often mixed in a ratio of 2:1. Lard and sausage meat (ham trimmings, jowls and throats as well as shoulders and bellies) make up 10% and 20%, respectively, of the pork carcass. They are selected mainly on the basis of bacteriological quality, visual fat content, pH (<5.8) and unsaturation (<12% polyunsaturated fatty acids in fat) as well as oxidation status (minimal peroxide value) of the fat. Widely used additives (range of incorporation) are salt (2% ~4%) containing sodium nitrite ($NaNO_2$) (added as curing salt containing 0.4% ~0.6% $NaNO_2$), glucose (0.5% ~1%) sodium ascorbate or ascorbic acid (0.5% ~1%) and spices. The use of nitrite is considered essential because of its antibacterial, colour-forming, antioxidant and flavouring properties.

4 Comminution or Chopping

Raw materials and additives, including microbial starters, are added for mixing and chopping, often under vacuum, in a mincer or 'cutter'. The cutter consists of a set of knives that rotate rapidly (3×10^3 r · min^{-1}), producing a batter in a bowl that rotates slowly [(10 ~20) r · min^{-1}]. The relative speeds of the knives and bowl and the sequence of addition of raw materials and additives determine the fat particle size and are optimized to produce a batter within less than 5 minutes at temperatures ≤2℃, ensuring minimal damage to the fat tissue.

5 Stuffing

In most industrial processes, the batter is immediately stuffed under vacuum into natural, semisynthetic (collagen) or synthetic casings that are permeable to water and air, and both ends are clipped. The sausage diameter (e. g. 2 ~15 cm) is related positively to the relative importance of fermentation (pH) versus drying (A_w) for stability.

6 Ripening

The sausages are hung in racks and placed in natural or, mostly, air-conditioned fermentation chambers at high relative humidity (RH). Sausages are usually left for ripening in two consecutive stages: fermentation for bacterial growth and, mostly after transfer to another chamber, drying for development of sensory characteristics. Temperature/RH/time combinations during fermentation differ between Northern (20 ~26℃/50 ~90%/62 h) and Mediterranean (5 ~24℃/10% ~90%/100 h) types, whereas drying is carried out under similar conditions (14℃/78%) for anywhere between 2 weeks (Northern) and several months (Mediterranean). It is recommended to have air RH values not more than 0.10 points below the associated aw values of the sausage, to prevent case hardening, and recommended air speeds are approximately 0.1 m · s^{-1}. Controlled fermentation and ripening in air-conditioned surroundings consumes considerable amounts of en-

ergy and alternative methods, involving the use of fresh air, have been proposed, inspired by the traditional methods for Mediterranean type sausages and adapted to local climatic conditions.

7 Smoking

At the end of the fermentation period, Northern type sausages are subjected to smoke, generated by controlled combustion of oak wood (300 ~ 600 ℃) to minimize the production of polycyclic hydrocarbons. Smoke contributes to antimicrobial and antioxidant effects, besides generating specific flavour and colour components. Smoking is not used in the production of Mediterranean type sausages, except for Hungarian and Rumanian products, where a light smoking period precedes fermentation.

8 The Use of Microbial Starters

Traditionally, fermentation was based on the selective development of the flora contaminating raw materials, sometimes reinforced with 'back-slopping', the addition of a previously successfully ripened fermented sausage. Such practices, however, may induce great variability in the ripening changes determining safety and quality. The need for standardized processing and safety assurance led in the 1950s, first in the United States and later in Europe, to the commercial use of starter cultures to ensure rapid acidulation. Although excellent fermented sausages can be produced without starter cultures, the majority of fermented sausage produced nowadays makes use of 'combined' starter inoculation [$(1 \sim 2) \times 10^6$ g^{-1}] as frozen cultures of both lactobacilli and Micrococcaceae to ensure rapid acidulation and optimal flavour development, respectively. The desired properties of 'starters' are numerous and obviously include, above all, safety for the consumer and competitive growth compared to that of the contaminating flora of the raw materials under the conditions of sausage processing. Lipolytic and proteolytic activities have long been emphasized for flavour development, but it is now realized that muscle and fat tissue enzymes are by far the most important actors in these processes. Although recent developments consider the use of probiotic starter cultures, the major microorganisms now used as starters are classified into the following groups: lactic acid bacteria, Micrococacceae, yeasts and moulds.

2.2 参考翻译

发酵

1 引言

用盐和/或糖加调味料、草药以及其他植物性原料腌制斩碎的肉和脂肪，将这些腌制过得混合物灌装到肠衣中形成干制的香肠，这种生产方式可以追溯到公元前好几个世纪。从早期开始，人们通过采用不同种类的肉，调整其他成分和添加物的不同配比，控制温度和湿度条件，已经产生了至少56种不同的发酵肉制品。这些产品的货架期和安全性以及它们各自特殊的风味、质地、颜色等都是由以上因素通过不同的组合决定的，乳酸产

生导致的酸化以及添加食盐和干制引起的水分活度的降低，对它们也有一定的影响。

这些同时或者连续进行的过程称为做“发酵”。由于盐的存在，加盐或干制降低了水分活度，限制了氧气的利用率，越来越多的工业化生产中采用真空包装，让我们从污染或添加的菌群中挑选出耐盐菌，这些耐盐菌可以将混合物中本身存在或者添加的碳水化合物转化为乳酸。这种“发酵”可以将 pH 降低至 4.5～5.5，诱导盐溶性蛋白质变性成为可切片的凝胶。适当（快速）的降低 pH 和水分活度是决定货架期和安全性的最重要因素。

如今大量的研究工作已经形成了“肉发酵”期间许多详细的关于微生物学、生物化学、化学和物理变化之间的综合知识，偏重于两个主要研究方向：①对具备优良酸化特征、抗氧化和氨基酸降解酸度型发酵剂的需求；②蛋白质水解酶和脂肪分解酶在肉和/或脂肪原料中使用的重要性。

微生物、肉和脂肪酶之间复杂的相互作用和决定香肠质量的加工条件超出了发酵的概念，因此称之为“代谢”更好。

2 发酵香肠的加工

欧洲大陆的工业生产技术转移到美国和澳大利亚后，发酵肉制品的产品类型有所减小。这些发酵肉制品主要根据水分含量、水/蛋白质比率、重量损失、水分活度、表面处理方式、质地、脂肪粒大小以及其他参数等方式分类。

称为“成熟”的工业生产时期分为两个连续阶段：发酵和之后的干燥。其技术的区别主要在于发酵期后熟时间的长短。乳酸发酵的高起始速率取决于产乳酸发酵剂的应用和发酵过程中干燥期的高温。

流行于美国地区的发酵温度在 38℃的“熏香肠”，它的干燥阶段甚至会被忽略。在欧洲，所谓的北方香肠和地中海香肠就存在明显差别。北方香肠（NS）主要以牛肉和猪肉作为原料肉，经短期的成熟（3 周以上）和烟熏过程。这种方式生产的香肠货架期和安全性主要取决于 20°C 以上时 pH 的迅速降低（3 天后<5.0）和烟熏工艺，而不是干燥工艺。地中海香肠通常仅以猪肉为原料肉，成熟时间较长（几个星期甚至是几个月），且烟熏不是主要的操作，其酸解速度较慢，一般在较低温度（<20°C）时开始，在 pH 较高时（3 天后 pH>5）结束，货架期通常取决于干燥过程和水分活度的降低。

3 原材料和添加剂

冷冻肉（-4℃）和去外皮后的猪脂肪（≤18℃）通常都以 2：1 的比例混合。选择猪脂肪和猪碎肉（腿部、颚骨、喉部、肩部和腹部）各占 10% 和 20% 的猪胴体。猪肉选择主要依据细菌、可见脂肪含量、pH（<5.8）、不饱和脂肪（<12%，多不饱和脂肪酸）以及氧化的脂肪（最小过氧化值）的含量。广泛使用的添加剂是盐（2% ～4%），包含加入作为腌制盐的亚硝酸钠（0.4% ～0.6%），糖（0.5% ～1%），抗坏血酸钠或抗坏血酸（0.5% ～1%），还有部分香辛料。亚硝酸盐因其抗菌、发色、抗氧化以及增味作用，必须使用。

4 绞碎或斩拌

原材料和添加剂，包括微生物发酵剂，一起加入到绞肉机或者斩拌机中真空混合斩拌。斩拌机包含一套高速旋转刀具［（1～3）$\times 10^3$ r·min^{-1}］，肉糜在一个旋转缓慢的碗状容器（10～20 r·min^{-1}）中生成。刀片的相对速度、斩拌容器的大小、原材料的添加顺序和添加剂决定了脂肪微粒的大小，以及如何在温度小于等于2℃下，5分钟之内制备最佳肉糜，保证脂肪组织损坏最小。

5 灌肠

在大多数工业生产过程中，肉糜会在真空条件下立即充填到天然的、半合成或合成的透气透水的肠衣中，然后将两端修剪整齐。香肠直径（2～15 cm）与发酵期pH和干燥期水分活度的稳定性呈正相关。

6 成熟

将香肠悬挂于货架，放置在天然的或者有较高相对湿度的空调发酵室内。香肠成熟通常要有两个连续阶段：一是适合细菌生长的发酵，二是转移至另一发酵室，继续干燥，以形成合适的感官特征。发酵期间，北方型（20～26℃/50～90%/62 h）和地中海型（5～24℃/10%～90%/100 h）的发酵温度/相对湿度/时间不同，而干燥条件类似（14℃/78%），干燥时间是北方型两周而地中海型几个月。为了阻止香肠表面硬化，空气的相对湿度应低于香肠水分活度值不超过0.1，空气流速也应控制在约0.1 m·s^{-1}。可控的发酵和成熟，在空气可调节环境下会消耗大量的能量。受地中海类型香肠传统方法的启发，为适应当地气候条件，已经有人提议使用包括新鲜空气在内的替代方法。

7 烟熏

在发酵期结束后，北方型香肠要进行烟熏，控制橡木（300～600℃）燃烧所产生得烟雾减少多环烃的产生。烟熏除了产生特定的风味和色泽物质，还有抗菌和抗氧化的作用。除了匈牙利和罗马尼亚的产品在发酵前有一个轻微的烟熏过程，地中海式的香肠一般不使用烟熏。

8 微生物发酵剂的应用

传统上，发酵是基于原料微生物菌群中某些特定微生物的繁殖，有时也用“回种”来增强，就是将先前发酵好的原料香肠重新接种到新鲜原料里。然而，这种做法可能在成熟过程中引起很大的变化，从而改变最终产品的安全性和质量。20世纪50年代，先是美国而后是欧洲，引入标准化工艺和安全保障的需要，促使了以确保迅速酸化为目的的发酵剂的商业性使用。尽管不用发酵剂也可以生产出质量优良的发酵香肠，但是，为了确保产品迅速酸化和产生优良风味，现在大多数发酵香肠的生产都会接种［（1～2）$\times 10^6$ g^{-1}］“复合的”冷冻培养的乳酸杆菌和微球菌作为发酵剂。发酵剂所需的性能很多，首先包括消费的安全性以及与香肠生产条件下原料污染的杂菌竞争性生长的特性。长期以来，人们都在强调脂类分解和蛋白质降解反应是风味形成的主要途径，但是现在人们开始意识到肌肉和脂肪组织中的酶类是迄今为止风味形成的最重要因素。虽然最近也有

考虑用益生菌做发酵剂的，但是，目前作为发酵剂应用的微生物主要包括以下几种：乳酸菌、微球菌、酵母菌和霉菌。

3 阅读链接

[1] http://www.fao.org/docrep/015/i2477e/i2477e00.pdf

[2] http://www.formatex.info/microbiology/2/1160-1167.pdf

[3] http://www.foodadditives.org/cultures/IDF-IDJ-Food-Fermentations[1].pdf

4 课后作业

4.1 句子翻译

4.1.1 原句

(1) The chopping or mincing of meat and fat with curing salt and/or sugar together with spices, herbs and other plant material, followed by the stuffing of such mixture to form a 'sausage' that is left to dry is a practice dating back to centuries before the Common Era.

(2) This 'fermentation' lowers the pH to final values between 4.5 and 5.5, inducing the denaturation of salt-solubilized protein to a gel that can be sliced. The adequate (rapid) reduction of pH and the lowered aw are the major factors determining both shelf-life and safety.

(3) High initial rates of lactic acid production resulting from the use of lactic acid-producing 'starters' and/or high temperatures during fermentation are associated with short drying periods.

(4) In these sausages, shelf-life and safety are mainly due to the fast drop to acid pH (<5.0 after 3 days) at temperatures >20℃ and to smoking rather than to drying.

(5) The relative speeds of the knives and bowl and the sequence of addition of raw materials and additives determine the fat particle size and are optimized to produce a batter within less than 5 minutes at temperatures ≤2℃, ensuring minimal damage to the fat tissue.

(6) It is recommended to have air RH values not more than 0.10 points below the associated aw values of the sausage, to prevent case hardening, and recommended air speeds are approximately 0.1 $m \cdot s^{-1}$.

(7) Although excellent fermented sausages can be produced without starter cultures, the majority of fermented sausage produced nowadays makes use of 'combined' starter inoculation [$(1 \sim 2) \times 10^6\ g^{-1}$] as frozen cultures of both lactobacilli and Micrococcaceae to ensure rapid acidulation and optimal flavour development, respectively.

(8) Although recent developments consider the use of probiotic starter cultures, the major

microorganisms now used as starters are classified into the following groups: lactic acid bacteria, Micrococacceae, yeasts and moulds.

4.1.2 参考翻译

（1）用盐和/或糖加调味料、草药以及其他植物性原料腌制斩碎的肉和脂肪，将这些腌制过的混合物灌装到肠衣中形成干制的香肠，这种生产方式可以追溯到公元前好几个世纪。

（2）这种“发酵”可以将 pH 降低至 4.5～5.5，诱导盐溶性蛋白质变性成为可切片的凝胶。适当（快速）的降低 pH 和水分活度是决定货架期和安全性的最重要因素。

（3）乳酸发酵的高起始速率取决于产乳酸发酵剂的应用和发酵过程中干燥期的高温。

（4）这种方式生产的香肠货架期和安全性主要取决于 20°C 以上时 pH 的迅速降低（3 天后 pH<5.0）和烟熏工艺，而不是干燥工艺。

（5）刀片的相对速度、斩拌容器的大小、原材料的添加顺序和添加剂决定了脂肪微粒的大小，以及如何在温度小于等于 2℃下，5 分钟之内制备最佳肉糜，并且保证脂肪组织损坏最小。

（6）为了阻止香肠表面硬化，空气的相对湿度应低于香肠水分活度值不超过 0.1，空气流速也应控制在约 0.1 $m \cdot s^{-1}$。

（7）尽管不用发酵剂也可以生产出质量优良的发酵香肠，但是，为了确保产品迅速酸化和产生优良风味，现在大多数发酵香肠的生产都会接种［（1～2）$\times 10^6$ g^{-1}］“复合的”冷冻培养的乳酸杆菌和微球菌作为发酵剂。

（8）虽然最近也有考虑用益生菌做发酵剂的，但是，目前作为发酵剂应用的微生物主要包括以下几种：乳酸菌、微球菌、酵母菌和霉菌。

4.2 科技论文常见句型

（1）回顾研究背景，常用词汇有：review，summarize，present，outline，describe 等。

We review evidence for this view of …

This paper outlines some of the basic methods and discusses related …

（2）阐述写作目的，常用词汇有：purpose，attempt，ai，objective 等。

The aim of this paper is to provide methods to construct such probability distribution.

In order to achieve these objectives，… must meet the following requirements:

（3）介绍论文的重点内容或研究范围，常用词汇有：study，present，include，focus，emphasize，emphasis，attention 等。

This paper focuses on the promise of artificial neural networks.

We emphasize the following points …

（4）介绍研究或试验过程，常用词汇有：test，study，investigate，examine，analysis，

consider 等。

To improve the efficiency of the method, the following approach may be applied.

This approach will be explained and discussed thoroughly in the body of the report.

(5) 展示研究结果，常用词汇有：show, result, present, demonstrate 等。

The experimental results for … are reported in Table 2.

We show this cell death to be dependent upon expression of …

(6) 介绍结论，常用词汇有：summary, introduce, conclude 等。

Form the above discussion, the conclusion can be reached that …

In conclusion to this, it becomes obvious that the problem of … lies not only in …

(7) 陈述论文的论点和作者的观点，常用词汇有：suggest, report, present, explain, expect, describe 等。

A major goal of this report is to extend the utilization of a recently developed procedure for the …

We present representation and uniqueness theorems for the fundamental measurement of fuzziness when the domain of discourse is orderdense …

(8) 阐明论证，常用词汇有：support, provide, indicate, find, confirm, clarify 等。

The results indicate that the total benefits are higher than the total costs.

These results demonstrate that …

(9) 存在问题，常用词汇：problem, issue, question。

… is a difficult problem, yet to be adequately resolved.

Some important issues in developing a … system are discussed.

(10) 图表描述，常用词汇：Tables and Figures。

At the top of Table … are shown two blocks of data.

The graphical representation of these functions is shown in Figure …

Chapter 3　Food Technology

Unit 1　Food Processing

1　专业词汇分析

（1）substantial　adj. 本质的，实在的，大量的，重大的

［记忆窍门］可分解成“substant”+“ial”，其中“substant”跟“substance”（物质，实质）非常接近，“ial”常作为形容词的词尾，表示“…的”，合起来就是实在的，本质的。

（2）geographical　adj. 地理学的，地理的

［记忆窍门］该词为“geography”的形容词，“geography”由词根“geo”（地）+“graph”（写、文字）+“y”（名词后缀）组成，意为“关于大地的论述”，即“地理学”。

（3）perishable　adj. 易腐烂的

［记忆窍门］该词是由名词“perish”（腐烂，死亡）+“able”（形容词词尾，表示“…的，能”）组成。“perish”与“cherish”组成相近，可联想记忆为：珍惜（cherish）生命，不应随意死亡（perish）。

（4）scrutiny　n. 细看，监视，详细审查

［记忆窍门］该词可分解为“scru”（理解）+“tiny”（微小的）两部分，很微小的地方都需要去理解，当然要“详细审查”了。

（5）simultaneously　adv. 同时地

［记忆窍门］该词为形容词“simultaneous”+“ly”构成的副词。“simultanoues”可分解成“simul+tanoues”两部分，其中“simul”（一起，同时）源自拉丁语，而“taneous”可看成是“spontaneous（自动的，自发的）”的缩写，合起来即为“同时地”。

（6）peel　n. 果皮；vt 剥，削，剥落

［记忆窍门］该词发音类似于“皮儿”，很容易想到“果皮”。

（7）sterilize　vt. 消毒，杀菌

［记忆窍门］该词可分解为“steril”+“ize”构成，其中“steril”意为“不能生育的，无菌的，消过毒的”，“ize”为动词后缀，因此合起来，即为消毒，杀菌。

（8）dehull　vt. 除去…的壳（或皮等）

［记忆窍门］由前缀“de-”+“hull”构成，其中“de-”表示“去除”的意思，而“hull”为“外壳”，合起来即为除去…的壳（或皮等）。

（9）cylindrical　adj. 圆柱形的；圆柱体的

［记忆窍门］该词为“cylinder”（圆柱体）的形容词。“cylinder”谐音为谁拎的——圆柱体（cylinder）没有把柄，不好拿，是谁拎的（cylinder）。

（10）hexane n. 己烷

［记忆窍门］其中“ane”为烷烃的后缀。

（11）evaporate vt/vi.（使）蒸发；（使）脱水；（使）消失

［记忆窍门］该词由“e”（出）+“vapor”（蒸气）+“ate”（使），合起来为“使蒸气出来”，即为蒸发。

（12）contaminate vt. 污染，玷污；弄脏

［记忆窍门］该词由“con”（共同）+“tamin”（接触）+“ate”（吃），多人共同接触吃的，肯定会把它“污染”了。

（13）shelf-life n. 贮藏寿命，货架期

（14）irradiation n. 辐照，照射，放射

［记忆窍门］该单词为“irradiate”的名词形式，可分解为“ir”（进入，使……成为）+“radi”（发光）+“ate”（使），合起来“使进入发光”，即辐照，照射。

（15）pathogen n. 病原体；病菌

［记忆窍门］该词由“patho”（痛苦，疾病，不好的感觉）+“gen”（原），合起来即为疾病之原（源）——病菌。

（16）intermediate adj. 中间的，中级的；n 中间物；媒介

［记忆窍门］该词可分解为“inter”（在…之间，相互）+“medi”（中间）+“ate”（…的），合起来即为中间的。

（17）pesticide n. 杀虫剂

［记忆窍门］该词由“pest”（害虫）+“icide”（杀害者）组成，合起来即为杀虫剂。

（18）disinfectant n. 消毒剂；adj 消毒的

［记忆窍门］该词由前缀“dis”（表否定）+“infect”（传染，感染）+“ant”（名词后缀）组成，能够阻止传染的东西，即为消毒剂。

2 课文

2.1 原文

Food Processing[①]

1 Overview

The food processing industry transforms the products of agriculture into the foods and drinks we consume daily. The industry is relatively diverse, dealing with some products that need minimal processing, such as fresh fruits and vegetables, and others that require substantial secondary processing to create a final product, such as dry cereal or baked goods.

The food processing industry has an interesting structure that is determined partly by the ge-

① 选自：Greening the Industrial Facility: Perspectives, Approaches, and Tools. Heidelberg: Springer Publisher, 2005, 239-255. 作者：Thomas Graedel, Jennifer Howard-Grenville.

ographical distribution of its raw materials, the products of agriculture. In the European Union, 92% of food and drink processors are small or medium sized companies. Some processors are located in rural areas while others are more industrial in scale, e. g. , large sugar plants. Some processors, like olive oil producers, have a highly seasonal production cycle that is determined by the harvest, while others, like dairy processors, have a more stable production cycle. Perishable items, like fruits and vegetables, tend to be processed and packed near their source, whereas other products, like soft drinks, are produced closer to population centers and sources of water.

The food processing industry is a heavily regulated industry, with regulatory scrutiny focused primarily on the quality and safety of the products delivered to the consumer rather than on environmental aspects of production. In recent years, however, the industry has made progress in improving environmental performance through waste minimization (which also increases production efficiency). Solutions that simultaneously address the quality and safety of the products and the environmental performance of the production process will be particularly attractive to this industry.

2 Physical and Chemical Operations

1) Physical Operations

Many of the operations used in processing foods and drinks are physical in nature. Raw materials are received, sorted, cleaned, cut, blended, ground, formed, or mechanically separated before they are either packaged or sent for further processing or heat treatment. The production of canned juices, for example, consists of the following steps illustrated in Figure 1: washing, extracting, straining, container filling, container sealing, cooling, labeling, casing, and storing for shipment. Where vegetables are concerned, peeling, coring, cutting, cooking, and heat sterilizing are included in the process.

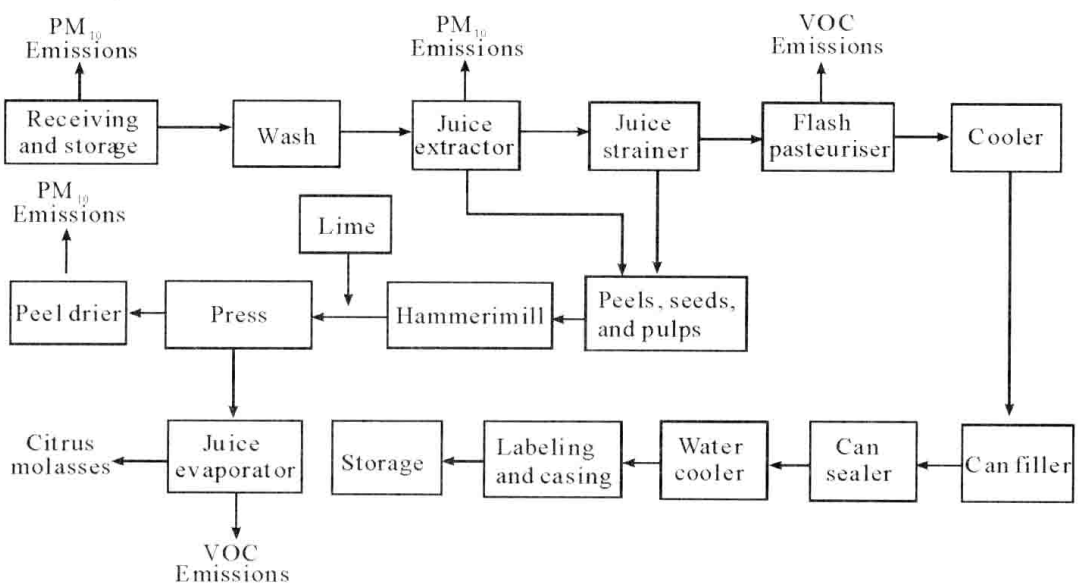

Figure 1 The technological sequence diagram for the food processing industry

The production of soybean oil is slightly more complex, with a number of physical processes used to prepare the beans for the subsequent extraction of the oil. Figure 2 shows the typical steps

in preparation and extraction. The beans enter a mill on conveyor belts and are weighed, cleaned of metal using magnets, and passed through a roller for "cracking" into several pieces. The hulls are removed from the cracked beans by aspiration, and the cracked beans are heated slightly prior to being pressed through a cylindrical roll which forms them into flakes. The oil is extracted from the flakes by washing them in a hexane solvent. The solvent is then evaporated from the oil and the flakes and steam is used to desolventise the oil further. Residual hexane is removed using mineral oil scrubbers. The oil is then stored for further processing or packaging.

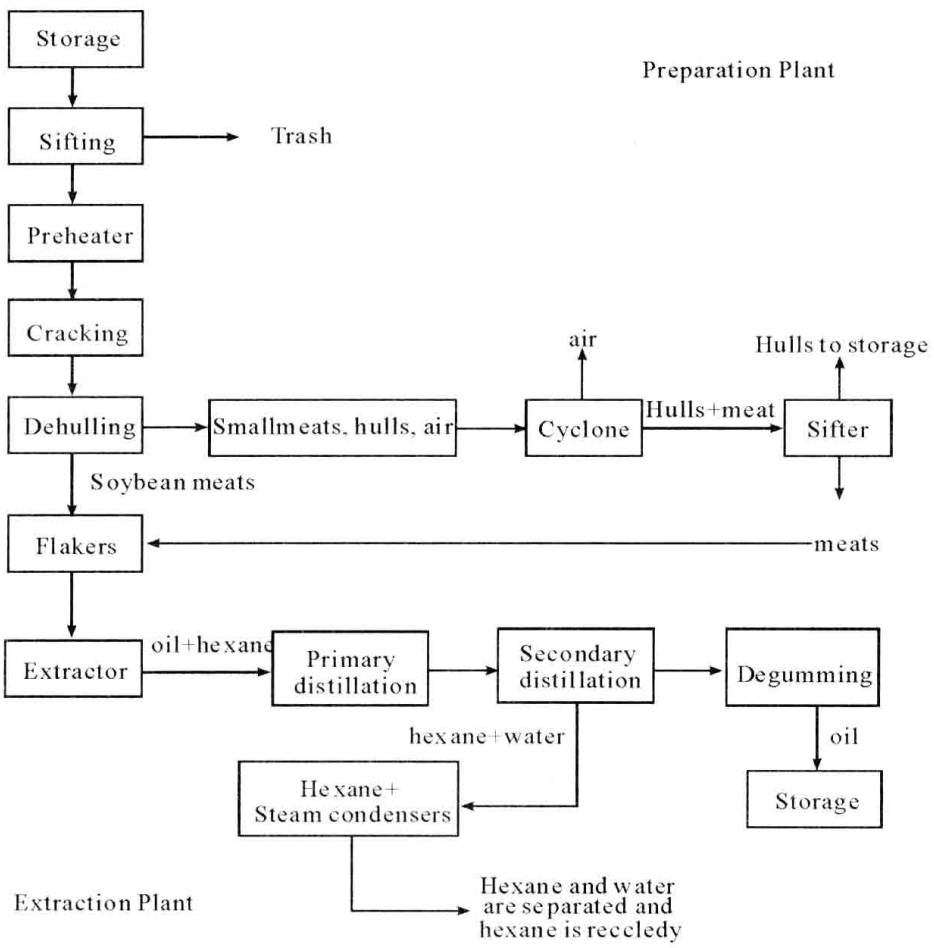

Figure 2 Process steps in the preparation of oil from soybeans

2) Chemical and Biological Operations

Chemical and biological operations play an important role in the manufacture of many foods and beverages, including bread, cheese, yogurt, beer, wine, and meats.

Fermentation is used to alter the texture, preserve, or produce certain flavors and aromas in foods and beverages, while curing is used to preserve and alter the flavor of meats.

Fermentation involves the controlled used of biological organisms to break down the sugars in food into either alcohol or lactic acid. To produce beer or wine, yeast is used to break down sugars and produce ethanol and carbon dioxide, as shown in the equation.

$$C_6H_{12}O_6 \longrightarrow 2C_2H_5OH + 2CO_2$$

Breadmaking uses yeast fermentation to leaven the bread (i. e., to generate carbon dioxide to cause the bread to rise) and the ethanol in this case is released to the air.

Cheese and yogurt are produced using various bacterial cultures to break down the lactose in milk and produce lactic acid. Different bacteria give different tastes and aromas, and the conditions under which these cultures are used must be carefully controlled to prevent contamination or spoilage. Fermentation processes also require close regulation of temperature and may require extended periods of storage at specific temperatures, resulting in energy and cooling water consumption.

Meat is cured by adding common salt (NaCl) and a source of nitrite from a curing salt (including $NaNO_3$, $NaNO_2$, KNO_3, or KNO_2). A pigment in the meat reacts with nitrite to give the meat a certain color. The presence of the salt and nitrite in the meat inhibits the growth of organisms and increases its shelf-life.

A final type of operation that is starting to be employed in the food processing industry is irradiation. Low-dose radiation applied to foods can kill pathogens like E. coli and salmonella, and hence increase shelf-life of the products. It can also inhibit ripening or sprouting in fruits and vegetables. Foods that are irradiated must be labeled as such in the U. S., a factor that may inhibit the use of this technique as the public is wary of consuming irradiated products. If public perception changes, the irradiation of foods will become more widespread over the next decade or so. Food safety and purification are central concerns in this sector. As a result, much of the water used in the industry is drinking-water quality. This requirement tends to be in opposition to the desire to reduce energy and water use for environmental reasons.

3 The Sector's Use of Resources

1) Energy

The food processing industry is not as energy intensive as the heavy industries, like mining, metal processing, and chemicals. However, the industry ranks relatively high (fifth) on the use of energy by all industrial sectors. The food processing sector uses 5.9% of the total energy consumed by U. S. industry for fuel uses. Similarly, in Germany, the food processing industry uses 6.7% of the total energy consumed by industry, and ranks as the fifth largest energy-consuming sector.

Some subsectors of the food and beverage industry are much more energy intensive than others. For example, the manufacture of sugar involves the use of steam and direct heat for evaporation (sugar beets are 75% water). Sugar manufacture ranks highest in energy consumption of the sub-sectors of the German food industry. Other subsectors that rely on heating, cooling, freezing, or the storage and transportation of bulky raw and processed products are also relatively heavy consumers of energy. For example, 77% of the electricity used for the transportation and storage of frozen vegetables is consumed by compressors.

2) Water

The food and beverage industry has historically been a large consumer of water. Water is used as a primary ingredient (e. g. , in the manufacture of beverages), as well as to clean ingredients and equipment, to transport raw materials in a plant, and for heating and cooling. Data for Germany show that, the food and drink industry uses about 5% of the total water consumed by industrial sources, but it uses about 30% of all drinking water consumed by industrial sources. Overall, almost two-thirds of the water used by the industry is of drinking-water quality and some subsectors, like soft drink, beer, and dairy manufacture, use drinking water almost exclusively.

The amount of water used for some practices, like washing and rinsing, may be set by regulation. For example, the U. S. Department of Agriculture (USDA) defines minimum standards for the amount of water needed to clean poultry products. While water will always be an important resource for the food and beverage industry, there is scope for conservation and reuse, especially in its non-ingredient uses.

3) Materials and Process Chemicals

The raw materials used in the food and drink industry are primarily products of agriculture. Some subsectors, like fruits and vegetables, rely directly on agricultural products, while others, like breadmaking, rely on intermediate products that have been derived from agricultural products. The abundance or scarcity of these raw materials, or ingredients, is determined by the output of the agricultural sector.

Consumer preference will also, to some degree, dictate the supply of raw materials used in the food and beverage industry. In recent years, for example, sub-sectors of the food industry have developed product lines to serve consumers who wish to avoid consuming foods containing genetically modified organisms (GMOs). At the same time, agricultural biotechnology companies are developing techniques to improve the productivity or alter the properties of seeds and crops, potentially changing both the quantity and quality of the raw materials provided to the food processing industry.

Whether and how extensively agricultural biotechnology will change the supply of raw materials to the food processing industry remains to be seen. A complex set of issues surrounding consumer preference, government regulation, technology, and international trade are involved. U. S. consumers seem generally more receptive to agricultural biotechnology than are their counterparts in Europe and Japan. U. S. farmers have adopted the technology most widely; 70% of the biotech crops planted worldwide are planted in the U. S. On the other hand, major food processors and retailers, including McDonalds and Frito-Lay, have declared that they will not use ingredients produced using biotechnology. Regardless of the rate of change in the industry in terms of adopting or abandoning agricultural biotechnology, fundamental scarcity of raw materials seems unlikely to

pose a major problem for the food and beverage industry. Scarcity of agricultural products is typically a question of distribution rather than quantity.

4 Potential Environmental Concerns

1) Releases to Land

Solid wastes released by the food processing industry consist largely of organic waste derived from food waste such as trimmings and peelings. While they are typically very high in nitrogen and phosphorous, these organic wastes are not of very high volume relative to the waste generated by other industrial sectors. Some organic wastes are reused as components of fertilizer or animal feed. However, much of the solid waste from food processing is disposed of by conventional means, to landfill, by incineration, or by composting.

A second source of solid waste is the packaging of foods and beverages. This includes both end-consumer packaging, and the packaging used to handle and transport the products within a plant and to retail locations. Use of reusable plastic totes in a plant or substitution of packaging materials for more environmentally favorable ones are examples of attention to this solid waste issue. Some packages are used almost exclusively by this industry; 95% of all steel cans produced are used by the food and beverage industry, for example.

2) Releases to Water

Just as the food processing industry is a large consumer of water; it is a large producer of wastewater. Cleaning of the raw materials is the biggest user of water in the industry. The quality of wastewater emitted is of as much, or more, concern than the quantity. Waste water from food processing is unique among industrial wastewater in that it is relatively low in metals and inorganics, but very high in organic contaminants.

Food processing waste water is highly variable, but it is typically very high in biochemical oxygen demand (BOD) and chemical oxygen demand (COD). A high BOD level is associated with high levels of dissolved and/or suspended solids, minerals, and organic nutrients containing nitrogen and phosphorus. Wastewaters with high BOD cannot be released directly to an aquatic environment or POTW (publicly owned treatment works) and will typically be pretreated to lower the BOD. The pH of food processing wastewater can also vary a great deal depending on the natural pH of the raw material, and the process steps used (e. g., dairy operations can produce acid waste streams). Wastewater from the fruit and vegetable subsector may contain residual pesticides, while that from the meat subsector will contain fats and oils.

A final component of the wastewater that is of concern in this industry is pathogens. Such organisms may be present in the water used to clean and process meats, poultry and seafood. Chlorine is typically used to disinfect the wastewaters prior to their discharge, but alternative techniques using UV light or ozone as disinfectants are starting to be used to reduce the use of chlorine.

3) Releases to Air

Air emissions from the food processing industry contain few hazardous compounds. The release of volatile organic compounds (VOCs, involved in smog production) is common, however. Air emissions from brewery operations are among the more significant among the industry's subsectors, and they largely consist of CO_2, ethanol, particulates, and by-products of combustion. Odors can be a significant concern from many food processing plants, but they are difficult to control by regulation and are typically treated as a nuisance rather than an environmental concern. Many food processing plants have some form of odor controls in place.

5 Possible Future Scenarios

1) Trend World

The trend world for the food processing sector is a world of gradually increasing efficiency in manufacturing, packaging, and distribution. Energy and water will be used with gradually improving attention to conservation (and reuse where possible). Better refrigeration and management will decrease food wastage. Escalating pressures for more convenient foods will result in increased packaging per unit of food, however, and an accompanying increase in the costs of shipment and storage will be realized.

2) Green World

In an environmentally superior world, emphasis will be placed on locally derived foods to the degree possible, cutting transport and packaging challenges substantially. Spoilage will be reduced to very low levels by improved control of processing and refrigeration, and by the safe irradiation of a number of food products. Packaging will be reduced, and may be either biodegradable or edible. The world will grow enough food for all its citizens, and will process, package, and distribute it so that hunger is no longer a problem, even in relatively poor countries.

3) Brown World

In a brown world, scarcity of energy and water in many parts of the world will increase the rate of spoilage of whatever food is available. Food distribution will be hampered by a shortage of transportation fuels, and at the same time the increasing desire for convenience will make locally-sourced food less viable. Continued problems with food safety will raise its cost and force tradeoffs with environmental goals. Rapid climate changes will have resulted in rapidly changing mixes of available food products, and processing facilities and machinery have been unable to adjust in an efficient manner.

2.2 参考翻译

食品加工

1 概述

食品加工业把农产品转变为我们日常消费的食品和饮料。食品加工业种类多样，既涉及到一些只需要最少化加工的产品，如新鲜果蔬，又涉及到那些需要大量的二次加工的制成品，如干麦片或焙烤食品。

在一定程度上，农产品原料的地域分布情况决定了食品加工业的结构。在欧盟国家，92%的食品和饮料加工企业都是一些中小型公司。有些加工业坐落在农村地区，而另外一些更加工业化，比如大规模的制糖加工厂。有些加工业有很强的季节性，比如橄榄油加工业，由于采收的原因，生产有很强的季节性周期，而其它加工业，比如乳制品加工业，则具有更稳定的生产周期。易腐烂的果蔬类往往在它们的产地被加工和包装，而软饮料的生产则更靠近人口密集地和水源区。

食品加工业是受到严格监管的一个行业，这种监管主要集中在对运送到消费者手中的产品的质量和安全上，而不是生产的环保方面。然而，最近几年，该行业通过废物最少化（也能提高生产效率）在提高生产过程的环保方面取得了进步。因此，既能保证食品的质量和安全，又能提高生产的环保性的技术将越来越受到该行业的关注。

2 理化处理

1）物理法处理

在加工食品和饮料时，很多操作都是采用的物理方法。原材料在经过采收、分级、清洗、切分、混合、破碎、成型或机械分离后进行包装、深加工和热处理等操作。例如，罐装果汁的生产包括以下几个步骤（图1），清洗、提取、压榨、罐装、封罐、冷却、贴标、装箱、储存。对于蔬菜类加工还包括去皮、去核、切分、蒸煮和加热灭菌的操作。

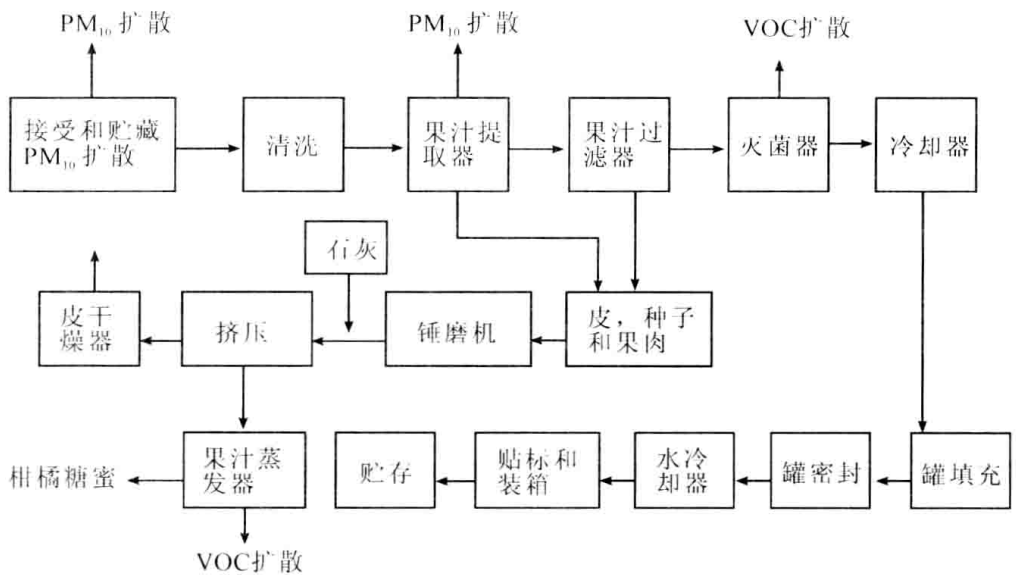

图1 食品加工流程图

为了便于油脂的后续提取，大豆需要大量的物理法进行预处理，因此大豆油的生产过程更复杂些。如图2即为预处理和提取过程的典型步骤。大豆进入到粉碎机的传送带上经称重、磁选和穿过圆筒进行破碎。通过风选除去豆皮，再将破碎的大豆加热并通过圆柱滚筒压成薄片状料坯。之后用正己烷作为溶剂从料坯里浸提豆油，溶剂从油和料坯里被蒸发除去，蒸汽可进一步提取油脂。残留的正己烷通过矿物油洗涤器除去。然后，油被贮存起来用于进一步地加工或包装。

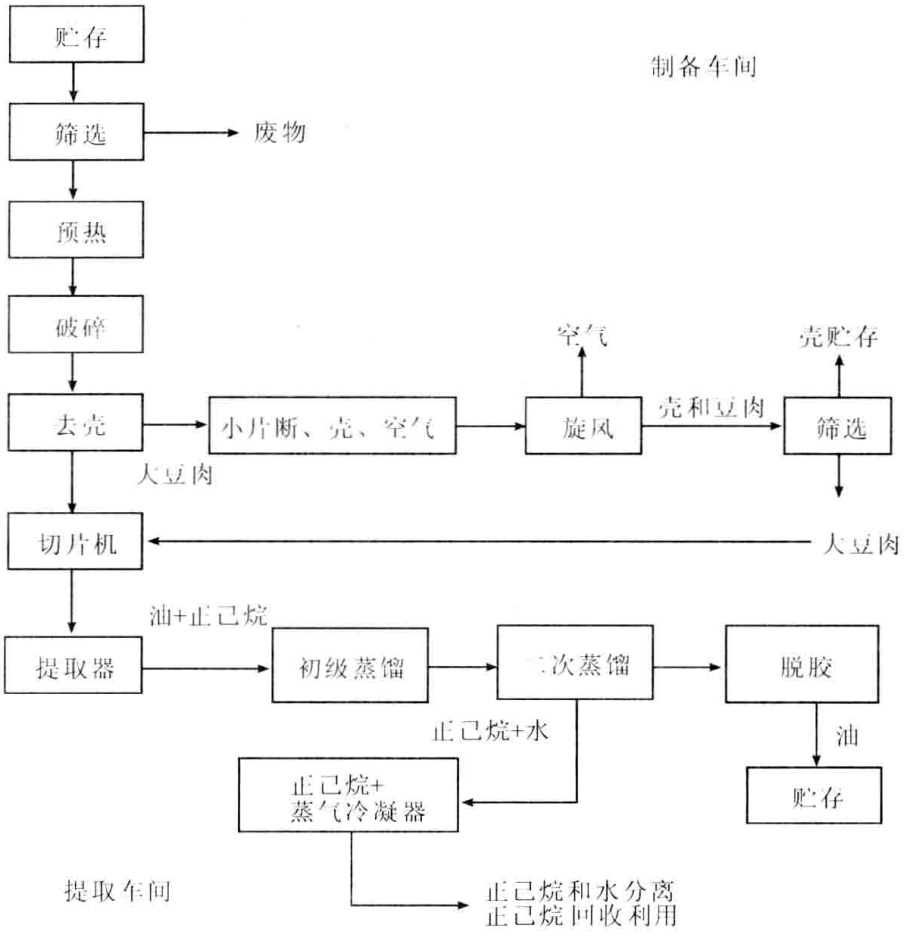

图2 从大豆中制备豆油的处理工艺

2）化学和生物处理

化学和生物处理在许多食品和饮料的生产中起着很重要的作用，包括面包、奶酪、酸奶、啤酒、白酒和肉制品。

发酵可以改变食品的组织结构，利于保藏和产生食物和饮料中某些特定的风味和芳香物质，同时腌制也利于肉的保藏和改变其风味。

发酵就是通过控制微生物来将食品中的糖类降解为酒精或乳酸的过程。在生产啤酒或白酒的过程中，利用酵母菌分解糖类产生酒精和二氧化碳，如下式所示：

$$C_6H_{12}O_6 \longrightarrow 2C_2H_5OH + 2CO_2$$

面包制作中常用酵母菌发酵作用（产生的二氧化碳使面包膨胀起来），然后产生的酒精挥发到空气中。

奶酪和酸奶的制作是用各种细菌培养物来降解牛奶中的乳糖产生乳酸。不同的细菌可以产生不同的风味，同时要很好地控制细菌培养物的生长环境以免造成杂菌污染和细菌腐败。发酵工艺也需要对温度进行精确调控，以及在特定温度下延长贮藏期，因此需要消耗能源和冷水。

肉的腌制就是向肉中添加食盐（氯化钠）和亚硝酸盐（硝酸钠、亚硝酸钠、硝酸钾、或亚硝酸钾）。肉中的色素与亚硝酸盐反应产生肉类特定的色泽。肉中的食盐和亚硝酸盐可以抑制微生物的生长和延长食品货架期。

辐射技术是新应用到食品加工业的一种处理。食品中低剂量的辐射可以杀死致病菌如大肠杆菌和沙门氏菌，因此能够延长食品的货架期。它也可以抑制果蔬的成熟和发芽。由于公众对辐照食品的担心，在美国辐照食品必须标注，这或许会限制这一技术的应用。如果公众的认知有所改变的话，在未来的十年中食品辐照可能会得到广泛应用。

在生化处理中，食品安全和纯化是人们关注的焦点。因此，很多加工用水都是饮用水级别的。这种要求与出于环境因素考虑而降低能源和节约用水的愿望正好相反。

3 部门的资源利用

1）能源

食品加工业不像重工业如采矿业、冶金和化工业的能耗那么大。然而，该行业的能源消耗在整个工业中相对较高（排第五）。在美国，食品加工业消耗了工业能源消费总量的5.9%。同样地，在德国食品加工业占整个工业能源消耗量的6.7%，位居第五大耗能业。

食品和饮料工业中某些分部门的耗能还是很大的。例如，制糖业需要使用水蒸汽和直接加热蒸发（甜菜的含水量为75%）。制糖业在德国食品加工业各部门中耗能最大。其他需要加热、冷却、冷冻、大量原料和制成品的储存和运输等过程中消耗的能源也相对较大。例如，在冷冻蔬菜的运输储存过程中压缩机消耗77%的电量。

2）水资源

一直以来，食品和饮料加工业是耗水量很大的工业。水是加工食品的基本原料（如饮料业的生产），同时也用于清洗原料和设备、运输原材料和加热冷却等过程。德国有数据表明，食品和饮料加工业的耗水量大约占整个工业的5%，占饮用水消耗总量的约30%。总之，在食品业2/3的水是饮用水级别的，其他如软饮料、啤酒和牛奶的生产，几乎完全使用饮用水。

很多单元操作中如清洗和漂洗所需要的水量都要符合一定的标准要求。例如，美国农业部规定了清洗禽肉产品用水量的最低标准。虽然水一直是食品和饮料行业中重要的资源，但是应该在一定程度上节约用水和循环使用，特别是当水不作为主要成分使用的时候。

3）原料和生产中的化学药品

用于饮食工业的原材料主要是农产品。像水果蔬菜类行业直接依赖于农产品，其他

的，像面包制作类依赖于来自农产品的中间产品。这些原材料的充足或稀缺是由农业部门的产量决定的。

在饮食行业内，消费者的喜好一定程度上也影响了原材料的使用。例如，近几年，食品工业的一些行业专门为不喜欢转基因食品的消费者开发产品生产线。与此同时，农业生物技术公司正在发展技术以提高生产率或者改变种子和作物的特性，从而改变食品加工原料的质和量。

农业生物技术能否以及怎样广泛地改变食品加工工业中原材料的供给尚未可知，涉及到消费者的喜好、政府监管、科学技术和国际贸易等一系列复杂的问题。与欧洲和日本相比，美国消费者更能接受农业生物技术。美国农民已经广泛采用了这些技术，全球70%的生物技术作物种植在美国。另一方面，包括麦当劳和菲多利的主要食品生产商及加工商已经明确声明，他们不会使用生物技术生产的原料。抛开采用或放弃农业生物技术的角度来改变加工业，原材料的基本缺乏不可能成为食品和饮料工业发展的一个大问题。农产品的短缺主要是由于分布不均造成的，而不是数量方面的问题。

4 潜在的环境问题

1）土地排放物

食品加工业排放的固体废料大部分是由有机废料组成的，这些有机废料来自于像整理、去皮等食品废料。它们富含氮和磷，但与其他行业的废料比起来它们的量并不高。一些有机废料可以作为肥料或者动物饲料的组成部分再利用。然而，多数的食品加工固体废料用传统的方法处理，通过填埋、焚化或者堆制肥料进行处理。

固体废料的第二个来源就是食品和饮料的包装。这包括终端消费者的包装，以及产品在工厂和零售地之间处理和运输时的包装。工厂里可重复使用的塑料手提袋，以及更加环境友好型包装替代材料都是人们开始关注固体废物的例子。一些工业使用专门的包装，例如，95%的钢罐都被用到了饮食工业。

2）水排放物

正因为食品加工工业需要大量水，它产生的废水自然也很多。在工厂里，原材料的清洗是最大的用水。相比于废水的数量，它的质量同样甚至更令人关心。食品加工的废水非常独特，因为它金属和无机物含量较低，而有机污染物含量很高。

食品加工废水可变性很高，但是通常它的生化需氧量（BOD）和化学需氧量（COD）很高。高生物需氧量与溶解或者悬浮的固体、矿物质、和含氮磷的有机营养物的含量高有关。这类废水不能直接排放到环境中或者公共污水处理厂，通常会先把BOD降下来。食品加工废水的pH会依据原材料的天然pH和使用的加工工艺而变化（例如，乳制品的操作会产生酸性废液）。水果和蔬菜加工产生的废水会包含残留的农药，而肉质制品的会有脂肪和油。

另外，人们比较关心的是工厂废水里含有病原体。在用来清洗和加工肉、家禽和海产品的废水里，这些生物可能会存在。氯通常用于废水排放之前的消毒，但是以紫外线

或者臭氧作为消毒剂的技术也开始被使用以减少氯的使用。

3）大气排放物

来自食品加工业的空气排放物包含很多有害物质。而挥发性有机化合物的释放是最常见的。酿酒厂的空气排放物是所有工业中最严重的，它的排放物中多是 CO_2、乙醇、微粒和燃烧的副产物。气味是很多食品加工厂非常关心的，但是他们会通过管理进行不同的控制，通常会把它看做是麻烦事而不是一个环境问题。许多食品加工厂都采取了一些就地的气味控制措施。

5 未来情景展望

1）世界趋势

食品加工业的趋势是在加工制造，包装和分配方面效率逐渐增大。能源和水的使用要逐步把注意力放到保护上（和尽可能的再利用）。更好的冷藏和管理能减少食品浪费。对于更加方便的食品的日益需求，将会增加单位食物的包装成本。然而，人们也会认识到与之相伴随的运输和贮藏成本的上升。

2）绿色环保的世界

在一个环境优越的世界里，应该更强调尽可能地从当地获取食品，充分减少运输和包装带来的挑战。食品腐败将会通过改善工艺和冷藏，以及安全照射等方式降到非常低的水平。通过采用生物降解或者可食用的材料，包装成本也会减少。这个世界会为人类提供足够的食物，然后进行加工、包装和分配，因此，即使是在相对贫穷的国家里，饥饿也不再是问题。

3）阴郁的世界

在一个阴郁世界里，许多地方能源和水的不足会增加食品败坏的速度，无论食品作何种包装。食品的分配会受到运输燃料不足的束缚，同时，人们日益增长的对舒适生活的追求将会降低本地食品生产。持续出现的食品安全问题提高了食品的成本，迫使产品生产与环境要求相适应。快速的气候变化将会导致现有食品的快速变化组合，加工设备和机械将不能有效地调整。

3 阅读链接

[1] Thomas Graedel, Jennifer Howard-Grenville. Greening the Industrial Facility: Perspectives, Approaches, and Tools. Heidelberg: Springer Publisher, 2005, 239-255

[2] http://link. springer. com/content/pdf/10. 1007/s11947-009-0207-x. pdf

4 课后作业

4.1 句子翻译

4.1.1 原句

(1) The industry is relatively diverse, dealing with some products that need minimal processing, such as fresh fruits and vegetables, and others that require substantial secondary processing to create a final product, such as dry cereal or baked goods.

(2) Solutions that simultaneously address the quality and safety of the products and the environmental performance of the production process will be particularly attractive to this industry.

(3) Fermentation processes also require close regulation of temperature and may require extended periods of storage at specific temperatures, resulting in energy and cooling water consumption.

(4) This requirement tends to be in opposition to the desire to reduce energy and water use for environmental reasons.

(5) Regardless of the rate of change in the industry in terms of adopting or abandoning agricultural biotechnology, fundamental scarcity of raw materials seems unlikely to pose a major problem for the food and beverage industry.

(6) Use of reusable plastic totes in a plant or substitution of packaging materials for more environmentally favorable ones are examples of attention to this solid waste issue.

(7) Chlorine is typically used to disinfect the wastewaters prior to their discharge, but alternative techniques using UV light or ozone as disinfectants are starting to be used to reduce the use of chlorine.

(8) Escalating pressures for more convenient foods will result in increased packaging per unit of food, however, and an accompanying increase in the costs of shipment and storage will be realized.

(9) In an environmentally superior world, emphasis will be placed on locally derived foods to the degree possible, cutting transport and packaging challenges substantially.

(10) Rapid climate changes will have resulted in rapidly changing mixes of available food products, and processing facilities and machinery have been unable to adjust in an efficient manner.

4.1.2 参考翻译

(1) 食品加工业种类多样，既涉及到一些只需要最少化加工的产品，如新鲜果蔬，

又涉及到那些需要大量二次加工的制成品，如干麦片或焙烤食品。

（2）既能保证食品的质量和安全，又能提高生产的环保性的技术将越来越受到该行业的关注。

（3）发酵工艺也需要对温度进行精确调控，以及在特定温度下延长贮藏期，因此需要消耗能源和冷水。

（4）这种要求与出于环境因素考虑而降低能源和节约用水的愿望正好相反。

（5）抛开采用或放弃农业生物技术的角度来改变加工业，原材料的缺乏不可能成为食品和饮料工业发展的一个大问题。

（6）工厂里可重复使用的塑料手提袋，以及更加环境友好型包装替代材料都是人们开始关注固体废物的例子。

（7）氯通常用于废水排放之前的消毒，但是以紫外线或者臭氧作为消毒剂的技术也开始被使用以减少氯的使用。

（8）对于更加方便的食品的日益需求，将会增加单位食物的包装成本。然而，人们也会认识到与之相伴随的运输和贮藏成本的上升。

（9）在一个环境优越的世界里，应该更强调尽可能地从当地获取食品，充分减少运输和包装带来的挑战。

（10）快速的气候变化将会导致现有食品的快速变化组合，加工设备和机械将不能有效地调整。

4.2 科技论文常见句型

（1）The purpose of the present study was to …

（2）…were characterized by …

（3）It was found that …

（4）This result is compatible with the …

（5）Considering that …

（6）It is worth pointing out that …

（7）As can be seen …

（8）The present study demonstrated that …

（9）This study deals with …

（10）This result was in opposition to …

Unit 2 Food Preservation

1 专业词汇分析

（1）inactivating n. 钝化

［记忆窍门］“active”意为“积极的，活跃的”；前缀“in”表示“否定”，“inactivating”意为“不活跃的”，使之不活跃，即钝化。

（2）biopreservatives n. 生物防腐剂

［记忆窍门］“bio”为“生物”，“preservatives”为“防腐的”，合在一起即为生物防腐剂。

（3）antimicrobial adj. 抗菌的

［记忆窍门］前缀“anti-”意为“反对的”，“micro”意为“微小的”，“bio”即“生物”，组合即是抗微小生物的，即抗菌的。

（4）decontaminate v. 净化

［记忆窍门］前缀“de”表示“离开，去除”；“contaminate”意为“污染”。除去污染即为净化。

（5）artificially adv. 人为地

［记忆窍门］“art”指“艺术”，而艺术多由人创作，词尾“ly”多表示词性为副词，综上可以联想到词意为人为地。

（6）fermented adj. 酿造；v. 使发酵

［记忆窍门］“ferment”谐音发馒头，而馒头属于发酵食品，可以联想到“fermented”即为酿造的意思。

（7）textural adj. 组织的，结构的

［记忆窍门］“text”意为“课文，文本”，既然是课文一定有其逻辑结构和一定的思路，语言也是经过组织的，由此可以记住“textural”意为组织的，结构的。

（8）radiation n. 辐射，放射物

［记忆窍门］“radia”与“radio”形似，“tion”发音谐音射，“radiation”即是能类似广播一样发射信号，即可联想到辐射。

（9）modified atmosphere packaging（MAP） 气调贮藏包装

（10）preservation n. 保存，保藏

（11）dehydration n. 脱水，去湿，干燥

［记忆窍门］前缀“de-”意为“除去”，“hydration”意为“水合作用”，组合即是脱水，干燥。

（12）superchilling n. 过冷

[记忆窍门] 前缀“super-”意为“过度的”，“chilling”意为“冷却，寒冷”，组合即是过冷。

(13) hurdle technology (HT) n. 栅栏技术

(14) recrystallisation n. 重结晶；再结晶

[记忆窍门] 前缀“re-”意为“再、反”，“crystallisation”意为“结晶、结晶作用”，组合即是重结晶，再结晶。

(15) food and agricultural organization (FAO) 联合国粮食与农业组织

(16) world health organization (WHO) 世界卫生组织

(17) polyvinylidene n. 聚乙二烯

[记忆窍门] 前缀“poly-”意为“多、聚”，“vinylidene”意为“亚乙烯基”，组合即是聚乙二烯。

2 课文

2.1 原文

A Review on Fresh Meat Preservation Technologies①

Abstract: Fresh meat is a highly perishable product due to its biological composition. Many interrelated factors influence the shelf life and freshness of meat such as holding temperature, atmospheric oxygen (O_2), endogenous enzymes, moisture, light and most importantly, micro-organisms. With the increased demand for high quality, convenience, safety, fresh appearance and an extended shelf life in fresh meat products, alternative non-thermal preservation technologies such as high hydrostatic pressure, superchilling, natural biopreservatives and active packaging have been proposed and investigated. Whilst some of these technologies are efficient at inactivating the micro-organisms most commonly related to food-borne diseases, they are not effective against spores. To increase their efficacy against vegetative cells, a combination of several preservation technologies under the so-called hurdle concept has also been investigated. The objective of this review is to describe current methods and developing technologies for preserving fresh meat. The benefits of some new technologies and their industrial limitations are presented and discussed.

Keywords: fresh meat, preservation technologies, superchilling, hhp, natural biological preservation, packaging

1 Introduction

Meat is defined as the flesh of animals used as food. The term 'fresh meat' includes meat from recently processed animals as well as vacuum-packed meat or meat packed in controlled-at-

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mospheric gases, which has not undergone any treatment other than chilling to ensure preservation. The diverse nutrient composition of meat makes it an ideal environment for the growth and propagation of meat spoilage micro-organisms and common food-borne pathogens. It is therefore essential that adequate preservation technologies are applied to maintain its safety and quality. The processes used in meat preservation are principally concerned with inhibiting microbial spoilage, although other methods of preservation are sought to minimise other deteriorative changes such as colour and oxidative changes.

A number of interrelated factors influence the shelf life and keeping quality of meat, specifically holding temperature, atmospheric oxygen (O_2), endogenous enzymes, moisture (dehydration), light and, most importantly, micro-organisms. All of these factors, either alone or in combination, can result in detrimental changes in the colour, odour, texture and flavour of meat. Although deterioration of meat can occur in the absence of micro-organisms (e. g., proteolysis, lipolysis and oxidation), microbial growth is by far the most important factor in relation to the keeping quality of fresh meat. Traditionally, methods of meat preservation may be grouped into three broad categories based on control by temperature, by moisture and, more directly, by inhibitory processes (bactericidal and bacteriostatic, such as ionising radiation, packaging, etc.), although a particular method of preservation may involve several antimicrobial principles. Each control step may be regarded as a 'hurdle' against microbial proliferation and combinations of processes [so-called hurdle technology (HT)] can be devised to achieve particular objectives in terms of both microbial and organoleptic quality.

The latest investigated preservation technologies for fresh meat are non-thermal inactivation technologies such as high hydrostatic pressure (HHP), new packaging systems such as modified atmosphere packaging (MAP) and active packaging (AP), natural antimicrobial compounds and biological preservation. All these alternative technologies attempt to be mild, energy saving, environment friendly and to guarantee natural appearance while eliminating pathogens and spoilage micro-organisms. The aim of this article is to review these technologies for the preservation of fresh meat.

2 Refrigeration

Temperatures below or above the optimum range for microbial growth will have a preventative action on the latter. For fresh meat, refrigeration, including storage above or below the freezing point, has been the traditional preservation method. Superchilling technology, which stores meat just above the freezing point, has been used with success.

1) Chilling

Recognition by early civilizations of the preservative effects of cool temperature storage of perishable products such as meat led to storage of such products in natural caves where tempera-

tures were relatively low throughout the year. The principles of artificial ice formation and of mechanical refrigeration date from about 1750 and commercial-scale operations based on mechanical refrigeration were in use 100 years later.

Chilling is critical for meat hygiene, safety, shelf life, appearance and eating quality. Chilling in air reduces carcass surface temperature and enhances carcass drying; both of which reduce the growth of bacteria. An increase in air velocity and/or a decrease in temperature (both controllable) decrease chilling time. A limiting factor, however, is the difficulty in removing heat quickly from the deeper tissue of carcasses.

Natural-convection air chilling, where refrigerant is pumped through cooling tubes, is slow and largely uncontrollable, whereas forced-convection air chilling, coupled with fans for air movement is much more efficient. Rapid carcass chilling increases product yield due to lower evaporation from the surface, while rapid drying of the carcass surface helps to reduce bacterial growth. Ultra-rapid chilling of pre-rigour meat may, on the other hand, lead to cold-shortening and toughening. Spray-chilling can enhance the oxygenation of surface myoglobin without increasing metmyoglobin, thus maintaining a bright appearance and eliminating weight loss.

2) Freezing

In Britain, large scales of meat preservation by freezing commenced about 1880, when the first shipments of frozen beef and mutton arrived from Australia. At that time, there was a surplus of meat animals in the southern hemisphere, especially in New Zealand and Australia, and freezing offered a means of preserving meat during the long voyages involved between the two areas. The advantages of temperatures below the freezing point were in prolonging the useful storage life of meat and in discouraging microbial and chemical changes.

Fast freezing produces minute intracellular ice crystals and thus diminishes drip on thawing. The rate of freezing is dependent not only on the bulk of the meat and its thermal properties (e.g., specific heat and thermal conductivity), but also on the temperature of the refrigerating environment, on the method of applying the refrigeration and, with smaller cuts of meat, on the nature of the wrapping material used.

A temperature of −55℃ has been suggested as ideal storage conditions for frozen meat to completely prevent quality changes. At these low temperatures, enzyme reactions, oxidative rancidity and ice recrystallisation are likely to be minimal and thus few deteriorative changes will occur during storage.

Cryogenic freezing offers faster freezing times compared with conventional air freezing because of the large temperature differences between the cryogen and the meat product and the high rate of surface heat transfer resulting from the boiling of the cryogen. Cryogenic freezing requires no mechanical refrigeration equipment; simply a cryogen tank and suitable spray equipment. How-

ever, there may be some distortion of the shape of the product caused by the cryogenic process that might impact on the commercial application. Furthermore, the cost of cryogenic liquid is relatively high and therefore may limit its commercial application.

3) Superchilling

The process of superchilling was described as early as 1920 by Le Danois, even though he did not actually use the terms 'superchilling', 'deep-chilling' or 'partial ice formation'. The terms 'superchilling' and 'partial freezing' are used to describe a process where a minor part of the product's water content is frozen. During superchilling, the temperature of the product is lowered, often 1 ~2℃, below the initial freezing point of the product. After initial surface freezing, the ice distribution equilibrates and the product obtains a uniform temperature at which it is maintained during storage and distribution. This has been effectively used for seafood and there is now increasing interest in this process for extension of chilled storage life of meat.

(1) Advantages and Application

At superchilling temperatures, most microbial activity is inhibited or terminated. Chemical and physical changes may progress and, in some cases, even accelerate. Superchilling, as a commercial practice, can reduce the use of freezing/thawing for production buffers and thereby reduce labour, energy costs and product weight losses. The ice present in superchilled products protects the meat from temperature rises in poor cold chains; however, some increase in product drip loss may occur during storage.

'Super' or 'deep' chilling has been commonly used in the USA, although the product is seldom referred to as 'super-chilled' since, legally, in the USA poultry meat kept above -3.3℃ can be marketed as 'fresh' (US Poultry Products Inspection Regulations 9CFR381). The process involves water chilling of carcasses and then putting them through an air freezer operating at -15℃ for approximately 30 min. After packaging, they are again placed in an air freezer to achieve the required meat temperature. The carcasses are then stored and distributed at -1 to -2℃.

The main reason for implementing this technology is its ability to prolong shelf life of meat for at least 1.4 ~4 times the life of traditional meat-chilling methods. Ice-forming and recrystallisation can cause microstructural changes to food tissue during freezing, resulting in cell dehydration, and drip loss and tissue shrinkage during thawing. Food characteristics such as pH, ionic strength, and concentration of dissolved gases, viscosity, oxidation-reduction potential and surface tension may also be altered, leading to changes in enzymatic activity and protein denaturation.

Reports on superchilling have mainly involved fish and poultry. Gallart-Jornet et al. evaluated the effect of superchilled storage compared with ice and frozen storage on the quality of raw Atlantic salmon (Salmo salar) fillets and found superchilled storage was beneficial for the preservation of freshness of the raw material before processing. Duun, Hemmingsen, Haugland, &Rustad

also found the storage time of vacuum-packed salmon fillets could be doubled by superchilled storage at −1.4℃ and −3.6℃ compared to ice chilled storage. Drip loss was not a major problem in superchilled salmon. Textural hardness was significantly higher in superchilled salmon fillets stored at −3.6℃ compared to those stored at −1.4℃, ice chilled and frozen. Cathepsins B and B +L remained active at the selected storage temperatures, which may therefore lead to softening during subsequent chilled storage.

Duun et al. (2008) found superchilling of pork roasts at −2.0℃ improved the shelf life significantly compared with traditional chilling at +3.5℃. The superchilled roasts maintained good sensory quality and low microbiological counts during the whole storage period (16 weeks), while the shelf life of chilled samples was just 14 days. Sensory tests indicated that the quality of the superchilled roasts was not reduced by high numbers of psychrotrophic bacteria. The drip loss in superchilled samples was low and showed less variation than in the chilled references and the temperature-abused samples. The temperature-abused and chilled samples had lower liquid losses, measured by centrifugation, than the superchilled samples.

(2) Challenges in Superchilling

Calculating the required superchilling times and estimating the temperature distributions in a chilling and freezing process is a challenging exercise. It is also difficult to define the degree of superchilling required to sufficiently improve shelf life and fulfil the demands of the process to achieve the quality attributes desired.

The media used to achieve superchilling will affect the possibilities for implementing it in an industrial process. A change from 'traditional technologies' such as chilling, freezing, thawing to the more complex superchilling technology is difficult. Superchilling demands more accurate information on product variation and flow. Special care needs to be taken prior to, and after, the superchilling process itself. Most equipment producers today do not have the required energy and thermodynamic competence to design and control superchilling processes.

Clearly, industry will need support to develop basic data for graphs and software, of chilling times, chilling temperatures, air-flow and refrigeration loads. This also includes principles for control regulates monitor (CRM) systems for the superchilling process and refrigeration system.

3 Ionising Radiation

Ionising radiation has been a method of direct microbial inhibition for preserving meat since around 1940. In 1980, participating bodies (including the Food and Agricultural Organization (FAO) and World Health Organization (WHO)) proposed that irradiation with a dose less than 10 kGy (1 Mrad) should be accepted as a process for preserving all major categories of food. In the UK, 'The Food (Control of Irradiation) Regulations (1990)' allows certain classes of food may be irradiated up to a maximum dosage (e.g., 7 kGy for poultry) and under 'The Food Label-

ling (Amendment) (Irradiated Food) Regulations (1990)' all irradiated foods are required to have a label indicating that they have received such treatment. Irradiation technology was promoted by the FAO in the Codex Alimentarius in 2003 and has been well accepted in 50 countries, especially in the USA, Egypt, and China and across Latin America.

The radionuclides approved for food irradiation include ^{137}Cs and ^{60}Co. radioactive cobalt (^{60}Co) decays to non-radioactive nickel by emitting high-energy particles and X-rays. The X-rays kill rapidly growing cells (microbes) but do not leave the product radioactive. Because it is highly penetrating, it can be used to treat packaged food.

The advantages of ionising radiation for food preservation include its highly efficient inactivation of bacteria, the fact that the product is essentially chemically unaltered and the appreciable thickness of material, which can be treated after packing in containers. A maximum dosage of 10 kGy represents a low amount of energy (equivalent to that needed to raise the temperature of 1 g water 2.4℃), which is why the technology is considered non-thermal, thus preserving the freshness and nutritional quality of the meat and meat products when compared with thermal methods.

Colour changes in irradiated fresh meat occur because of the inherent susceptibility of the myoglobin molecule to energy input and alterations in the chemical environment; haem iron being particularly susceptible. Brewer (2004) summarised the effects of ionising radiation on meat colour, and concluded that maintenance of ideal meat colour during the process of irradiation could be enhanced by various combinations of pre-slaughter feeding of antioxidants to livestock, condition of the meat prior to irradiation (pH, oxymyoglobin vs. metmyoglobin), addition of antioxidants directly to the product, gas atmosphere (MAP) or lack thereof, packaging and temperature control. Radiation treatment resulted in essentially no loss of thiamine (one of the least stable vitamins), therefore suggesting that such radiation has no detrimental effects on these nutrients.

4 Chemical Preservation and Biological Preservation

1) Chemical Preservation

Carbon dioxide and ozone have been used to discourage the growth of surface micro-organisms on beef carcasses during prolonged storage at chill temperatures. Although ozone leaves no toxic residues in meat, its use in a production environment can be dangerous for personnel. Moreover, it accelerates the oxidation of fat and is more effective against air-borne micro-organisms than against those on meat.

Various micro-organisms produce organic acids and alcohols by anaerobic fermentation of food substrates and these, by inhibiting other organisms that are concomitantly present and which could spoil the food or make it toxic, can act in its preservation. Lactic acid, for example, is a frequently effective inhibitory agent used in fresh meat preservation; however, other organic acids

have also been found to be responsible for discolouration and production of pungent odours.

Salts such as sodium lactate have been used in the meat industry because of their ability to increase flavour, prolong shelf life, and improve the microbiological safety of products. The antimicrobial effects of lactates are due to their ability to lower water activity and the direct inhibitory effect of the lactate ion. Several researchers have successfully extended the shelf life of fresh meat products by adding sodium lactate. Nadeem et al. (2003) extended freshly slaughtered sheep and goat carcasses stored at 5 ~ 7℃ for 3 and 2 days, respectively, after spraying the carcasses with solution 'B' containing potassium sorbate, sodium acetate, sodium citrate, sodium lactate each at 2.5% and sodium chloride at 5%, when compared with solution 'A' (without potassium sorbate) and control.

2) Biological Preservation and Natural Antimicrobials

Natural compounds, such as essential oils, chitosan, nisin and lysozyme, have been investigated to replace chemical preservatives and to obtain 'green label' products. Storage life is extended and safety is increased by using natural or controlled microflora, of which lactic acid bacteria (LAB) and their antimicrobial products such as lactic acid and bacteriocins have been studied extensively. Bacteriocins are a heterogeneous group of antibacterial proteins that vary in spectrum of activity, mode of action, molecular weight, genetic origin and biochemical properties.

Various spices and essential oils have preservative properties and have been used to extend the storage life of meat products. These include eugenol in cloves and allyl isothiocyanate in mustard seed. Roller et al. (2002) and Sagoo, Board and Roller (2002) reviewed the antifungal and antimicrobial properties of the polysaccharide chitosan. Its efficacy, especially in combination with other antimicrobial agents, warrants further investigation.

Nisin is the only commercial bacteriocin and has been used to decontaminate artificially contaminated pieces of raw pork and in combination with 2% of sodium chloride as an anti-listerial agent in minced raw buffalo meat. Bacteriocins produced by lactic acid bacteria are listed in Table 1.

Recently, pentocin 31-1, which was produced by Lactobacillus pentosus 31-1 and isolated from the traditional Chinese fermented Xuanwei ham, was studied as a biopreservative in storage of tray-packaged chilled pork. Results showed that pentocin 31-1 could substantially inhibit the accumulation of volatile basic nitrogen (VBN) and generally suppress the growth of microflora, especially Listeria and Pseudomonas, during chilled pork storage.

Table 1 Bacteriocins produced by lactic acid bacteria

Producer organism	Bacteriocin	Producer organism	Bacteriocin
L. lactis subsp. lactis	Nisin	*Lb. curvatus* LTH1174	Curvacin A
L. lactis BB24	Nisin	*Lb. curvatus* CRL705	Lactocin 705
L. lactis WNC	Nisin Z	*Lb. curvatus* FS47	Curvaticin FS47
L. lactis subsp. *lactis*	Lacticin 481	*Lb. curvatus* L442	Curvacin L442
L. lactis subsp. *cremoris*	Diplococcin	*Lb. plantarum* CTC305	Plantaricin A
L. lactis subsp. *lactis*	Lactostrepcins	*Lc. gelidum* UAL187	Leucocin A
L. lactis subsp. *diacetilactis*	Bacteriocin 550	*Lc. mesenteroides* TA33a	Leucocin A
L. fermenti 46	ND	*Lc. carnosum* TA11a	Leucocin A
L. helveticus 27	Lactocin 27	*P. acidilactici* L50	Pediocin L50
L. helveticus	Helveticin J	*P. pentosaceous* Z102	Pediocin PA-1
L. acidophilus	Lactacin B	*C. piscicola* LV17B	Carnobacteriocin B2
L. acidophilus	Lactacin F	*C. piscicola* V1	Piscicocin vla
L. plantarum	Plantaricin A	*C. piscicola* LV17A	Carnobacteriocin A
L. sakei Lb 706	Sakacin A	*C. piscicola* JG126	Piscicolin 126
L. sakei I151	Sakacin P	*C. piscicola* KLV17B	CarnobacteriocinB1/B2
L. sakei LTH673,674	Sakacin K,P	*C. divergens* 750	Divergicin 750
L. sakei CTC494	Sakacin K	*C. divergens* LV13	Divergicin A
L. sakei L 45	Lactocin S	*E. faecium* CTC492	Enterocin B
L. sakei MN	Bavaricin MN	*E. faecium* CTC492	Enterocin A
Lb. brevis SB27	Brevicin 27	*E. casseliflavus* IM416K1	Enterocin 416K1
L. casei	Caseicin 80	*P. acidilacticii* PAC1.0	Pediocin PA1
P. acidilactic H	Pediocin AcH	*P. pentosaceus* FBB61	Pediocin A

5 High Hydrostatic Pressure (HHP)

Derived from material sciences (ceramics, superalloys, artificial diamonds, etc.), high-pressure technology (100 ~ 1000 MPa, i. e., 1000 ~ 10 000 bar) is of increasing interest to biological and food systems. High hydrostatic pressure (HHP), a non-thermal technology, is of primary interest because it can inactivate product-spoiling micro-organisms and enzymes at low temperatures without changing the sensory or nutritional characteristics of the product. Pressure processing is usually carried out in a steel cylinder containing a liquid pressure-transmitting medium such as water, with the sample being protected from direct contact by using sealed ? exible packaging. Maintaining the sample under pressure for an extended period of time does not require any additional energy apart from that required to maintain the chosen temperature.

HHP renders food more stable due to its ability to reduce the number of spoilage and pathogenic micro-organisms, and to inactivate certain food enzymes. HHP is a powerful tool to control risks associated with Salmonella spp. and Listeria monocyto-genes in raw or marinated meats. The effectiveness of HHP for microbial control depends on factors such as the process parameters, pressure level, temperature and exposure time, as well as by intrinsic factors of the food itself, such as pH, strain and growth stage of micro-organisms, and food matrix.

HHP, combined with moderate temperature, has been shown to result in changes in the me-

chanical properties leading to improved tenderness of meat. However, HHP even at low temperatures may have an undesirable effect on fresh meat colour. Colour of fresh beef changes with pressure as a result of denaturation of globin in myoglobin and haem displacement or release, and ferrous oxidation. Denaturation of other proteins such as myosin and actin results in a greater opacity and therefore minimises the red appearance. In contrast to beef and pork, poultry muscles are not drastically discoloured because of their lower myoglobin content. Lipid stability of pressure-treated foods of animal origin has rarely been investigated, and results are contradictory. Rivas-Cañedo, Fernández-García and Nuñez (2009) used high pressure (400 MPa, 10 min at 12℃) to treat minced beef and chicken breast, which was packaged with or without aluminium foil in a multilayer polymeric bag. They found pressurisation produced significant changes in the levels of some volatile compounds presumably originating from microbial activity and the plastic material. In the USA, several meat companies have made this methodology available (e. g., Hormel Foods and Purdue Farms) for the extension of shelf life of processed, sliced meats.

Table 2 Application of HHP in meat products

Target	Product	Initial counts log(cfu/g)	Reduction log(cfu/g)	Process*	Reference
FBP**	Meat homogenate	6 ~ 7	Total inactivation after treatment	400 MPa, 10 min, 25℃	Shigehisa, Ohmori, Saito, Taji and Hayashi (1991)
C. freundii	Minced beef muscle	7	> 5 after treatment	300 MPa 10 min, 20℃	Carlez, Rosec, Richar dand Cheftel (1993)
P. fluorescens				200 MPa 20 min, 20℃	
L. innocua				400 MPa 20 min, 20℃	
Total microflora	Minced beef muscle	~6.8	>4 after 10 days (3℃)	450 MPa, 20 min, 20℃	Carlez, Rosec, Richard and Cheftel (1994)
E. coli O157:H	Raw minced meat	5.9	5 after treatment	700 MPa, 1 min, 15℃	Gola et al. (2000)
Aerobic total count	Marinated beef loin	6.5	>4.5 after 120 days(4℃)	600 MPa, 6 min, 31℃	Garriga, Aymerich, Costa, Monfort and Hugas (2002)
Toxoplasma gondii cysts	Ground pork meat	Viable tissue cysts	Non-viale	300 MPa	Lindsay, Collins, Holliman, Flick and Dubey (2006)
Salmonella enteritidis strains	Chicken breast fillets	7	4.8	400 MPa; 15 min, 12℃	Morales, Calzada, Rodriguez, de Paz and Nunez (2009)

* Initial temperatures are reported. ** *Escherichia. coli*, *Campylobacter jejuni*, *Pseudomonas aeruginosa*, *Salmonella typhimurium*, *Yersinia enterocolitica*.

Although the initial investment is high, the processing cost has been estimated at about 14 eurocent per kilogram of product when treated at 600 MPa, including investment and operation costs, and the technology is well accepted in Europe as an alternative technology. Table 2 lists some applications of HHP in meat products.

6 Packaging

Packaging protects products against deteriorative effects, which may include discolouration, off-flavour and off-odour development, nutrient loss, texture changes, pathogenicity and other measurable factors. Variables are product type, gas mixture, package and headspace, packaging equipment, storage temperature and additives.

Fresh meat packaging is only minimally permeable to moisture and so surface desiccation is prevented, while gas permeability varies with the particular film type used. Packaging options for raw chilled meat are air-permeable packaging, low O_2 vacuum, low O_2 MAP with anoxic gases and high O_2 MAP. While air-permeable packaging is not MAP, use of overwrapped packaging materials within master pack or tray-in-sleeve systems allows for this packaging option to be a component of MAP.

1) Vacuum Packaging (VP)

Vacuum packaging materials for primal cuts are usually three layered co-extrusions of ethyl vinyl acetate/polyvinylidene chloride/ethyl vinyl acetate, which generally have an O_2 permeability of less than 15.5 ml · m^{-2} · (24 h)$^{-1}$ at 1 atmosphere as a result of the polyvinylidene chloride layer. The lack of O_2 in packages may minimise the oxidative deteriorative reactions, and reduce aerobic bacteria growth, which usually causes pigments to be in the deoxymyoglobin state. Low O_2 vacuum packages for retail meat cuts are usually vacuum skin packaging (VSP) systems for placing the retail cut in a barrier styrene or polypropylene tray and vacuum sealing barrier films that are heat shrunk to conform to the shape of the product. VSP packaging equipment removes atmospheric air or flushes the air from the package with gaseous mixtures such as N_2, CO_2 or mixtures of N_2 and CO_2 before heat sealing the film layers. The common construction for the top and bottom package webs is nylon barrier polymer of polyvinylidene chloride or ethylene vinyl alcohol, tie layer and ionomer. Nylon provides bulk, toughness and low melting point, while the barrier layer prevents vapour permeation and the ionomer gives necessary seal characteristics. A variation of VSP is for the lidding film to have outer barrier and inner air-permeable layers so that before retail display, the outer barrier film layer is peeled away from the permeable layer so that air can then contact the meat product and result in a bloomed colour.

2) Modified Atmosphere Packaging (MAP)

MAP for meat requires a barrier of either of moisture and gas permeation through packaging materials to maintain a constant package environment during storage. For any type of MAP, it is necessary to remove or change the normal composition of atmospheric air, and encompass both aerobic and anaerobic types of packaging for meat. The major gases in dry air by volume at sea level are N_2(78%), O_2(20.99%), argon (0.94%) and CO_2(0.03%), but the percentages vary when calculated by weight.

Non-barrier overwrapped packages of meat may be enclosed in a barrier pouch appropriately sized for each individual overwrapped tray package (tray-in-sleeve configuration), or in a larger barrier film master pack that contains multiple packages in the anoxic gas. The meat pigments become oxygenated when the overwrapped permeable film package is removed from the master pack for retail display. Another variation is the use of anoxic MAP that has an inner air-permeable film and outer barrier film sealed to the barrier tray or bottom web containing the meat. When the outer film is peeled before display, the meat is exposed to O_2 in the atmospheric air and subsequently blooms. Where air-permeable films may not allow sufficient O_2 passage for adequate oxymyoglobin formation, microperforated shrink films with additional holes or perforations have been manufactured and used to promote faster meat blooming after removal of barrier film or removal of overwrapped trays from master packs.

7 Hurdle Technology (HT)

HT (also called combined methods, combined processes, combination preservation, combination techniques or barrier technology) advocates the deliberate combination of existing and novel preservation techniques to establish a series of preservative factors (hurdles) to improve the microbial stability and the sensory quality of foods as well as their nutritional and economic properties.

The most important hurdles used in food preservation are temperature (high or low), water activity (A_w), acidity (pH), redox potential (Eh), preservatives (e. g., nitrite, sorbate, sulphite), and competitive micro-organisms (e. g., lactic acid bacteria). However, more than 60 potential hurdles for foods, which improve the stability and/or quality of the products, have been described, and the list of possible hurdles for food preservation is by no means complete. The influence of food preservation methods on the physiology and behaviour of micro-organisms in foods, that is, their homeostasis, metabolic exhaustion and stress reactions, should be taken into account.

Generally, biological preservation and natural antimicrobials provide an excellent opportunity for such combined preservation systems. For example, oregano essential oil, combined with MAP, were studied as hurdles in the storage of fresh meat and a longer shelf life was observed over that of the same packaging alone. In Atlantic salmon (S. salar) fillets, the greatest extension of shelf life was obtained by a combination of superchilling and MAP. The samples with the highest CO_2 concentration (90%) and gas-to-product volume (g/p) ratio of 2.5 showed the highest shelf life: 22 days versus 11 days for the control sample.

Many studies indicate that it is possible to reduce bacterial spores through combinations of mild heat or nisin and HHP. The combined effect of gamma irradiation in the presence of ascorbic acid on the microbiological characteristics and lipid oxidation of ground beef coated with an edible coating were evaluated. Results showed that lactic acid bacteria and Brochothrix thermosphacta were more resistant to irradiation than Enterobacteriaceae and Pseudomonas. Shelf-life extension

periods estimated on the basis of a limit level of 6 log cfu · g^{-1} for APCs were 4,7 and 10 days for samples irradiated at 1,2 and 3 kGy, respectively. However, the incorporation of ascorbic acid in ground beef did not improve significantly ($p>0.05$) the inhibitory effect of gamma irradiation.

8 Conclusion

This review aimed to describe current methods and technologies for fresh meat preservation and their developments. In addition to the relatively mature technologies, such as chilling, freezing and ionizing radiation, new preservation techniques for fresh meat are introduced. We conclude this review by presenting important opportunities and some drawbacks of the following new techniques.

(1) Superchilling can reduce the use of freezing/thawing for production buffers and thereby reduce labour, energy costs and product weight losses. The other two advantages of the technique are its capability for prolonging shelf life and improving meat safety. However, the major drawback is that complex calculations and measurements of heat transfer and temperatures are required for each product. More research is required before the wide application of this new technology. Furthermore, this process will only function effectively with improved cold chains, as many current meat supply chains are comprised of fragmented components rather than logical cold chain systems.

(2) As a mild, non-thermal technology, HHP can inactivate some product spoilage micro-organisms and enzymes at low temperatures without changing the majority of the sensory or nutritional properties. However, spores are not sensitive to these pressures and they can only be inactivated when pressure is combined with heat or another system such as lactoperoxidase or lysozyme treatment. Although HHP has certain advantages, it does however have some drawbacks in that high pressures may result in discolouration through protein denaturation. Further, commercially it involves a batch process, which is not convenient for product handling.

(3) Natural antimicrobial compounds: Essential oils, chitosan, nisin and lysozyme are natural compounds. As they can replace chemical preservatives, they provide the opportunity for 'Green labelling' to which consumers are attracted by their 'natural image'. This is imperative in the current world environment in which food quality and safety food are of prime importance. Nevertheless, they are often less attractive commercially due to their ability to react with other food ingredients and some may have low water solubility. They can also change the organoleptical properties and have a narrow activity spectrum.

In conclusion, by applying these new technologies to meet increased demand, the storage life of fresh chilled meat can be largely extended to many weeks by proper control of the hygienic condition and temperatures of the product, and by the appropriate selection and use of preservative methods. Factors restricting the commercial extension of shelf life are the current processing and distribution systems.

2.2 参考翻译

鲜肉保藏技术综述

摘要：由于生物组成的原因，鲜肉是高度易腐败产品。许多相关的因素影响肉品的货架期和新鲜度，比如保持温度和大气氧浓度（O_2）、内源酶、水分、光照和最重要的微生物。随着对高品质、方便性、安全性、外观新鲜度和延长的货架期的鲜肉产品需求的增加，可供选择的非热保藏技术例如高静水压、过冷、天然生物保鲜剂和活性包装技术已经被提出和深入研究。这些技术可以有效钝化多数与食源性疾病相关的微生物的作用，但是它们对微生物孢子的作用效果甚微。为了增加他们对营养细胞的有效性，在被称为栅栏概念下的几种保藏技术的结合，也正在被深入研究。本综述的目标就是对当前使用的鲜肉保藏方法和正在开发中的技术进行总结，提出并且探讨了其优势和工业局限性。

关键词：鲜肉，保藏技术，过冷，高静水压，天然生物保鲜，包装

1 引言

肉是供食用的新鲜的动物的肉。鲜肉包括近期加工处理过的和真空包装或气调包装而不经冷冻等任何处理的肉。肉类丰富的营养成分使之成为了腐败微生物和常见的食源性致病菌的理想生长繁殖环境。因此应用适当的保藏技术以保证肉品的安全性和品质是至关重要的。用于肉品保藏的加工主要针对抑制微生物所引起的腐败，其他方法主要试图减少其在如颜色和氧化等方面的变化。

许多相关因素影响肉的货架期和存储质量，特别是保持温度、大气中的氧气、内源酶、水分（脱水）、光，最重要的是微生物。所有这些因素，无论是单一的还是复合的，都能够导致肉品的颜色、气味、质地和风味的劣变。尽管肉在缺少微生物的条件下能够发生劣变（如：蛋白水解作用，脂类分解和氧化作用），但是目前为止微生物仍然是关系到肉的品质的最重要的因素。传统上肉品保存方法基于控制温度、湿度和更直接的通过抑菌过程（杀菌和抑菌、如电离辐射、包装等）可以分为三大类，虽然特定的保藏方法可能也涉及几种抗菌原理。每个控制步骤可以看成是针对微生物增生的一个“栅栏因子”，组合处理［被称为栅栏技术（HT）］能够实现无论是微生物还是感官品质的特定目标。

鲜肉保藏技术的最新研究主要是非热杀菌技术，例如：高静水压（HHP）、例如气调包装（MAP）和活性包装（AP）的新包装系统、天然抗菌剂和生物保藏。所有这些可供选择的技术都试图温和、节能、环保和保证自然外观的同时，消除病原体和腐败微生物。本文目的就是综述这些鲜肉保藏技术。

2 冷藏

温度低于或高于微生物最适生长温度都会对其生长产生抑制作用。对鲜肉冷藏，包括高于或低于冰点的冷藏是传统的保藏方法。贮藏肉品的温度高于冰点的过冷技术，已经在肉品保藏中取得成功。

1）冷却

早期认识到采用低温有效保藏易腐产品如鲜肉类，使其贮藏于全年温度相对较低的天然洞穴中。人工制冰的作用和机械冷冻的原理可追溯到1750年，同时基于机械冷冻的商业规模操作也有100年的历史了。

冷却对于肉类的卫生、安全、货架期、外观和食用品质来说是至关重要的。空气冷却能够降低胴体表面的温度和提高胴体的干燥程度，二者共同作用能够减少细菌数量的增长。增加空气流速或降低温度（均可控）能够减少冷却时间。然而对于胴体深层组织的快速降温是一个难度较大的限制因素。

由冷却管压送的自然对流空气冷却速度慢且不可控，然而，配备了空气流动风机的对流空气冷却设备则更有效。因为减少表面蒸发能够使胴体迅速冷却，从而增加产品产量，同时胴体表面的迅速干燥也能够有助于减少细菌的生长。另一方面，预僵直处理过的肉再进行快速冷却会缩短冷却时间和增加韧度。喷雾冷却能够在不增加高铁肌红蛋白的同时，增加表面的氧含量，从而维持肉品表面颜色鲜艳同时避免重量损失。

2）冷冻

大约从1880年第一批冷冻牛羊肉从澳大利亚运达英国开始，大规模肉制品保藏都是通过冷冻实现的。在那时，南半球存在肉用家畜过剩的现象，尤其是在新西兰和澳大利亚，冷却提供了一种在两地间长途运输过程中肉品保藏的方法。温度在冰点以下能延长肉品的货架期并且抑制微生物生长和化学变化。

速冻能够产生微小的细胞内冰晶并且因此减少了解冻时的滴水。冻结速度不仅依赖于肉的量和其热性能（如比热和电导率），还取决于制冷环境的温度和冷却方法，同时，对那些切成小块的肉，取决于所使用的包装材料。

冷冻肉品能达到完全防止品质变化的理想贮藏温度是-55℃。在此低温条件下酶促反应、氧化酸败和重结晶的可能性最小，因而在贮藏阶段发生变质的机率也很小。

相比传统的空气冷却，低温冷冻能够提供更短的冷冻时间，因为制冷剂和肉品间的温度差异较大，由制冷剂沸腾引起的表面热传递非常迅速。低温制冷不需要机械制冷设备，只需简单的制冷剂罐和适当的喷雾设备即可。然而，有些由于深度冷冻而造成的变形可能会影响到商业价值。此外，低温冷却液的成本是相对较高的，因此可能会限制其商业应用。

3）过冷

对过冷的过程的描述早在1920年已经由LeDanois提出，虽然他并没有使用术语“过冷”“深度冷却”或者“部分冰形成”。“过冷”和“部分冻结”术语是用来描述一个过程中产品的一小部分的含水冻结。在过冷过程，产品温度通常会下降1～2℃，低于产品原始冰点。经过初步的表面结冰，冰分布平衡且产品获得均匀的温度，此即在贮藏和配送过程中所维持的温度。这已经有效地应用在水产品中，且现在已经有越来越多的应用在肉品的贮藏。

（1）优势和应用

在过冷温度下，大多数的微生物活性被抑制或终止。在某些情况下化学和物理变化可能仍在进行甚至加速进行。过冷，作为一种商业实践，能够减少冻结/解冻过程对于产品的影响，从而减少劳动力、能源成本和产品重量损失。冰如果出现在过冷产品中能够达到保护肉品免受冷链温度上升的影响，然而在贮藏期间产品水分可能会损失。

“超级”或者“深度”冷却一直在美国广泛使用，虽然产品一直很少涉及到“超冷”。在法律上，美国禽肉在-3.3℃条件下保藏都能够按照“新鲜”食品售卖（美国肉鸡产品检验规范 9CFR318）。这一过程包括使用水冷冻胴体，然后通过冰箱将其在-15℃条件下冷冻 30 分钟。包装后，将其再次放置在冰箱中冷冻以达到所需温度。之后将胴体在-1 至-2℃条件下贮藏和运输。

这个技术能够执行的主要原因是，相对于传统肉制品的冷藏方法，过冷技术至少能延长肉品的货架期 1.4 ~4 倍。在冻结期间，冰的形成和重结晶能够造成食品组织的显微结构改变，从而导致细胞脱水，在融化期间能够导致水分损失和组织收缩。食品特性例如 pH、离子强度、气体浓度、粘度、蛋白质氧化和表面张力也可能改变，最终导致酶活性和蛋白质变性。

关于过冷技术的报道主要涉及鱼类和禽类。Gallart-Jornet 通过与冰冻贮藏进行比较，评价了过冷技术对大西洋鲑鱼片（安大略鲑）的品质的影响。他发现过冷技术贮藏有利于保藏未经处理的生鲜原料。Duun，Hemmingsen，Haugland，&Rustad 同时发现真空包装的鲑鱼片在-1.4 至-3.6℃条件下经过过冷贮藏与冷冻保藏相比，其保藏时间能够加倍。针对于过冷处理过的鲑鱼水分损失并不是最主要的问题。与-1.4℃条件下的冰冻保藏相比，在-3.6℃条件下的过冷保藏能够显著增加鲑鱼片的组织硬度。在选定温度条件下组织蛋白酶 B 和 B+L 仍然保持活性，这可能会导致在随后冷却过程中出现软化。

Duun 等（2008）曾发现，在-2.0℃条件下过冷技术处理的猪排与传统条件+3.5℃冷却相比，货架期有了明显改善。过冷条件处理的猪排保持了较好的感官品质且在整个贮藏阶段（16 周）微生物菌群数量较低，然而冷却处理过的样品货架期只有 14 天。感官测验表明，过冷处理过的猪排的并没有大量减少嗜冷细菌的数量。在过冷处理的样品中水分损失较小，同时与冷却和温度滥用相比变化也较小。通过离心方法测定，与过冷处理的样本相比，滥用温度和冷却的方法处理的样本液体水分损失更小。

（2）过冷技术的挑战

计算过冷所需的时间和估计在冷却和冻结过程中温度分布情况是一个挑战。也很难定义充分延长货架期和完成产品生产过程并保证品质的情况下所需要的过冷程度。

媒体曾经报道过冷将影响其在工业生产上的可能性。从例如冷却、冷冻、解冻等“传统技术”到更复杂的过冷技术的改变是个难题。过冷技术需要更精确的品质差异的信息和流动特性。处理前后和过冷过程本身都需要更加小心谨慎。大多数设备生产商目前都还没有所需的能量和热力学能力设计控制过冷流程。

很明显，行业需要支持发展基本的数据图和软件，包括冷却时间、冷却温度、气流和制冷负荷。这也包括过冷过程和制冷系统的控制调节监视器（CRM）的操作原则。

3 电离辐射

电离辐射是自大约 1940 年开始使用的一种直接抑制微生物来保藏肉制品的方法。1980 年，参与的机构［包括联合国粮农组织（FAO）和世界卫生组织（WHO）］提出针对食品保藏所有主要类别的可接受最低辐射计量是 10kGy（1Mrad）。在英国，食品管理条例（辐射控制 1990 年）允许某些种类的食品可能达到最大辐照剂量（比如家禽是 7 kGy），在食品标签（修订）（辐照食品）条例（1990 年）的所有辐照食品必须有标签说明他们是否进行过辐照处理。在 2003 年辐照技术由联合国粮农组织食品法典委员会得到了推广，已经被五十多个国家所接受，特别是在美国、埃及、中国和整个拉丁美洲。

允许用于食品辐照的放射性同位素包括铯 137 和钴 60。放射性钴 60 通过发射高能粒子和 X 射线衰变成非放射性的镍。X 射线能迅速杀死生长的细胞（微生物）但不在产品中存留放射性。因为它是高穿透性，它可以用来处理包装食品。

食物保藏的电离辐射技术的优点包括对细菌的高效失活、产品本质上的化学组成不变、可以在包装在容器内之后处理的很大的材料厚度。最大剂量 10 kGy 代表低能量（相当于 1g 水升温 2.4℃需要的能量），这就解释了为什么称此项技术是非热的。与热处理方法相比，能够更有效的保藏肉制品的新鲜度和营养品质。

辐照会引起鲜肉变色，因为鲜肉中肌红蛋白分子固有的对能量供给和化学环境改变的敏感性，血红素铁最容易受到影响。Brewer（2004）总结了电离辐射对肉品颜色的影响，并得出结论，若想保持在辐照过程中肉的理想颜色，可以在宰杀前对牲畜喂食适当的抗氧化剂、控制辐照前肉制品的条件（pH、氧合肌红蛋白与高铁肌红蛋白）、在产品中直接添加抗氧化剂，气调或缺少气体、包装和温度控制。辐照本质上不会导致硫胺素的损失（一种稳定的维生素）由此表明这种辐照不会对这些营养素有不利影响。

4 化学保藏和生物保藏

1）学保鲜剂

通常采用二氧化碳和臭氧来阻止牛肉胴体表面微生物生长，以达到在低温条件延长其保质期。虽然臭氧残留在肉制品中没有毒性，但在生产环境中对使用的人员有危害。此外，它也加速了脂肪氧化，以及相对于胴体表面，更能有效抑制空气传播的微生物。

各种微生物以食物为基质进行厌氧发酵产生有机酸和醇类，从而起到保藏作用。能够抑制伴随产生的其他有机体，这些有机体能够破坏食品或产生毒素。以乳酸为例，通常将其作为有效的抑菌剂用于鲜肉包藏，但是其他有机酸也能导致变色并且产生刺激性气味。

盐类如乳酸钠能够增加风味、延长货架期、提高产品微生物安全性，所以被用于肉制品工业。乳酸盐的抑菌作用是能够降低水分活度同时直接抑制乳酸离子的作用。一些研究人员已经通过添加乳酸钠成功的延长了鲜肉产品的保质期。Nadeem 等（2003）延长

了新鲜屠宰的绵羊和山羊在5~7℃条件下的保藏时间分别为3天和2天。分别对在胴体表面喷涂了2.5%山梨酸钾，醋酸钠，柠檬酸钠，乳酸钠和5%氯化钠的“B”溶液、“A”溶液（未添加山梨酸钾）及空白溶液进行了对比。

2）生物保藏和天然抗菌剂

已经进行了大量的关于研究天然化合物，如精油、壳聚糖、乳酸链球菌素和溶菌酶，来代替化学防腐剂，并且产品获得了“绿色标签”。通过使用天然或者可控微生物菌群达到延长贮藏期和提高产品安全性，其中乳酸菌（LAB）及其抗菌剂产品如乳酸和细菌素已被广泛研究。细菌素是抗菌蛋白的一个异质群体，拥有多样的光谱活性、作用方式、分子量、遗传起源和生化属性。

各种有防腐特性的香料和精油已经用于延长肉制品的货架期。这其中包括在芥末种子中的丁香酚和异硫氰酸烯丙脂。Roller等（2002）和Sagoo、Board、Roller（2002）综述了抗真菌和壳聚糖的抗菌特性。它的功效，特别是结合其他抗菌素之后的功效，需要进一步研究。

乳酸链球菌素是唯一商用的抗菌素，已经被用于净化人为污染的生肉块，添加2%的氯化钠作为切碎的生牛肉中的抗李斯特菌剂。乳酸菌产生的细菌素由表1列出。

表1 乳酸菌产生的细菌素

自养型微生物	细菌素	自养型微生物	细菌素
L. lactis subsp. *lactis*	Nisin	*Lb. curvatus* LTH1174	Curvacin A
L. lactis BB24	Nisin	*Lb. curvatus* CRL705	Lactocin 705
L. lactis WNC	Nisin Z	*Lb. curvatus* FS47	Curvaticin FS47
L. lactis subsp. *lactis*	Lacticin 481	*Lb. curvatus* L442	Curvacin L442
L. lactis subsp. *cremoris*	Diplococcin	*Lb. plantarum* CTC305	Plantaricin A
L. lactis subsp. *lactis*	Lactostrepcins	*Lc. gelidum* UAL187	Leucocin A
L. lactis subsp. *diacetilactis*	Bacteriocin 550	*Lc. mesenteroides* TA33a	Leucocin A
L. fermenti 46	ND	*Lc. carnosum* TA11a	Leucocin A
L. helveticus 27	Lactocin 27	*P. acidilactici* L50	Pediocin L50
L. helveticus	Helveticin J	*P. pentosaceous* Z102	Pediocin PA-1
L. acidophilus	Lactacin B	*C. piscicola* LV17B	Carnobacteriocin B2
L. acidophilus	Lactacin F	*C. piscicola* V1	Piscicocin vla
L. plantarum	Plantaricin A	*C. piscicola* LV17A	Carnobacteriocin A
L. sakei Lb 706	Sakacin A	*C. piscicola* JG126	Piscicolin 126
L. sakei I151	Sakacin P	*C. piscicola* KLV17B	CarnobacteriocinB1/B2
L. sakei LTH673，674	Sakacin K，P	*C. divergens* 750	Divergicin 750
L. sakei CTC494	Sakacin K	*C. divergens* LV13	Divergicin A
L. sakei L 45	Lactocin S	*E. faecium* CTC492	Enterocin B
L. sakei MN	Bavaricin MN	*E. faecium* CTC492	Enterocin A
Lb. brevis SB27	Brevicin 27	*E. casseliflavus* IM416K1	Enterocin 416K1
L. casei	Caseicin 80	*P. acidilacticii* PAC1．0	Pediocin PA1
P. acidilactic H	Pediocin AcH	*P. pentosaceus* FBB61	Pediocin A

最近，由中国传统发酵制作的宣威火腿中独立分离出的戊糖乳杆菌31-1所产生的乳酸菌素31-1已经作为生物防腐剂在托盘包装的冷鲜猪肉贮藏中进行了研究。结果表明，

乳酸菌素 31-1 能够大幅度抑制挥发性盐基氮（VBN）的积累，同时广泛抑制微生物群落的生长，尤其冷鲜猪肉贮藏时李斯特菌和假单胞菌的增长。

5 高静水压（HHP）

来源于材料科学（陶瓷、超合金、人工钻石等）的高压技术（100～1000 MPa，即，1000～10000 bar）在生物和食品体系中的研究兴趣日渐增加。高静水压（HHP）是一个十分热门的非热技术，因为它能够在低温下不改变产品感官及营养特性的条件下钝化失活引起产品腐败的微生物和酶类。压力处理通常是在像水为液体压力介质的钢瓶中进行，将样品用密封的软包装保护起来以避免直接接触。使样品在压力条件下保持一段时间除恒温之外并不需要额外的能量。

因为高静水压能够减少腐败及致病微生物的数量，使食品中特定的酶灭活，从而使食品的稳定性更强。高静水压是一个在生肉或卤肉中控制沙门氏菌、单核增生李斯特菌的强大的工具。高静水压对控制微生物的有效性体现在不同的因素，比如工艺参数、压力、温度和处理时间，同时也包括食品本身的内在因素，如 pH、张力、微生物生长阶段和食品基质。

高静水压结合适当的温度，已经被证明能够改变机械性能，使肉的嫩度增强。然而，高静水压即使在低温条件下也可能对于鲜肉颜色有不良影响。鲜牛肉颜色随着压力变化而变化，导致肌红蛋白变性和血红素移位或释放，亚铁氧化。其他蛋白质变性，如肌球蛋白和肌动蛋白将导致更大的不透明，从而使红色外观显现程度最小。与牛肉和猪肉相比，家禽因为含肌红蛋白量低，所以褪色不彻底。经过压力处理的动物性食品的脂质稳定性相关的研究很少，并且得出的结论相互矛盾。Rivas-Cañedo、Fernández-García 和 Nuñez（2009）用高压（400 MPa，12℃、10 min）处理了多层聚合物包装袋中含有或者不含有铝箔的切碎的牛肉和鸡胸。他们发现密封产品在某些挥发性化合物水平上发生显著变化，可能是由于微生物活性和塑料材质所致。在美国，一些肉制品公司已经使用这种可行的方法来（例如，荷美尔食品和普杜农场）延长经过处理的肉片的货架期。

虽然初期投资高，600 MPa 条件下处理成本估计在每克产品占 14 欧分，包括投资和运行成本，这种技术在欧洲已经作为替代技术被接受。表 2 列出了一些应用了高静水压技术的肉制品。

表 2 在肉制品中高静水压的应用

目标	产品	初始计数	减少	处理条件*	参考文献
		对数(cfu/g)	对数(cfu/g)		
FBP**	肉浆	6～7	处理后失活总数	400 MPa,10 min,25℃	Shigehisa,Ohmori,Saito,Taji and Hayashi (1991)
枸橼酸盐杆菌拮抗细菌菌株	肌腱牛肉糜	7	处理后>5	300 MPa,10 min,20℃ 200 MPa,20 min,20℃	Carlez, Rosec, Richard and Cheftel (1993)

续表

目标	产品	初始计数	减少	处理条件*	参考文献
		对数(cfu/g)	对数(cfu/g)		
英诺克李斯特氏菌				400 MPa,20 min,20℃	
总微生物区系	肌腱牛肉糜	~6.8	3℃10 天后>4	450 MPa,20 min,20℃	Carlez, Rosec, Richard and Cheftel (1994)
大肠杆菌 O157:H	生肉糜	5.9	处理5 天后	700 MPa, 1 min,15℃	Gola et al. (2000)
菌落总数	卤牛腰	6.5	4℃120 天后>4.5	600 MPa, 6 min,31℃	Garriga, Aymerich, Costa, Monfort and Hugas (2002)
弓形体包囊	猪肉糜	活体组织囊孢	不可用	300 MPa	Lindsay, Collins, Holliman, Flick and Dubey (2006)
肠炎沙门下菌菌株	鸡胸片	7	4.8	400 MPa,15 min,12℃	Morales, Calzada, Rodriguez, de Paz and Nunez (2009)

注：*初始温度。**大肠杆菌，空肠弯曲杆菌，绿脓杆菌，鼠伤寒沙门氏菌，小肠结肠炎耶尔森氏菌。

6 包装

包装能够保护产品免受变质的影响，包括变色，变味，营养损失，质地改变，致病性和其他可测量的因素。产品类型，气体组成，包装和顶部空间，包装设备，贮藏时间和活性是影响经过包装的鲜肉货架期的变量。

新鲜肉制品包装只是要使水分渗透降到最低，因此要防止表面干燥，同时使用具有不同透气性薄膜类型。冷冻肉的包装选择是空气可透过包装、低氧真空、低氧气调和高氧气调包装。虽然空气可透过包装不是气调包装，托盘包装系统中采用外包装材料也是气调包装的组成中的一种组成。

1）真空包装（VP）

精选肉的真空包装材料通常有三层共挤压乙基醋酸乙烯酯/聚偏二氯乙烯/乙基醋酸乙烯，聚偏二氯乙烯层会导致他们通常在一个大气压下测得的氧气透过率小于 15.5 ml·m^{-2}·(24 h)$^{-1}$。在缺氧条件下包装可能会减少氧化变质的反应，同时减少好氧细菌的生长，这些好氧细菌通常导致色素处在脱氧血红蛋白状态。对于零售的肉块低氧真空包装通常是真空贴体包装（VSP），将零售的肉块放置在苯乙烯或聚丙烯托盘上并且用热收缩阻隔性薄膜来密封，以符合产品的形状。真空贴体包装的包装设备在热封膜前要去除空气或者用气体混合物如氮气、二氧化碳或者二者混合物冲洗掉原气体。顶部和底部包装网采用聚氯乙二烯或乙烯乙烯醇组成的尼龙聚合物阻挡层，连接层和离聚物。尼龙具有散装、韧性和熔点低，且阻挡层防止蒸汽渗透，离聚物赋予必要的密闭性。真空贴体包装的变化是为了使薄膜具有外部屏障和内部空气透过性以方便零售前陈列。当外部屏障薄膜从透过层脱落，可使空气能够直接与肉制品接触，使颜色绽放。

2）气调包装（MAP）

肉制品的气调包装，要求通过包装材料阻挡水分和空气的渗透来保持贮藏过程中包

装环境的恒定。对于任何类型的气调包装，包括两种肉制品的有氧和无氧包装方式，移除或调整正常的大气组分是必须的。在海平面上的干燥空气中的主要气体按体积比为氮气（78%），氧气（20.99%），氩气（0.94%），二氧化碳（0.03%），但是按照重量计算的时候百分比是不同的。

肉的非阻隔外包装可以是装入独立托盘包装对应的适当尺寸的包装小袋中（托盘在套筒内的结构），或在一个包含多个缺氧气体的小包装的较大的阻隔性膜的主包装中。当零售展示时，可透气的包装膜，从主包装中除去之后，肉制品的色素发生了氧化。另外一种变化是使用具有透气性的内膜和阻隔性的外膜密封在放置肉的阻隔托盘或底部网状物上的无氧气调包装。当外层膜在陈列之前剥离，肉暴露在大气的氧气中随后颜色绽放。透气性薄膜无法留出足够的氧合肌蛋白形成所需的氧气进入的通道的时候，。有额外的孔或穿孔的微孔收缩膜可以被生产用于促进加快肉在拆除阻隔性膜拆除外包装托盘后的颜色绽放。

7 栅栏技术（HT）

栅栏技术（也称联合法、组合过程、联合保藏、组合技术或屏障技术）提倡将现有的和新颖的保藏技术合理结合，建立一系列防腐因子（栅栏）来提高食品的微生物稳定性和感官品质以及食品的营养和经济特性。

食品保藏中最重要的屏障是温度的高低、水分活度（A_w）、酸度（pH）、氧化还原电位（Eh）、防腐剂（例如亚硝酸盐、山梨酸盐、亚硫酸盐）和竞争性微生物（例如乳酸菌）。然而，能够提高食品稳定性和产品质量的60多种潜在的屏障也已经有过描述，对食品保藏的可能障碍列表仍然是不完整的。食品保藏方法对食品中微生物的生理和行为的影响，即它们的体内平衡、代谢消耗和压力反应应该考虑在内。

总的来说，生物保护和天然抗菌剂对这种联合保藏系统提供了一个绝佳的机会。例如，牛至精油与气调包装的结合，都被作为一种栅栏技术在鲜肉的保藏中进行了研究，结果发现，比单独的包装会有更长的保质期。对于大西洋鲑鱼的研究中发现，通过将过冷和气调包装相结合的方法可以最大限度的延长的保质期。利用高二氧化碳浓度（90%）和气体/产品体积比2.5的结合条件下，样品的最长保质期可达22天，而空白样品的保质期只有11天。

许多研究表明，通过轻度加热、乳酸链球菌素和高静水压技术的结合来减少细菌孢子是可行的。研究者对γ射线辐照和抗坏血酸结合对涂有可食性涂层的绞碎牛肉中的微生物特征和脂肪氧化进行了研究。结果表明，乳酸菌和热死环丝菌要比肠杆菌科和假单胞菌更耐辐照。在基于抗原提呈细胞（APCs）为6 log cfu · g^{-1}的极限水平下，对产品的保质期进行估算。样品分别经过1、2和3 kGy的辐照条件下，产品的保质期分别为4、7和10天。但是，结合了抗坏血酸（$P>0.05$）处理的碎牛肉，并没有发现对辐照抑制效果的增强作用。

8 结论

本综述目的是介绍当前对鲜肉的保藏的方法、技术及其发展。除了相对成熟的技术，例如冷却、冷冻和电离辐射，也介绍了新的鲜肉保藏技术。我们对以下的新技术的一些重要的机遇和缺点进行了总结，得出以下结论。

（1）过冷可以减少冻结/解冻过程对于产品的影响，从而减少劳动力、能源成本和产品重量损失。过冷技术的其他两个优势是它能延长货架期和增强肉的安全性。然而，最主要的缺点是计算复杂、要求测量每个产品的传热和温度。这个新技术的广泛应用还需要进行更多的研究。此外，这个过程只能利用冷链高效的运行，目前很多肉的供应链是有分散的组件组成，而不是符合逻辑的完全冷链系统。

（2）作为一个温和的、非热的技术，高静水压技术可以在较低的温度下抑制一些产品中的腐败微生物和酶的活性，而不改变大多数的感官及营养特性。但是，孢子对这些压力并不敏感，他们仅能在高静水压与热处理、或其他系统如乳过氧化物酶和溶菌酶处理相结合的条件下，才能得到抑制。尽管 HHP 具有特定的优势，但仍然存在一些缺点，高压下可能导致由蛋白质变性引起的褪色。而且，商业上可能涉及到一些间歇加工过程，导致这些产品不方便处理。

天然抗菌化合物：精油、壳聚糖、乳酸链球菌素、溶解酶都是天然化合物。因为他们可以代替化学防腐剂，它们为“绿色标签”提供了机会，使消费者被他们的“自然影像”所吸引。这些在当前认为食品质量和安全非常重要的世界环境中是必要的。但是，它们缺乏足够商业吸引力，主要是因为它们往往由于具有与其他食品添加剂反应的能力、某些具有较低的水溶性。同时，它们也能改变肉制品的感官特性，具有相对狭窄的活性范围。

总之，通过应用这些新的技术来满足日益增长的需求，对产品卫生条件和温度的适当控制、以及适当选择和使用的保藏方法，新鲜的冷冻肉的保存期限可以延长数周。限制了商业上货架期延长的限制因素，是当前的加工和流通系统。

3 阅读链接

[1] http://www.clemson.edu/extension/hgic/food/food_safety/preservation/

[2] http://www.princeton.edu/achaney/tmve/wiki100k/docs/Food_preservation.html

[3] http://onlinelibrary.wiley.com/journal/10.1111/(ISSN)1745-4549

[4] http://www.sciencedirect.com/science/journal/09255214

4 课后作业

4.1 句子翻译

4.1.1 原句

(1)The paper aims to investigate the effect of storage period on the chemical, microbiological and sensory characteristics of frozen dumpling.

(2)The effects of variety preservation methods were compared, and the experiments show that using the freeze dry method to long-term preserve caproic acid bacteria is better.

(3)Good hygienic slaughtering practices reduce the contamination of carcasses by faeces, but will not guarantee the absence of Campylobacter from meat and meat products.

(4)The study found that higher intakes of red and processed meat were associated with modest increases in total mortality, including death associated with cancer and heart disease.

(5)In the absence of cold chains, such conditions favoured further processing of meat and temporary storage of processed meat products.

(6)The gas proportion mixing, packaging material required and shelf life on 0 ~ 4℃ for some fresh produces of modified atmosphere packaging can be obtained by testing.

(7)Active packaging is in line with the new direction of food packaging. The antimicrobial packaging has attracted much attention and has undergone extensive investigation

(8)In this paper, the safety in irradiation food and the application of irradiation technology in food preservation were discussed. The developmental future of food irradiation preservation was expected

(9)The concentration of ethanol and acetaldehyde in Meiguixiang grape after 120 day storage was studied.

(10)Fresh beef were treated with different methods for the surface sterilizing, dipped short time in coating fresh-keeping solvent of different proportion and stored at 0 ~ 4℃.

4.1.2 参考翻译

(1) 本文主要目的是研究冷冻保藏时间对于速冻水饺的理化性质、微生物指标及感官特性的影响。

(2) 实验比较了己酸菌的不同保存方式的保藏效果，表明采用冷冻干燥保藏法长期保藏菌种效果良好。

(3) 良好的卫生屠宰规范可减少粪便对动物尸体造成的污染，但并不会保证在肉类和肉制品中完全没有弯曲杆菌。

（4）该研究发现摄入较多的牛肉或羊肉或加工的肉制品，死亡率就呈相应的增长，包括因癌症或心脏病而引发的死亡。

（5）在缺乏冷链的情况下，这种气候条件有利于肉品的进一步加工以及肉制品的临时性贮藏。

（6）试验可以说明某些气调包装防腐保鲜的产品所需的气体混合配比、包装材料要求以及0～4℃下的保鲜期限。

（7）活性包装是食品包装发展的新方向，其中的抗菌包装得到了人们的高度重视和广泛研究。

（8）本文对辐照食品的安全性和辐照技术在食品保藏上的应用进行了综述，并对辐照食品技术的发展前景进行了展望。

（9）本文研究了玫瑰香葡萄果实内乙醇和乙醛浓度的变化。

（10）采取不同灭菌方式对鲜牛肉进行表面灭菌，在不同组成的涂膜保鲜剂中浸渍一定时间，在0～4℃下贮存。

4.2 科技论文常见句型

（1）研究目的（purpose of the study）

The work presented in this paper focuses in …

（2）背景和历史（background and history）

The new findings from the experiment agree well with the results obtained in …

Compared with the current research, the previous work was in connection with …

（3）问题的难易程度（difficulty of the problem）

It is easy to present (reveal, analyze, discuss) the problem in all its complexity (in every detail) …

It is no easy task to gain a insight into the intricate detail of …

（4）问题的范围（scope of the problem）

Studies of these effects cover various aspects of …

（5）理论说明（theoretical explanations）

The validity of the theory has become obvious in the light of recent findings …

The basic (essential, fundamental) feature of this theory is …

（6）方法介绍（method introduction）

The procedure we followed has certain advantages over the existing method …

The above procedure makes it possible to evaluate …

Another good feature of this method is …

（7）实验描述（experiment description）

The experiments reported here demonstrate a variety of changes in (a correlation between,

a much resistance to) …

Further experiments in this area lead us to conclude (believe, suggest) that …

From these experiments we can conclude that …

(8) 结果的意义 (meaning of the results)

These preliminary findings are very reliable (encouraging, promising. Convincing, ambiguous) …

We can consider (interpret, look at) these results as fully reliable (consistent with) …

(9) 导致结论 (conclusion deduced)

Further progress can be provided by this experiment …

Unit 3 Food Products Making

1 专业词汇分析

(1) abstaining n. 原意为弃权，此处意为戒酒

[记忆窍门]“abstain”意为“戒除、禁绝”，“-ing”表示动名词，此处意为戒酒。

(2) worty (wort aroma) n. 麦芽汁

(3) off-flavors n. 异味

[记忆窍门]“off-”意为“不在…上，离开”，“flavors”为“味道”。

(4) tailor-made adj. 特制的

[记忆窍门]“tailor”意为“裁缝”，则该词可记成：裁缝（tailor）制作的（made），即特制的。

(5) dealcoholization n. 脱醇

[记忆窍门] 该词可分解为“de”、“alcohol”、“ization”几个字母的组合，“de”意为“去除”，“alcohol”意为“酒精（乙醇）”，“-ization”意为“…的行为”，则该词可记成：去掉乙醇的行为，即脱醇。

(6) vacuum rectification n. 真空精馏

[记忆窍门]“vacuum”为“真空”，“rectification”为“精馏”。

(7) dialysis n. 透析

(8) reverse osmosis n. 反渗透

[记忆窍门]“re-”作为前缀意为“又、再”，“reverse”为“反面的”，“osmos”为“渗透性”。

(9) liveliness n. (指茶叶或饮料的) 清口性 lively

[记忆窍门]“lively”意为“快活、鲜明生动的”，“-ness”为名词性词缀。

(10) in terms of prep. 根据；用…的话；就…而言；以…为单位

(11) volatiles n. 挥发物

(12) carbonized beer n. 充气［碳酸气饱和］啤酒

(13) mashing n. 捣烂；糊状物；糖化

(14) spent grains n. 酒糟，(啤酒) 废麦糟

[记忆窍门] spent 为废的，grain 为粮食。

(15) lager yeast n. 贮藏啤酒酵母

(16) maturation n. (葡萄酒、奶酪等的) 酿熟过程

[记忆窍门] 该词可分解为“matura”、“tion”几个字母的组合，“-tion”为名词词根，可记忆成：(葡萄酒、奶酪等的) 的成熟 (matura)。

(17) krausen n. 发酵酸麦芽汁发酵时所产生的泡沫

2 课文

2.1 原文

A Review of Methods of Low Alcohol and Alcohol-Free Beer Production①

1 Introduction

In most of the EU countries beers with low alcohol content are divided into alcohol free beers (AFBs) containing ≤0.5% alcohol by volume (ABV), and to low-alcohol beers (LABs) with no more than 1.2% ABV. In the United States alcohol-free beer means that there is no alcohol present, while the upper limit of 0.5% ABV corresponds to so-called non-alcoholic beer or 'near-beer' (Montanari et al., 2009). In countries that enforce religious prohibition, the alcohol content in beverages must not exceed 0.05% by volume.

The terminology of this article in the following chapters will be governed by the aforementioned European legislation. However, while the methods to produce both LAB and AFB are from practical point of view identical, the AFBs market share prevails over the LABs one. Hence, in this article the beverages with low alcohol content produced from malt will be generally termed alcohol-free beers (AFBs).

2 Beer and Health

Alcohol abuse has been on the public agenda for many years since it carries risks of violent crime, traffic accidents, public disorder, and health damage. Ethanol is one of the most commonly used recreational drugs worldwide and it is often ingested as a component of beer. When beer is consumed, ethanol is absorbed from the gastrointestinal tract by diffusion and is swiftly distributed in the blood before entering tissues. Ethanol is metabolized to acetaldehyde mainly in the stomach and liver. Acetaldehyde is highly toxic and binds cellular constituents generating harmful acetaldehyde adducts.

Simultaneously, there are strong evidences that moderate alcohol consumption has not only a better long-term health outcome than excessive alcohol consumption, but even better than abstaining. Moderate beer drinking has shown to be, at least, as effective as wine drinking at reducing risks of coronary diseases, heart attack, diabetes, and overall mortality. Besides alcohol, which is probably the most important component of beer that counters atherosclerosis, these positive effects may be attributed to a whole range of other properties and valuable cereal and hop-related substances found in beer such as no fat or cholesterol content, low energy and free sugar content, high antioxidant (e.g., polyphenols, flavonoids), magnesium and soluble fiber content. In addition,

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beer provides essential vitamins and minerals and is thus contributing to a healthy balanced diet. The alcohol-free beers also claim beneficial effects of healthy beer components with a simultaneous effect of the lower energy intake and complete absence of negative impacts of alcohol consumption.

3 Methods of the Alcohol-free Beer Production

The strategies to produce AFBs can be divided into two main groups (physical and biological processes), which can be further broken down as shown here (Figure. 1). The so called physical methods are based on gentle removal of alcohol from regular beer and require considerable investments into the special equipment for alcohol removal. After the removal process has been optimized, the sensorial quality of produced AFBs is usually good. Their further advantage is that they can remove ethanol from beers to vanishingly low levels. The most widespread biological approaches are based on limited ethanol formation during the beer fermentation. They are usually performed in traditional brewery equipment and hence do not require additional investments, but their products are often characterized by worty off-flavors. Improvements taking advantage of special yeast increase the costs by the purchase, selection, or construction of the production organisms as well as by the need their propagation have to be separated. However, suitable tailor-made or selected microorganisms can contribute significantly to the product sensorial quality improvement. There are also AFB production processes (continuous fermentation with immobilized yeast) based on limited alcohol formation, which require special equipment and material (continuously operating bioreactor, carrier for cell immobilization). In this case, the higher investment costs have to be justified by the higher productivity of continuous processes. In general, the ethanol formation, which is intrinsic to the biological methods, makes impossible the production of AFBs with alcohol content close to zero.

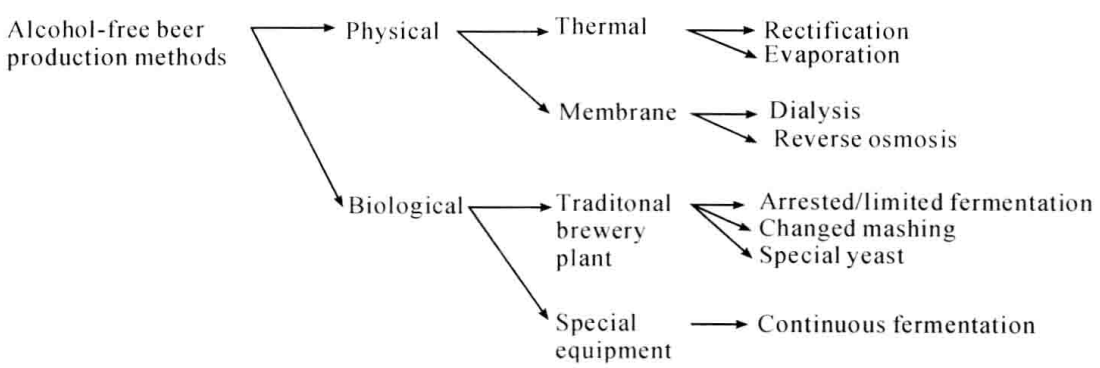

Figure 1 The scheme of most common alcohol-free beer production methods

4 Production of Alcohol-free Beer by Ethanol Removal Methods

The technologies applied for complete or partial ethanol removal from regular beers can be classified into two groups based on the principle of the separation process such as thermal and membrane processes (Figure 1). Besides the industrially applied methods of beer dealcoholization

(vacuum rectification and evaporation, dialysis, and reverse osmosis) there have been several other methods studied under laboratory conditions such as membrane extraction, supercritical CO_2 extraction, pervaporation, adsorption on hydrophobic zeolites, and freeze concentration.

1) Thermal Processes

The early attempts to dealcoholize beer by evaporation or distillation under atmospheric pressure, which revealed significant temperature damage to the beer taste, were soon replaced by vacuum distillation. If the pressure is reduced, alcohol can be drawn off at much lower temperature. All thermal processes to produce AFBs are therefore performed at an absolute pressure of 4 ~ 20 kPa, whereby evaporation temperatures of 30 ~ 60℃ are achieved. Even so, a great loss of beer flavor and liveliness can occur during thermal processes. The deterioration of beer quality by thermal dealcoholization depends mainly on the evaporation temperature and the period of exposure, which depends on the thermal separator construction. AFB production at industrial scale has been implemented using vacuum distillation (rectification) plants or vacuum evaporators (single or multistage) of two main construction variants i. e. centrifugal and falling film evaporators.

Generally, advantages of thermal processes are: the potential to remove alcohol from beer completely, the possibility to commercialize the separated alcohol, the continuous and automatic operation with a short start-up period, and the flexibility in terms of volumetric performance and the input beer composition. Conversely, the purchase of these systems requires significant investment as well as there is considerable running costs (energy consumption) and some risks of thermal damage or loss of volatiles from beer. At the end of all thermal processes the concentrated alcohol-free beer has to be diluted with oxygen-free water and carbonized.

2) Membrane Processes

These alcohol removal methods are based on the semipermeable character of membranes, which separate only small molecules like ethanol and water from the beer to the permeate liquid. Two types of membrane processes used for beer dealcoholization can be distinguished on the industrial scale: dialysis and reverse osmosis. They differ in applied pressures and temperatures, membrane materials and their structures. It is known that all of the membrane processes have less thermal impact on beer, they can be operated automatically and in flexible manner, but at the same time they require significant capital and running costs. The economic feasibility of membrane processes for the production of beverages with an alcohol percentage lower than 0. 45 vol. % was by some authors challenged, while others stated that the energy requirement of a membrane system for alcohol purification (reverse osmosis) would be significantly lower than that of a conventional distillation system. Membrane processes were suggested also as a part of a system for the continuous production of delacoholized beverages. And Dialysis and Reverse osmosis are used in common.

5 Production of Alcohol-Free Beer by Methods of Restricted Ethanol Formation

The methods of the alcohol-free beer (AFB) production based on limited alcohol formation can be divided according to the production equipment they require and further subdivided according to alterations in technology or use of special yeast (Figure 1). The most exploited technologies are those requiring the equipment of a traditional brewery plant, while the continuous limited fermentation is a promising but marginal technology. The respective procedures applied on the industrial scale are often combinations of strategies, which belong to technologies using traditional brewery facilities.

1) Changed Mashing Process

Mashing consists of complex physical, chemical, and biochemical (enzymatic) processes, the main purpose of which is to completely degrade starch to fermentable sugars and soluble dextrins. The spectrum of sugars formed depends on the actual enzyme activities present. β-Amylase (temperature optimum of 62 ~ 65℃) produces the fermentable sugar of maltose, whereas α-amylase (temperature optimum of 72 ~ 75℃) generates first non-fermentable sugars (dextrins) and at prolonged action also fermentable sugars. The final content of fermentable sugars in wort then determines the alcohol level in beer. Therefore, by changing the mashing process, it is possible to modulate the profile of wort sugars in a way that their fermentability is limited and results in low alcohol content. Low wort sugar content can be achieved by different strategies as follows.

(1) Inactivation of saccharifying β-amylase by high temperature mashing (75 ~ 80℃).

(2) Cold water malt extraction.

(3) Re-mashing of spent grains to produce a second extract with very little fermentable sugar.

(4) Used on their own, methods relying solely on the modified mashing are seldom successful for the production of AFBs and they have to be combined with further measures such as vigorous wort boiling (lowering the level of aldehydes), wort acidification, limited fermentation, color and bitterness adjustment, etc.

2) Arrested or Limited Fermentation Process

In general, the major disadvantage of both stopped and limited fermentation approach is that it is hardly feasible to achieve low alcohol levels with adequate conversion of wort to beer. Therefore, the objective of these methods is keeping the ethanol content low by removal of yeast before excessive attenuation (stopped fermentation) or creating conditions for restrained yeast metabolism (limited fermentation) and simultaneously reducing the worty flavor impression or limit it from the beginning. These production methods operate with traditional brewery equipment and unit operations, but they require accurate and swift analytical control. These approaches represent the most usual way to produce alcohol-free or low-alcohol beers. When these techniques were carried out with worts of original gravity from 9 to 13 wt. % the smell and taste of AFBs was charac-

terized by a strong worty flavor impression due to the non-reduced wort aldehydes. It has been verified that for stopped or limited fermentation processes an original gravity from 4.0 to 7.5 wt. % is desirable. However, brewing at high gravity (20 wt. %) increases the formation of higher alcohols and esters. This phenomenon can be exploited to strengthen the flavor of reduced alcohol beers obtained after dilution of a higher gravity beer. Further adjustments of volatiles can be achieved by higher fermentation temperature (greater effects on lager yeasts) or reduced oxygen content of wort, which increased dramatically the ester formation by ale yeasts.

The fermentation activity can be arrested (stopped or checked) quickly by temperature inactivation (rapid cooling to 0℃, pasteurization) and/or by removal of yeast from fermenting wort (filtration, centrifugation). The fermentation initial phase can be carried out at a relatively wide range of temperatures without a significant impact on the formation of volatiles and the reduction of aldehydes (Table 1). However, at higher temperatures the fermentation has to be arrested, either by yeast separation or cooling, rather shortly after the wort was pitched, which requires a prompt analytical control and intervention. The increasing fermentation temperature deepened the attenuation and simultaneously enhanced the formation of volatiles and diacetyl by bottom fermenting yeast. A comparison of yeast types showed that the top fermenting yeast achieved a significantly higher aliphatic alcohol formation at lower attenuation, but the top fermented AFBs had also rather high diacetyl content (Table 1). After interrupting the fermentation at an alcohol content less than 0.5 vol. %, the AFB is usually matured for at least 10 days at 0 to 1℃ to avoid an overpowering sulfur flavor. Then the AFB is filtered, carbonated, stabilized, and sterilized.

Table 1 The influence of yeast type and fermentation temperature on the composition of alcohol-free beers

Fermentation yeast	Bottom	Bottom	Bottom	Bottom	Top	Top
Temperature (℃)	0	4	8	12	8	12
Original gravity (wt. %)	11.4	7.5	7.5	7.5	7.4	7.4
Ethanol (wt. %)	0.27	0.37	0.37	0.42	0.32	0.27
Real extract (wt. %)	10.64	6.79	6.79	6.52	6.87	6.94
Attenuation (wt. %)	8	12	12	16	9	8
Fermentation time (h)	48	24	7/24 *	7/24 *	24	7/24 *
pH	5.01	4.87	4.92	4.89	4.87	4.89
Bitterness (EBC)	25.4	17.5	17.7	17.4	17.7	17.8
DMS (μg/l)	30	22	30	32	35	45
Total diacetyl (mg/l)	0.06	0.09	0.08	0.14	0.51	0.35
Total HAA (mg/l)	2.2	6.8	6.7	8.6	15.8	14.2
Total EAA (mg/l)	0.55	0.69	0.6	0.84	0.9	0.9
Reduction of aldehydes (%)	85.8	77.6	80.2	83	88.2	77.5

* After 7 h at the initial temperature the wort was cooled to 0℃ until 24 h were completed.

3) Use of Special Yeast

This approach to the AFB production is associated with the use of special yeast performing a limited fermentation process. The dissimilarity of these "special" yeasts compared to traditional

brewing yeast lies mainly in their tendency to produce lower amounts of ethanol or no ethanol at all. This can be achieved by strategies such as selection of a proper microbial genus (strain) with specific properties or intentional modification of brewing yeast by random mutation or genetic engineering.

The most common approach relies on the fact that the major fermentable sugar of all malt worts is maltose (ca. 75%) and some strains of the genus Saccharomyces (e. g. used in the wine fermentation) are unable to ferment this sugar. Thus the beer resultant from conversion of glucose, fructose, and sucrose will contain less than<0. 5% ethanol. Except the application of a special yeast strain this method of the AFB production is identical with the manufacturing of standard beer. However, due to limited yeast activity and high residual extract content this manufacturing process is vulnerable to microbial contamination. Therefore high standards of cleanliness and microbiological control are required.

The most successful genus, other that Saccharomyces, used for the industrial production of alcohol-free beer is Saccharomycodes ludwigii. The controlled fermentation can be carried out by this yeast thanks to its disability to ferment maltose and maltotriose, the prevailing fermentable sugars of all malt worts. Although according to some authors the beer fermented by S. ludwigii tends to be sweet due to its high residual maltose and maltotriose content, the relative sweetness of these sugars is significantly lower than that of sucrose and glucose (Attenborough, 1988). The fermentation with S. ludwigii is characterized by slow attenuation even at 20℃ which implies that the process does not require continuous monitoring. A comparison of traditional bottom fermenting yeast with S. ludwigii with/without wort acidification showed a significantly higher formation of sensorially active by-products (higher alcohols and esters) by special yeast (Table 2). These volatiles, together with wort acidification, were found to mask the typical worty flavor of AFBs and contributed positively to fullness and pleasant liveliness of AFBs. However, in spite of the high volatile content there was a remaining slight worty off-flavor, which can be ascribed to lower aldehyde reduction by S. ludwigii. The AFBs produced with S. ludwigii contained diacetyl slightly above the taste threshold level, which was picked up in the tasting (Narziss et al., 1992).

Table 2 The influence of yeast type and wort acidification on the composition of alcohol-free beers

Fermentation yeast	Bottom	S. ludwigii	S. ludwigii+acidification
Temperature(℃)	0	20	200
Original gravity(wt. %)	11.5	11.5	11.5
Ethanol(wt. %)	0.3	0.68*	0.68*
Real extract(wt. %)	10.7	10.34	10.34
Attenuation(wt. %)	9	13	13
Fermentation time(h)	48	120	120

Continued

Fermentation yeast	Bottom	S. ludwigii	S. ludwigii+acidification
pH	5.15	4.98	4.18
Bitter substances(EBC)	28	27.2	22.2
Total diacetyl(mg/l)	0.04	0.14	0.13
Total HAA(mg/l)	3	31.8	30.3
Total EAA(mg/l)	0.79	1.88	2.31
Reduction of aldehydes(%)	81	56.8	32.6

* Ethanol content higher than the legal limit for AFB.

Another invention suggests leading steam saturated air through alcoholic beer in a sieve bottom column in order to desorb the alcohol. The involved loss of sensorially active compounds by desorption was suggested to be compensated either by addition of a fermenting wort or by using the species Saccharomyces rouxii able to consume ethanol under aerobic conditions and at the same time to produce flavor active substances. However, the author does not suggest how to deal with the possible negative effect of oxygen from stripping air on flavor and colloidal stability of produced AFB.

A method for producing an alcohol-free beer-like fermented beverage employing a slow fermentation process by fungi from the genus Monascus has been proposed, too. According to the authors the final product looks like beer, has a refreshing taste, glittering red color, low alcohol content, and has high anti-oxidation activity. However, it is questionable whether this beverage can be considered beer.

4) Continuous Fermentation

Although the continuous beer fermentation has been studied for several decades, the number of industrial applications is still limited. The major obstacle hindering the industrial exploitation of this technology is the difficulty in achieving the correct balance of sensory compounds in the final product. Given the shifts in metabolism of cells grown in continuous culture, it has proven difficult to 'translate' the traditional batch process into a continuous and immobilized process. The production of AFBs using immobilized yeast cell systems rank among limited fermentation methods using short contact (1 ~ 12h residence time) between immobilized yeasts and wort. The continuous AFB fermentation can outperform the rival technologies in productivity; however, it is essential that it produces a final product competitive in terms of sensorial quality.

Alcohol-free beers are usually characterized by worty off-flavors and lack of pleasant fruity (estery) aroma found in regular beers. Although the formation of higher alcohols and esters during continuous AFB production has already been studied, very few papers comparing flavor formation in the traditional batch fermentation and the continuous one are available. One reported a significantly lower formation of higher alcohol and acetic acid esters, while more recent papers conclu-

ded the importance of process parameters and yeast strains for the formation of volatiles. Among process parameters it is aeration, which has perhaps the most important impact on the formation of volatiles in continuous systems. An optimal and constant flavor profile of the AFB can be achieved by the accurate oxygen supply. The concentration of total higher alcohols (HA) and ester (ES) as well as the HA/ES ratio found in continuously fermented model medium under optimized oxygen supply was comparable with those found in three commercial alcohol-4free beers.

Several studies have been carried out on the alcohol-free beer production by the limited fermentation with immobilized cells of S. cerevisiae at low temperature (0 ~ 4℃) and nearly anaerobic conditions. Similarly to the cold contact process (CCP) these conditions lead to the suppressed cell growth, low ethanol formation, and stimulated production of higher alcohols and esters. The authors hypothesized that the increased production of volatiles can be ascribed to the effort of cells to maintain the redox balance under anaerobic conditions by reoxidation of NADH coupled with the reduction of carbonyl compounds to higher alcohols. However, some oxygen is essential for several yeast biosynthetic pathways and thus for the long-term production of AFB with balanced flavor.

Wort carbonyls were proposed to contribute to the unpleasant worty taste of AFBs. Although the reduction of wort aldehydes by yeast is relatively fast during batch fermentations, there was concern it may not be sufficient at the speed of the continuous AFB production. However, the carbonyl reducing capacity of continuous immobilized cells systems for the AFB production has been reported to be satisfactory. This can be ascribed to either an increased alcohol dehydrogenase activity in immobilized yeast and/or a wise compromise between the alcohol formation and the carbonyl reduction by optimizing the process parameters (biomass load, residence time, temperature, and aeration) of the continuous systems.

As in the processes involving the limited fermentation, the pH drop during the continuous AFB production does not take place in the required extent, a continuous biological acidification for the direct adjustment of pH of mash and wort by immobilized lactic acid bacteria (DEAE cellulose) has been studied during test periods of a few months. The continuous acidification would suitably match with the subsequent continuous fermentation.

Several industrial examples of testing and implementation of the continuous AFB production have been reported. However, information on the current industrial application of the continuous limited fermentation of AFBs is not available to the authors. It can be assumed that the continuous fermentation systems have not found widespread utilization in the AFB production mainly due to the need of special equipment (bioreactor and tools for its continuous feed and control), eventually additional methods (immobilization) and materials (carrier).

6 Sensorial Properties and Additional Improvements of Alcohol- free Beer

The aroma and taste of an AFB is usually rather different from its fully fermented counterpart. The AFBs often suffer from various flavor imperfections. For instance, the AFBs produced by the membrane processes have usually less body and a low aromatic profile, the thermally dealcoholized AFBs may suffer heat damages, while the beers obtained by biological methods have often a sweet and worty off-flavor. It has been proved that ethanol significantly increases aldehyde retention, leading to lower perception of the worty character. In a usual 5% ABV beer the retention of aldehydes was 32 ~ 39% in comparison to 8% ~ 12% retention at 0.5% ABV. Similarly, higher levels of mono-and disaccharides in AFBs intensify such off-favors. Headspace extraction and sensorial analysis further showed that the aldehyde retention in AFBs can be enhanced by increasing the level of dextrins or glycerol. These findings suggest that the flavor perception of a regular beer cannot be mimicked simply by trying to get the volatile distribution in AFBs as close as possible to that one in a regular beer. Instead, promising results can be achieved by changing the degree of volatile retention in AFBs and/or by creating a balance of volatiles, different from that present in beers containing ethanol, but with similar flavor impression. Particular flavor balance can be produced by process adjustments as well as by adding flavor active compounds into the final product.

1) Post-treatments and Blending

Both the thermal and membrane processes often use different post-treatment and blending techniques in order to improve the sensorial quality and colloidal stability of dealcoholized beers. Improvements can be achieved by the addition of fresh yeast followed by maturation or by blending with the original beer, aromatic beer (beer fermented at elevated temperatures), or krausen. Another possibility is to adopt the Barrell patent to gently dealcoholized beer by treating it with CO_2 from fermenting green beer and finally add krausen followed by maturation and filtration process. The addition of 6 vol% of krausen into a beer dealcoholized to 0.1 ABV returned about 15% and 31% of the higher alcohols and esters originally present in the alcoholic beer, respectively. Other studies have shown that the thresholds of the important aroma components in the AFBs are significantly lower than in the alcohol-containing beer. This means that even a partial replacement of aroma compounds by one of the above suggested methods can improve significantly the AFB flavor.

2) Additives

The use of additives will be explained on the example of Czech alcohol-free beers. Currently there are 30 AFB brands commercialized in the Czech Republic (AFBs represented 2.92% of the Czech beer market in 2008). Among them 26 brands are produced by the arrested/limited fermentation (at least one uses also a changed mashing process), two are fermented with special yeast and one is produced by vacuum rectification. According to information on the labels, 10

brands from the whole group of AFBs are produced only using traditional brewing raw materials, 9 contain one additive, 9 contain two additives, and 2 contain three or more additives.

7 Cost Evaluation and Conclusions

The available literature is poor in comparisons of processes and their impact on the product quality, but the comparison of economic aspects of processes producing LABs of AFBs is even scarcer. Nevertheless, it is clear that the arrested/limited fermentation process can be performed in a common brewery equipment but shorter production time and fewer raw materials are needed. Therefore, the production costs for such LAB/AFBs are the same or lower, than for the regular beer. Conversely, processes of the alcohol removal do require an extra equipment, relevant utilities and space, which mean additional investments and operating costs above the production costs of the regular beer to be dealcoholized. The advantage of alcohol separation processes is their flexibility (start-up within hours, high productivity) and possibility to produce zero alcohol beers, which is hardly achievable by fermentative processes, given by their nature. Some authors also state that the taste of the dealcoholized AFBs is dryer and closer to regular beer. Somewhat contradictory to this is the fact the only Czech AFB produced by vacuum rectification was ranked 21st among 30 samples by the taste panel. Additional profit can be created also from the separated alcohol, which is obtained at different concentrations. The diluted alcohol solution can be further concentrated to a marketable content, used in the brewing process as blending water or sold for acetification to produce vinegar. From one rare cost comparison of four different processes it was the falling film system, which emerged victorious followed by the thin film evaporator, reverse osmosis, and, finally, dialysis. However, a reliable and comprehensive economic comparison of various methods of the LAB/AFB production is not available and therefore it is impossible to define the best process. Moreover, choosing the most appropriate process is further influenced by the available production capacity, expected sales, and marketing strategy of the product and hence it requires a detailed balance sheet reflecting the existing technology and the specifics of the local market.

2.2 参考翻译

低酒精度啤酒与无酒精啤酒生产方法的综述

1 简介

在大多数的欧盟国家里，低酒精度啤酒可分为无酒精啤酒（AFBs），酒精含量小于0.5%（按体积计，ABV）和低酒精度啤酒（LABs），酒精含量不超过1.2% ABV。在美国，无酒精啤酒意味不含酒精，然而，达到上限0.5% ABV的啤酒相当于所谓的“无醇啤酒”或“淡啤酒”。在一些实施宗教禁酒令的国家中，饮料中的酒精含量必须不超过其体积的0.05%。

本文以下章节中的术语将遵从前述的欧洲立法。而同时，生产低酒精度啤酒和无酒精啤酒的方法从实践的观点上看二者是一致的，与低酒精度啤酒相比无酒精啤酒在市场份额上占有压倒的优势。因此，在本文中，产自于麦芽的低酒精度的饮料将通称为无酒精啤酒。

2 啤酒与健康

由于酒精带来暴力犯罪、交通事故、聚众骚乱及健康威胁等危险，酒精滥用成为公众议题已经很多年了。酒精是世界范围内最普遍使用的娱乐性药物之一，经常作为啤酒的一种成分被摄取。当啤酒饮入后，酒精通过扩散方式被胃肠道吸收，在进入组织之前迅速的分散到血液中。酒精在胃和肝脏中主要被代谢成乙醛，乙醛具有高毒性并且会与细胞成分结合形成有害的乙醛加合物。

同时，强有力的证据显示，适度的酒精消费不仅比过度饮酒甚至比戒酒更有助于长期的健康。有数据显示适量的饮用啤酒与葡萄酒一样能有效减少冠心病、心脏病发作、糖尿病风险及总体的死亡率。酒精可能是啤酒中抗动脉硬化的最重要成分，同时，啤酒中各种各样的其他特性以及谷物有效成分、啤酒花的相关物质，例如无脂肪或无胆固醇、低热量和无糖、高抗氧化剂（如多酚、类黄酮）、镁和可溶性纤维都具有积极作用。此外，啤酒还提供必要的维生素与矿物质，因此有益于健康均衡的膳食。无酒精啤酒同样具有健康啤酒成分的有益效果，具有低能量摄入，完全没有酒精消费的负面作用。

3 无酒精啤酒的生产方法

无酒精啤酒的生产方法可以分成两个主要部分（物理过程和生物过程），它可以进一步细分（图 1），所谓的物理方法是建立在温和去除普通啤酒中酒精的基础上的，需要相当大的投资，购入专用设备来去除酒精。酒精去除工艺优化之后，所生产的无酒精啤酒的感官品质普遍是良好的。物理方法的更大优点是，可以把啤酒中的酒精去除到难以检测的水平。最广泛使用的生物学方法是抑制啤酒发酵过程中产生酒精。这种方法通常在传统啤酒厂中应用，因此，它们不需要额外的投资，但是，这种方法所生产出来的产品往往具有麦芽汁的异味。利用特殊酵母的改进提高了购买、选择和构建生产用微生物的成本，而且，这些微生物必须相互隔离繁殖。然而，特制的或经过筛选的微生物有助于显著提高产品的感官质量。也有些基于抑制酒精生成的无酒精啤酒的生产工艺（用固定化酵母连续发酵）是需要特殊的设备和材料（连续操作的生物反应器，细胞的固定化载体）。在这种情况下，毫无疑问的证实了，投资成本越高，连续生产的生产率越高。一般来说，乙醇的形成是生物学方法所固有的，不可能使无酒精啤酒产品的酒精度达到零度。

4 乙醇去除法的无酒精啤酒生产

这项完全或部分去除普通啤酒中乙醇的技术，依据分离工艺如加热和膜处理的原理可以将其分为两类（图 1）。除工业应用的啤酒脱醇的方法以外（真空精馏，蒸馏，透

析，反渗透），实验室条件下还研究了一些其他的方法，诸如膜分离、二氧化碳超临界萃取、渗透蒸发、疏水性沸石吸附和冷冻浓缩。

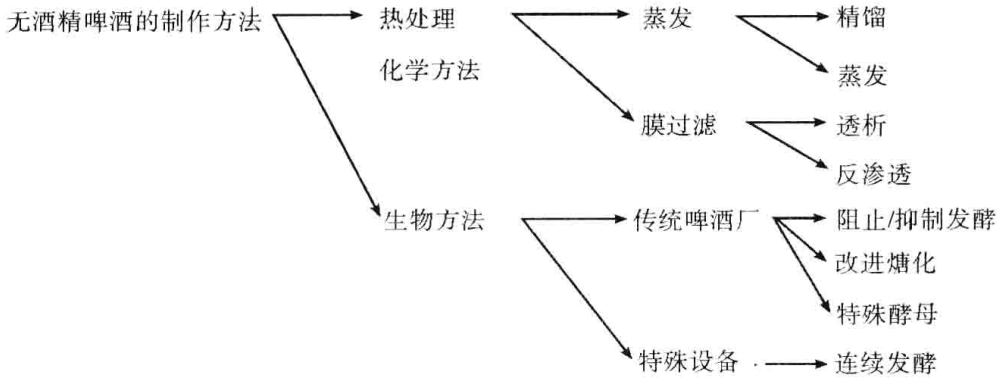

图 1 大多数普通无酒精啤酒的生产工艺

1）热加工过程

常压下通过蒸发或蒸馏对啤酒脱醇的早期尝试结果显示，温度严重破坏啤酒的味道，所以很快被真空蒸馏取代。如果压力降低，酒精可以在更低的温度下流出。所有生产无酒精啤酒的加热过程是在绝对压力为 4 ~ 20 kPa、蒸发温度为 30 ~ 60℃的条件下完成的。即便如此，在加热过程中仍然会对啤酒的风味和清口性造成很大的损失。加热脱醇所导致的啤酒品质下降，主要因为热分离器结构所需要的蒸发温度和时间。工业化生产无酒精啤酒上已经实现了利用真空蒸馏（精馏）设备或真空蒸发器（单一或多级）中两个主要结构变形即离心和降膜式蒸发器。

一般来说，加热过程的优点是：完全去除啤酒中酒精的能力、单离酒精商品化的可能性、短周期的连续和自动操作、根据体积动态和投入的啤酒成分可以灵活性控制。相反的，购买这些系统需要大量的投资以及有相当大的运行成本（能量消耗）和啤酒挥发的损失。所有的加热过程结束之后浓缩的无醇啤酒必须用无氧水稀释并充气。

2）膜处理

这类酒精去除方法是基于膜的半渗透性，能分离啤酒的小分子物质像乙醇和水到渗透液中。用于工业规模啤酒脱醇的膜处理可以分为的两种类型：透析和反向渗透。他们的不同在于应用的压力和温度、膜材料及其结构。众所周知，所有的膜处理对啤酒没有热影响，可以自动和灵活操作，但同时也需要大量的资本和运营成本。薄膜处理生产酒精百分比低于 0. 45 vol. % 饮料的经济可行性遭到一些学者的质疑，而其他一些阐述指出，对用于酒精纯化的膜系统（反渗透）对能源的需求会远远低于传统的蒸馏系统。膜处理也被认为是连续生产脱醇饮料系统的一个部分。常用的膜处理方法有透析和反渗透等。

5 限制乙醇形成生产无酒精啤酒的方法

基于限制乙醇形成的无酒精啤酒的生产方法，可以按照所需产品设备分类，还可以根据技术的变化或使用的特殊酵母来进一步的细分（图 1）。最常用的技术是那些只需要传统啤酒厂中使用的设备，而连续抑制发酵是一个很有前景但处于边缘的技术。各自的

工艺过程应用于工业化生产中常常是策略的组合，属于使用传统酿酒设备的技术。

1）糖化过程的改变

糖化是由复杂的物理的、化学的和生化的（酶的）过程组成，主要目的是使淀粉完全降解变成可发酵糖和可溶性糊精。糖色谱的形成取决于实际呈现的酶活力。β-淀粉酶（最适温度62～65℃）产生可发酵的麦芽糖，而α-淀粉酶（最适温度72～75℃）首先生成不可发酵的糖类（糊精），延长反应也生成可发酵糖。麦芽汁中的可发酵糖的终浓度决定了啤酒中酒精的含量。因此，通过改变糖化过程，在某种程度上可以改变麦芽汁中糖的情况，抑制其发酵能力，致使酒精含量较低。可以通过如下不同策略使麦芽汁的糖含量达到一个较低的水平。

（1）高温（75～80℃）糖化使糖化的β-淀粉酶失活。

（2）冷水麦芽抽提。

（3）用酒糟再糖化来制备只含有少量可发酵糖的二次提取物。

单独使用上述方法，或者仅仅依赖于改进糖化都很难成功地生产出无酒精啤酒，必须结合更多的措施如麦芽汁煮沸（降低醛的含量）、麦芽汁酸化、抑制发酵、颜色和苦涩感的调整等。

2）阻止或抑制发酵过程

一般来说，停止和抑制发酵方法主要的缺点是麦芽汁充分转换成啤酒时很难实现低酒精含量。因此，这些方法的目标是在发酵糖过度减少之前，通过去除酵母保持低乙醇含量（停止发酵）或为抑制酵母代谢创造条件（限制发酵），同时减少麦芽汁味或从一开始就抑制它的味道。这些生产方法采用传统酿酒设备和单元操作运转，但是需要精准的分析控制。这些方法是生产不含酒精或低度啤酒最常用的方法。当麦芽汁的初始浓度在9～13 wt.%范围时使用这些技术，由于非还原麦芽醛的作用会使无酒精啤酒的气味和口感具有强烈的麦芽味。已经证实了对于阻止或抑制发酵工艺，初始浓度在4.0到7.5 wt.%之间是比较理想的。然而，高浓度（20 wt.%）下酿造增加了高级醇和酯的形成。这种现象可以应用于高浓度啤酒稀释后获得的低酒精啤酒，增强其风味。对挥发物的进一步调整可以通过提高发酵温度（对啤酒酵母影响较大）或降低麦芽汁中的氧含量来实现，这样能通过爱尔酵母大幅增加酯的形成。

发酵活性可以通过温度失活（快速冷却到0℃、巴氏杀菌）和/或从发酵麦芽汁中（过滤、离心）去除酵母而被迅速地抑制（停止或受阻）。发酵初始阶段可以在一个相对宽泛的温度范围下进行，这对挥发物的形成及醛类的减少没有什么大的影响（表1）。然而，在较高的温度下，发酵会因酵母分离或是冷却被抑制，需要在麦芽汁投入后马上进行快捷的分析控制和调节。发酵温度的上升加剧了糖的消耗，同时由下面发酵酵母增强了挥发物和双乙酰的形成。酵母类型的比较显示：在糖消耗较低时上面发酵酵母能形成相当多脂肪醇，但上面发酵的无酒精啤酒也含有相当多的双乙酰（表1）。在酒精含量小于0.5 vol.%时中止发酵后，无酒精啤酒通常需要在0到1℃成熟至少10天，以避免强烈

的硫磺味。然后无酒精啤酒被过滤、碳酸化充气、稳定和除菌。

表 1 酵母类型和发酵温度对无酒精啤酒组成物质的影响

发酵酵母	下面发酵	下面发酵	下面发酵	下面发酵	上面发酵	上面发酵
温度(℃)	0	4	8	12	8	12
原浓度(wt.%)	11.4	7.5	7.5	7.5	7.4	7.4
乙醇(wt.%)	0.27	0.37	0.37	0.42	0.32	0.27
实际提取量(wt.%)	10.64	6.79	6.79	6.52	6.87	6.94
消糖率(wt.%)	8	12	12	16	9	8
发酵时间(h)	48	24	7/24*	7/24*	24	7/24*
pH	5.01	4.87	4.92	4.89	4.87	4.89
苦涩味(EBC)	25.4	17.5	17.7	17.4	17.7	17.8
二甲基硫醚(μg/l)	30	22	30	32	35	45
二乙酰总量(mg/l)	0.06	0.09	0.08	0.14	0.51	0.35
高级脂肪酸总量(mg/l)	2.2	6.8	6.7	8.6	15.8	14.2
乙酸脂总量(mg/l)	0.55	0.69	0.6	0.84	0.9	0.9
乙醛还原量(%)	85.8	77.6	80.2	83	88.2	77.5

注 * 初始温度发酵 7h 后，将麦芽汁冷却到 0℃至 24h。

3) 使用特殊的酵母

这种无酒精啤酒的生产方法是关于使用特殊酵母限制发酵的工艺。这些“特殊”酵母与传统酿造酵母相比的主要差别在于它们倾向于产生少量的乙醇或不产乙醇。这可以通过一些方法来完成如选择合适的具有特定属性微生物种属（菌株）或选择通过随机突变或基因工程有意改造的酿造酵母。

最常见的方法依赖于这样的情况，所有麦芽汁中主要的可发酵糖是麦芽糖（大约 75%），酵母属的一些菌株（例如用于葡萄酒发酵）是无法发酵这种糖的。因此通过葡萄糖、果糖、蔗糖的转换得到的啤酒其乙醇含量少于 0.5%。除去使用特殊酵母菌株，这种生产无酒精啤酒的方法与标准啤酒的生产是相同的。然而，由于有限的酵母活性和提取物的高残留量，这种制造工艺容易受到微生物污染。因此需要高标准的清洁度和微生物控制。

酵母属的其他菌种中，路德酵母是工业化生产无酒精啤酒最成功的。这种酵母的控制发酵得以实现是它缺乏发酵麦芽糖和麦芽三糖的能力，而这两种糖是所有麦芽汁中是占优势的可发酵糖。尽管一些学者认为由路德酵母发酵的啤酒因为麦芽糖和麦芽三糖的残余量高而使口感偏甜，但是这些糖的相对甜度是远远低于蔗糖和葡萄糖。路德酵母发酵的特点是即使在 20℃耗糖也很缓慢，意味着发酵过程不需要连续监测。传统的下面发酵酵母与路德酵母关于有/没有麦芽汁酸化的比较结果显示，通过特殊的酵母形成的感官活性副产品（高级醇和酯类）的量明显更高（表 2）。已发现这些与麦芽汁一起被酸化的挥发物能掩盖无酒精啤酒典型的麦芽汁味并确实地促成无酒精啤酒的饱满性和令人愉快的爽口性。然而，尽管挥发物含量高但仍然有轻微的麦芽汁异味，这归结于路德酵母对醛的还原能力较低。把路德酵母生产的无酒精啤酒拿来品尝，其所含双乙酰略微超过的

品味的阈值。

表 2 酵母类型及麦芽汁酸化对无酒精啤酒组成的影响

发酵酵母	下面发酵	路德类酵母	路德类酵母+酸化
温度（℃）	0	20	200
原浓度（wt.%）	11.5	11.5	11.5
乙醇（wt.%）	0.3	0.68*	0.68*
实际提取量（wt.%）	10.7	10.34	10.34
消糖率（wt.%）	9	13	13
发酵时间（h）	48	120	120
pH	5.15	4.98	4.18
苦感物质（EBC）	28	27.2	22.2
二乙酰总量（mg/l）	0.04	0.14	0.13
高级脂肪酸总量（mg/l）	3	31.8	30.3
乙酸脂总量（mg/l）	0.79	1.88	2.31
乙醛还原量（%）	81	56.8	32.6

注 * 酒精含量高于无酒精啤酒的规定限制。

另一个发明建议在一个有过滤底的容器中使饱和蒸汽的空气通过含酒精啤酒，以便其释出酒精。在解吸过程中感官活性化合物的相关损失，建议通过添加发酵麦芽汁补偿或使用鲁氏酵母，它能在有氧条件下消耗乙醇同时产生风味活性物质。然而，如何应对脱除空气中的氧对所生产的无酒精啤酒的风味和胶体稳定性可能带来的负面效应，作者并没有给出建议。

还有一种推荐的方法是利用源自红曲霉的真菌缓慢发酵生产无醇的类啤酒发酵饮料。根据作者的描述，最后的产品看起来像啤酒，有一种清爽的味道，颜色亮红，酒精含量低并具有较高的抗氧化活性。然而值得怀疑的是，这种饮料是否可以被认为是啤酒。

4）连续发酵

尽管连续啤酒发酵已经研究了几十年，但是工业上的应用仍然有限。阻碍这项技术工业化开发的主要障碍是最终的产品很难实现感官化合物的正确平衡。鉴于连续培养中生长细胞新陈代谢的变化，已经证实很难将传统的分批发酵工艺“转换”成连续的和固定化的工艺。利用固定化酵母细胞系统生产无酒精啤酒属于限制发酵方法中固定化酵母与麦芽汁之间的接触法（1～12 h 停留时间）。在生产效率上，这种无酒精啤酒的连续发酵是可以超越许多竞争技术的；然而，最终产品在感官品质上的竞争力也是十分必要的。

无酒精啤酒的特点通常是具有麦芽汁异味，缺乏普通啤酒中令人愉快的水果（酯）香气。尽管在连续的无酒精啤酒生产中高级醇和酯的形成已经有过研究，但是只有很少的比较传统分批发酵和连续发酵中风味形成的论文是可用的。有一篇报道了高级醇和乙酸酯的形成显著降低，而最近更多的论文得出了工艺参数和酵母菌株对挥发物形成起重要作用的结论。工艺参数中，充气可能是连续系统中影响挥发物形成最重要的因素。准确的氧气供应可以使无酒精啤酒的风味最佳且恒定。在优化的供氧条件下，连续发酵的模型培养基中，总高级醇（HA）和酯（ES）的浓度以及 HA/ES 的比率比得上三种商业

无酒精啤酒。

一些研究在低温（0～4℃）和几乎厌氧的条件下，利用固定化的酿酒酵母细胞通过限制发酵进行了无酒精啤酒的生产。类似于冷接触法（CCP），这些条件导致细胞生长受到抑制、乙醇形成量低并能刺激生产高级醇类和酯类。作者推测，产品中挥发物的增加可以归结于细胞在厌氧条件下为保持氧化还原平衡，通过还原型辅酶 I 的再氧化所做出的努力，同时伴随着羰基化合物还原成高级醇。然而，一定的氧气对于一些酵母生物合成途径、长期生产具有和谐风味的无酒精啤酒都是必要的。

无酒精啤酒中不愉快的麦芽汁异味被认为是麦芽汁羰基化合物造成的。虽然在分批发酵期间麦芽汁醛能够相对快速地被酵母还原，但令人担忧的是，连续无酒精啤酒的生产中可能没有足够的还原速度。然而，已有报道表明，生产无酒精啤酒的连续固定化细胞系统中羰基的还原能力令人满意。这可以归因于固定化酵母乙醇脱氢酶活性的增加和/或通过优化连续系统的工艺参数（生物质装载、停留时间、温度和换气）对酒精形成和羰基还原良好的协调。

已经有一些连续生产无酒精啤酒工业上测试和实施样例的报道。然而，在当前的工业信息下，用连续抑制发酵方法来生产无酒精啤酒是不可能实现的。可以假设连续发酵系统没有广泛运用在无酒精啤酒的生产上主要是由于特殊设备的需求（生物反应器和连续进料及控制装置）、最终额外的方法（固定化）及材料（载体）。

6 无酒精啤酒的感官性状及进一步改进

无酒精啤酒的气味和味道与完全发酵的对照啤酒相比通常会有相当大的差别。无酒精啤酒在风味上常常会有各种欠缺。例如，通过膜处理生产出的无酒精啤酒通常醇香和风味物质会减少，热脱醇的处理的无酒精啤酒可能遭受热损伤，而通过生物学方法所获得的啤酒通常含有甜味和麦芽汁异味。已经证实乙醇能显著提高对乙醛的保留能力，从而降低对麦芽汁特征的感知。在酒精含量 5% ABV 的普通啤酒中乙醛的保留量为 32%～39%，相比之下酒精含量为 0.5% ABV 的啤酒中乙醛保留量为 8%～12%。类似地，无酒精啤酒中较高浓度的单糖和二糖增强了异味感。顶部空间回收物和感官分析进一步表明可以通过增加糊精或甘油的含量来提高无酒精啤酒对乙醛的保留。这些发现表明，在无酒精啤酒中，不能简单地试图通过所获挥发物尽可能接近于普通啤酒的调配来模仿对普通啤酒风味的感知。反之，理想的结果可以通过改变无酒精啤酒中挥发物的保留程度和/或创立一个挥发物质的平衡来实现，啤酒中的乙醇含量不同，但有类似的风味感觉。特殊风味的平衡可以通过工艺调整以及向最终的产品中添加香味活性成分来得到。

1）后处理与调和

为了提高脱醇啤酒的口感和胶体稳定性，热处理法和膜处理法通常采用不同的后处理与调和技术。还可以在随后酿熟的过程中添加鲜酵母或者用原啤酒、香气浓郁的啤酒（高温发酵的啤酒）或是剧烈发酵的麦芽汁来调配以实现风味的改善。另一种可能性是采用 Barrel 专利，即用生啤中的 CO_2 来处理温和脱醇的啤酒，最后在酿熟过程中添加剧烈

发酵的麦芽汁并过滤。脱醇的至0.1 ABV的啤酒中添加6vol.%剧烈发酵的麦芽汁可使高级醇和酯类分别回归到含酒精啤酒中原浓度的15%和31%。其他的研究表明，无酒精啤酒中的重要的芳香成分的阈值明显低于含酒精啤酒。这就意味着即使采用上述任何一种方法部分放回香味成分都能够显著提高无酒精啤酒的风味。

2）添加剂

添加剂的使用将以捷克的无酒精啤酒为例来说明。目前，有30个无酒精啤酒的品牌在捷克共和国市场上销售（2008年在捷克，无酒精啤酒占据了2.92%的啤酒市场）。其中26个品牌是通过阻止/抑制发酵法生产的（至少有一种品牌也使用了改变糖化的工艺），两个品牌采用了特殊酵母发酵，还有一个品牌采用真空精馏的生产方式。根据标签上的信息，在整个的无酒精啤酒生产中，只有10个品牌使用传统的酿酒原料，9个品牌含有一种添加剂，9个品牌含有两种添加剂，2个品牌含有三种或更多的添加剂。

7 成本评估与判定

可查的文献中，比较生产工艺及其对产品质量影响的很少，而对无酒精啤酒中低酒精度啤酒生产工艺在经济方面的比较更是凤毛麟角。尽管如此，很明显，阻止/抑制发酵工艺可以在用普通的酿造设备完成，但所需生产时间更短和原材料使用更减少。因此，对于这样的低酒精度啤酒/无酒精啤酒的生产成本与普通啤酒相比是同样的甚至更低。相反，去除酒精的工艺需要额外的设备，以及相关的器械和空间，这就意味着去除酒精额外的投资和，高于普通啤酒的生产费用。酒精分离工艺的优势在于灵活性（在几个小时之内运转、生产效率高）和生产零酒精啤酒的可能性，这是自然发酵工艺很难实现的。一些学者指出，去除酒精的无酒精啤酒的味道更浓郁更接近于普通啤酒。对于这一点，某种程度上也有矛盾之处，真空精馏生产的捷克无酒精啤酒在30个样品中由品尝小组给出的排名仅为第21。从不同浓度的分离酒精中还可以创造额外的利润。稀释的酒精溶液可进一步浓缩到可销售的浓度、用于酿造过程中作为勾兑水或出售用于醋化制醋。在一分罕见的对四种不同工艺的成本比较中，降膜系统胜出，其次是薄膜蒸发、反渗透，最后是透析。然而，对于不同方法生产低/无酒精啤酒还没有一个可靠的综合性的经济比较，因此它不可能确定出最佳工艺。此外，选择最合适的方法，更进一步地受产品的现有生产能力，预计销售额以及市场策略的影响，因此需要一个详细的资产负债表来反映现有的技术和当地市场的具体情况。

3 阅读链接

[1] http://www.journals.elsevier.com/trends-in-food-science-and-technology/

[2] http://link.springer.com/journal/217#

[3] http://onlinelibrary.wiley.com/journal/10.1111/(ISSN)1365-2621

[4] http://www.journals.elsevier.com/journal-of-food-engineering/

4 课后作业

4.1 句子翻译

4.1.1 原句

(1) Concentrated lime juice with 20% total soluble solids was dried using three levels of maltodextrin (40%, 50%, and 60% solid base) and a BüCHI B-190 spray dryer.

(2) The results of this study are beneficial for scaling up the spray drying of lime juice to the food industry.

(3) Effect of freezing and thawing on bread quality can be studied objectively to develop relationships between temperatures, durations of holding and shelf life after baking.

(4) The same clarifying agent with the same concentration along with sterile filtration has decreased the tannins by 41.75% with improved visual clarity of 96%.

(5) Acrylamide inhibition through reducing the acrylamide precursors including asparagine and reducing sugars, by the use of asparaginase and/or substituting some of the added sugar using stevioside were investigated for their effects on dynamic rheology, hardness of dough, and for baking and sensory properties of the prepared cookies.

(6) Addition of bacterial α-amylase, specially to blends of enzymes also containing lipase and pentosanase, improved white, lidded-pan bread quality by increasing elasticity and lowering firmness of crumb, and enhanced the keeping quality over time by providing a significant 2-day increase in the shelf life.

(7) Response surface methodology (RSM) was used to optimise jelly formulation using as independent variables: total sugar content, ranging from 14 to 46°Brix; and total gum concentration ranging from 0.30 to 0.70% (w/v), with the proportion of gums in the mixture xanthan: LBG: gellan ranging from 5 : 5 : 90 up to 45 : 45 : 10.

(8) This paper describes semi-continuous acetic acid fermentations for wine vinegar production performed isothermally and using temperature gradients in order to determine the influence of temperature on this industrial biotransformation.

(9) The texture characteristics, i. e. gel hardness, cohesiveness and springiness, were found to be similar to those of a reference product, a previously developed reduced-calorie grape juice jelly with low methoxyl pectin.

(10) Powders hygroscopicity decreased with increasing maltodextrin concentration, decreasing temperature and increasing feed flow rate.

4.2.2 参考翻译

（1）用三个浓度（40%，50%，和60%固体基质）的麦芽糊精和BüCHI B-190型喷雾干燥机来干燥含有20%总可溶性固形物的浓缩酸橙汁。

（2）研究结果有助于在食品工业中按比例大规模进行浓缩酸橙汁的喷雾干燥。

（3）冻融对面包品质的影响可以通过展现温度、保温时间及焙烤后保质期之间的关系来客观地研究。

（4）同样的澄清剂在同样的浓度下伴随着无菌过滤处理，使丹宁酸减少41.75%，同时视觉透明度提高96%。

（5）有研究通过降低天冬酰胺酶和糖分来抑制丙烯酰胺，或使用天冬酰胺酶和/或用甜菊苷取代部分糖来抑制丙烯酰胺，来研究其对预处理曲奇的动态流变学特性、面团硬度及烘焙和感官特性等产生的影响。

（6）添加细菌源α-淀粉酶，特别是加入含有脂肪酶和戊聚糖酶的混合酶，可以提高白面包和模具成型面包的质量，可以增加弹性和降低面包芯儿的坚韧度，货架期显著延长2天。

（7）响应面法（RSM）用于以独立变量优化凝胶的形成：总糖含量范围14～46°Brix（百利糖度）、胶浓度范围0.30～0.70%（w/v）、混合胶黄原胶：刺槐豆胶：凝胶糖的比例从5：5：90升至45：45：10。

（8）本文描述了生产酒醋的半连续醋酸发酵，为了确定温度对这种工业生物转化的影响，发酵在等温和不同温度梯度下进行。

（9）与对照产品，一种先前开发的含有低甲基化果胶的减热量葡萄汁果冻相比，其质构特性如：凝胶硬度、内聚性和弹性是相似的。

（10）随着麦芽糊精浓度的增加、温度的降低及进料速度的加快，粉末的吸湿性降低。

4.2 科技论文常见句型

4.2.1 标题的写作

1）标题的书写格式

（1）第一个词和每一个实词的第一个字母都用大写，虚词则采用小写.

【例句】Effects of Heating Media and Operating Conditions on Drying Kinetics and Quality of Germinated Brown Rice

加热介质、操作条件对发芽糙米干燥动力学及品质的影响

（2）第一个词的第一个字母用大写，其余全部小写。

【例句】Enzymatic polishing of rice-A new processing technology

大米酶法抛光——一种新型加工技术

(3) 每个词的字母全部采用大写。

【例句】THE RAPID DETERMINATION OF γ-AMINOBUTYRIC ACID

γ-氨基丁酸的快速测定

2) 标题的结构

英文标题以名词短语为主要形式，由一个或几个名词连同定语构成．一般只有名词、形容词、连词、冠词和介词，动词只以现在分词或过去分词形式出现。标题要有中心词，并放在突出的位置上，如：Effects of heating media and operating conditions on drying kinetics and quality of germinated brown rice 中 Effects 是中心词．英文标题中心词提前，这是与汉语不同的，如上例："…的影响"。

另外，标题不是句子，在标题中不采用句子的形式，不用不定式短语，也不出现从句。

3) 标题中的冠词

论文标题中的一般冠词较多，近年来趋于简化，冠词多可以省略。

【例句】(The) Accumulation of γ-Aminobutyric Acid in Rice Germ Using Protease

利用蛋白酶富集糙米中的γ-氨基丁酸

4) 词的增减

标题的中英文在原则上应该一致，但也常有省略的情况，如汉语中的"…的研究"在英语中通常都省略例如："A Study on …"、"The Study of …" 等均应省略才更简洁更符合英语标题的写作习惯。

【例句】 "Comparative Studies on Rheological Properties of Mayonnaise Samples" 改为"Comparision of Rheological Properties of 4 Mayonnaise Samples"

4 种蛋黄酱的流变特性比较研究

4.2.2 正文写作

(1) 常放在摘要开头的主题句，一般是研究的目的，要研究和解决的问题．如：be aimed to …; The aim of this study was to …; be analysed; be discussed; … be described; … be evaluated

【例句】This study was aimed to analyse the impact of the debittering process (DP) in the overall sensory properties of orange juice.

本研究旨在分析脱苦工艺对橘子汁全部感官性质的影响。

(2) 介绍研究途径，分析方法或介绍实验条件等，可以采用的句型有：Measurements were carried out to …; Conditions were considered for/of …; the approach was based on …

【例句】All measurements were made in triplicate for each sample.

每份样品的所有测定都重复三次。

（3）经过试验和研究所得出的新数据、观点和结果，要进行评价，常见的句式有：Results show that …；Facts express that …；Study proves that …（结果显示…）。

【例句】The results for the physico-chemical analysis are shown in Table 2.

物化分析结果见表2。

【例句】The results showed that the juices obtained after the microfiltration and pasteurisation processes had low microbial counts.

结果表明果汁经过微孔过滤和巴氏杀菌之后微生物计数较低。

（4）处理结果或工艺处理之间的比较 Compare with …，There was no change，there was significant difference …

【例句】Compared with traditional juice processing methods，membrane processes are associated with low investment costs and athermal separation techniques which involve no phase change（low temperatures）or chemical agents（clarification）.

与传统果汁加工方法相比，膜处理投资成本低，属于不涉及相变（低温）或化学药剂（澄清剂）的非热分离技术。

【例句】There was no change in the parameters analysed in relation to different temperatures used in the thermal treatment.

不同温度热处理的相关分析参数没有变化。

（5）以 it 作为形式主语的情况，在科技英语中经常出现。下面是最常见的句型：It is easy to ；It is a simple matter to find ；It should be noted that；It is obvious that …

【例句】It is clearly seen that with increased SMC，wort viscosity decreased.

显然，随着浸提度的增加麦芽汁的粘度降低。

（6）结论句式，反映研究的成果与水平，以及应用范围。

【例句】Finally，it was concluded that microfiltration is a viable alternative to thermal processes in sugar cane juice conservation.

最后得出结论，相对于热加工而言微孔过滤对甘蔗汁的保存更为可行。

【例句】More research should be performed in order to satisfy consumer demands for fresh-tasting products while retaining safety.

保证食品安全的同时，为满足消费者对新鲜食品的需求，还应该进行更多的研究。

Chapter 4　Food Safety and Management

Unit 1　Transgenic Food

1　专业词汇分析

（1）GMOs = Genetically modified organisms　n. 转基因生物

（2）pharmaceutical　adj. 制药（学）的　n. 药物

［记忆窍门］“phar”是“pharmaceutical”的缩写。

（3）nutraceutical　n. 营养食品；功能食物

［记忆窍门］“nutr”是“nutraceutical”的缩写。

（4）prevalence　n. 流行，盛行；普遍；广泛

（polygenic　adj. 多基因的

［记忆窍门］“poly”是“聚合，复合”的意思；“genic”是形容词“基因的”。

（5）hypertension　n. 高血压

［记忆窍门］“hyper”意为“高度紧张的；亢奋的”；“tension”意为“拉力”。

（6）coronary artery disease（CAD）　n. 冠状动脉疾病

［记忆窍门］“corona”意为“冠状物”。

（7）susceptibility　n. 敏感性，易感性；感情；磁化系数

［记忆窍门］“sus”意为“可疑行为”；“suscept”意为“感病体”；“-ibility”后缀表示“性质，能力”。

（8）precursor　n. 前体

［记忆窍门］“pre-”前缀表示“提前”。

（9）heritability　n. 遗传力，遗传率

［记忆窍门］“heritage”意为“遗传”；“-ability”后缀表示“性质，能力”。该单词也可以拆分成“her”+“it”+“ability”。

（10）phenotype　n. 表型，表现型，显型

［记忆窍门］“type”意为“类型”。

（11）interaction　n. 相互作用

［记忆窍门］“inter-”前缀表示“在一起，交互”；“action”意为“行动，活动”。

（12）nucleate　adj. 有核的；vt. 使成核；vi. 成核

［记忆窍门］“nucl”表示“核”。

（13）genome　n. 基因组；染色体组

［记忆窍门］“geno”意为“基因族群”。

（14）transduction n.［遗］转导；转换；换能；变频

［记忆窍门］“trans-”前缀表示“转运，转移”；“-duction”后缀表示“导”。

（15）bacteriophage n.［病毒］噬菌体；抗菌素

［记忆窍门］“bacteria”意为“细菌”；“phage”意为“噬菌体”。

（16）pronuclear adj. 原核的

［记忆窍门］“pro-”前缀表示“居前；领先”；nuclear“细胞核的”。

（17）microinjection n. 显微镜下注射

［记忆窍门］“micro”意为“微小的”；“injection”意为“注射”。

（18）plasmid n.［遗］质粒；质体

（19）electroporation n.［遗］电穿孔

［记忆窍门］“electro-”前缀表示“电，电子的，用电”。

（20）permeability n. 渗透性；通透性

［记忆窍门］“-ability”后缀表示“性质，能力”。

（21）chromosome n.［遗］染色体

［记忆窍门］“chromo-”前缀表示“色”；“-some”后缀表示“…体。”

（22）remedy vt. 补救；治疗；纠正 n. 补救；治疗；赔偿

［记忆窍门］“re-”前缀表示“重新；再、又”。

（23）herbicide n.［农药］除草剂

［记忆窍门］“herb”意为“草本植物”；“-icide”意为“杀，消灭”。

（24）insecticide n. 杀虫剂，农药

［记忆窍门］“insect”意为“昆虫”；“-icide”意为“杀，消灭”。

（25）isolate vt. 使隔离；使孤立；使绝缘；n.［生物］隔离种群

［记忆窍门］“iso-”前缀表示“相同，相等”；“late”意为“迟的，晚的”。

（26）bacterium n.［微］细菌；杆菌属

［记忆窍门］“bacteria”意为“细菌”；“-ium”后缀表示“身体部位”，“生物构造”。

（27）lethal adj. 致命的，致死的 n. 致死因子

（28）larva n.［水产］幼体，［昆］幼虫，［复数］larvae

（29）virus n.［病毒］病毒；恶毒；毒害

（30）fungi n. 真菌；菌类；蘑菇（fungus 的复数）

（31）antifreeze n. 抗冻

［记忆窍门］“anti-”前缀表示“反对，抵抗”；“freeze”意为“冻结；冷冻”。

（32）seedling n. 秧苗，幼苗；树苗

［记忆窍门］“seed”意为“种子”。

(33) salinity n. 盐度；盐分；盐性

[记忆窍门]“salt”意为“盐”。

(34) malnutrition n. 营养失调，营养不良

[记忆窍门]“mal-”前缀表示“坏；不良”；“nutrition”意为“营养”。

(35) impoverished adj. 穷困的；用尽了的

[记忆窍门]“im-”前缀表示“否定，与…相反”；“poverty”意为“贫困”；“-ed”附在规则动词和名词后构成同义形容词。

(36) main staple n. 主要食物

(37) deficiency n. 缺陷，缺点；缺乏；不足的数额

[记忆窍门]“deficit”意为“赤字，不足”。

(38) alleviate vt. 减轻，缓和

(39) a strain of prep. 一种，一系

(40) beta-carotene n. β-胡萝卜素

[记忆窍门]“beta”意为“β”；“carrot”意为“胡萝卜”。

(41) vaccine n. 疫苗；牛痘苗 adj. 疫苗的；牛痘的

(42) injectable adj. 可注射的

[记忆窍门]“inject”意为“注射”；“-able”后缀表示“可以…的”。

(43) phytoremediation n. 植物修复

[记忆窍门]“phyto-”前缀表示“植物”；“mediation”意为“补救；矫正；补习”。

(44) caterpillar n. [无脊椎] 毛虫

[记忆窍门]“cater”意为“提供饮食及服务”；“pillar”意为“柱子”。

(45) perish vt. 使麻木；毁坏 vi. 死亡；毁灭；腐烂；枯萎

(46) allergenicity n. 致敏性

[记忆窍门]“allergen”意为“过敏原”；“-icity”后缀表示“性质”。

(47) incorporate vt. 包含，吸收；体现；把……合并 vi. 合并；混合

[记忆窍门]“corporate”意为“公司的”。

(48) aminoacid n. 氨基酸

[记忆窍门]“amino”意为“[化学] 氨基”；“acid”意为“酸”。

(49) irrespective adj. 无关的；不考虑的

[记忆窍门]“ir-”前缀表示“不”、“非”；“respect”意为“尊敬，尊重”。

(50) intestine adj. 内部的；国内的 n. 肠

[记忆窍门]“in-”前缀表示“在…内”。

(51) testicle n. [解剖] 睾丸

(52) embryo n. [胚] 胚胎；胚芽；初期 adj. 胚胎的；初期的

[记忆窍门]“em-”前缀表示“置于…之内”。

2 课文

2.1 原文

A Review on Impacts of Genetically Modified Food on Human Health①

Abstract: Genetically modified organisms (GMOs) are defined as organisms (except for human beings) in which the genetic material has been altered in a way that does not occur naturally by mating and/or natural recombination. GMOs have widespread applications as they are used in biological and medical research, production of pharmaceutical drugs, experimental medicine, and agriculture. The use of gene technology in food production has become interesting due to increased needs of food as well as its improved quality. With the application of gene technology to plants and animals, goals can be achieved more quickly than by traditional selection. Consequently, ethical dilemmas are opened concerning the eventual negative effects of production of genetically modified food. It seems that supplementation of nutraceuticals and wild foods as well as wild lifestyle may be protective, whereas western diet and lifestyle may enhance the expression of genes related to chronic diseases. Our genes or pathways are most likely regulated by microRNA. The prevalence and mortality due to multifactorial polygenic diseases; hypertension, coronary artery disease (CAD), diabetes and cancer vary depending upon genetic susceptibility and environmental precursors because they have identifiable Mendelian subsets. Rapid changes in diet and lifestyle may influence heritability of the variant phenotypes that are dependent on the nutraceutical or functional food supplementation for their expression. It is possible to recognize the interaction of specific nutraceuticals, with the genetic code possessed by all nucleated cells. There is evidence that South Asians have an increased susceptibility to CAD, diabetes mellitus, central obesity and insulin resistance at younger age, which may be due to interaction of gene and nutraceutical environment.

Keywords: Bacillus thuringiensis, genetically modified food, gene technology, human health, pharmaceutical drugs, transgenic plants

1 Technology to Produce Genetically Modified Organisms

Several methods of production of genetically modified organisms (GMO) are known. The foreign gene that has been inserted into the cell of a microorganism, a plant or an animal is called a transgene. It is integrated into the genome of the recipients which are called transgenic. The transgenes are genes with known traits or mutated variants of known genes. In most cases also marker genes are used because of identification of transgenic organism. The integration of transgene into

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the cell is carried out by different methods: ①Transduction with the use of bacteriophages; ②Transgene injection using pronuclear microinjection; ③Transfer using modified viruses and plasmids; ④Electroporation method by which higher permeability of cell membrane is achieved.

For transfer of foreign gene also artificial chromosomes or fragments of chromosomes can be used. Transgenes can be transferred into the egg-cell by spermatozoa containing fragments of chromosomes. Developed world, having material and intellectual capacities, leads the studies on transgenic technology for production increase and improved food quality. In fact, there is not only enough but even too much food in the developed world. However, developing countries that need this technology to exceed the food shortage cannot afford it. Hence, gene technology is not a remedy to prevent the world from starvation. Transgenic seeds that developed countries can provide to developing countries to diminish the rate of malnutrition seems to be the best idea of genetic engineering. Transgenic plants that are resistant to pests will cause higher resistance in pests; consequently stronger herbicides and insecticides should be used in the future. Finally, it has been proposed that transgenic food can cause certain allergies.

1) GM Foods are Promoted Why

The term GM foods or GMOs (genetically-modified organisms) is most commonly used to refer to crop plants created for human or animal consumption using the latest molecular biology techniques. These plants have been modified in the laboratory to enhance desired traits such as increased resistance to herbicides or improved nutritional content. Genetic engineering can create plants with the exact desired trait very rapidly and with great accuracy. For example, plant geneticists can isolate a gene responsible for drought tolerance and insert that gene into a different plant. The new genetically-modified plant will gain drought tolerance as well. Not only can genes be transferred from one plant to another, but genes from non-plant organisms also can be used. The best known example of this is the use of B. t. genes in corn and other crops. B. t., or Bacillus thuringiensis, is a naturally occurring bacterium that produces crystal proteins that are lethal to insect larvae. B. t. Crystal protein genes have been transferred into corn, enabling the corn to produce its own pesticides against insects.

2) Advantages of Gm Foods

(1) Pest Resistance

Farmers typically use many tons of chemical pesticides annually. Consumers do not wish to eat food that has been treated with pesticides because of potential health hazards, and run-off of agricultural wastes from excessive use of pesticides and fertilizers can poison the water supply and cause harm to the environment. Growing GM foods such as B. t. corn can help to eliminate the application of chemical pesticides and reduce the cost of bringing a crop to market.

(2) Herbicide Tolerance

Crop plants genetically-engineered to be resistant to one very powerful herbicide could help to prevent environmental damage by reducing the amount of herbicides needed.

(3) Disease Resistance

There are many viruses, fungi and bacteria that cause plant diseases. Plant biologists are working to create plants with genetically-engineered resistance to these diseases.

(4) Cold Tolerance

An antifreeze gene from cold water fish has been introduced into plants such as tobacco and potato. With this antifreeze gene, these plants are able to tolerate cold temperatures that normally would kill unmodified seedlings.

(5) Drought Tolerance/Salinity Tolerance

As the world population grows and more land is utilized for housing instead of food production, farmers will need to grow crops in locations previously unsuited for plant cultivation. Creating plants that can withstand long periods of drought or high salt content in soil and groundwater will help people to grow crops in formerly inhospitable places.

(6) Nutrition

Malnutrition is common in third world countries where impoverished peoples rely on a single crop such as rice for the main staple of their diet. However, rice does not contain adequate amounts of all necessary nutrients to prevent malnutrition. If rice could be genetically engineered to contain additional vitamins and minerals, nutrient deficiencies could be alleviated. For example, blindness due to vitamin A deficiency is a common problem in third world countries. Researchers at the 'Swiss Federal Institute of Technology Institute for Plant Sciences' have created a strain of 'golden' rice containing an unusually high content of beta-carotene (VitaminA). Plans were underway to develop golden rice that also has increased iron content.

Pharmaceuticals Medicines and vaccines often are costly to produce and sometimes require special storage conditions. Researchers are working to develop edible vaccines in tomatoes and potatoes. These vaccines will be much easier to ship, store and administer than traditional injectable vaccines.

(7) Phytoremediation

Plants such as poplar trees have been genetically engineered to clean up heavy metal pollution from contaminated soil.

3) Some Criticisms against GM Foods

GM foods fall into three categories: environmental hazards and human health risks and so on.

(1) Environmental Hazards

Unintended harm to other organisms: pollen from B. t. corn caused high mortality rates in

monarch butterfly caterpillars. Monarch caterpillars consume milkweed plants, not corn, but the fear is that if pollen from B. t. corn is blown by the wind onto milkweed plants in neighboring fields, the caterpillars could eat the pollen and perish.

Reduced effectiveness of pesticides just as some populations of mosquitoes developed resistance to the now-banned pesticide DDT; many people are concerned that insects will become resistant to B. t. or other crops that have been genetically modified to produce their own pesticides.

Gene transfer to non-target species is another concern that crop plants engineered for herbicide tolerance and weeds will cross-breed, resulting in the transfer of the herbicide resistance genes from the crops into the weeds. These "superweeds" would then be herbicide tolerant as well.

(2) Human Health Risks

Allergenicity: Many children in the US and Europe have developed life-threatening allergies to peanuts and other foods. There is a possibility that introducing a gene into a plant may create a new allergen or cause an allergic reaction in susceptible individuals. A proposal to incorporate a gene from Brazil nuts into soybeans was abandoned because of the fear of causing unexpected allergic reactions.

2 Application of Transgenic Plants in Human Nutrition

Genetically modified foods are classified into three categories according to their usage and legal regulations.

(1) Food is genetically modified (potato, tomato, soya, maize, sunflowers, rice, pumpkins, melons, rape, etc.).

(2) Food contains components of genetically modified plants (starch, oil, sugar, aminoacids, vitamins, etc.).

(3) Food contains genetically modified organisms (yoghurt contains transgenic microorganisms).

Gene technology enables higher yields in plants, resistance to pests and frost, as well as mechanical properties of fruits, etc. We can also modify physical and chemical composition in order to improve nutritional and physiological value of foods. Transgenic plants also enable production of more healthy food (more unsaturated fatty acids, transfer of proteins from legumes into wheat, increased content of essential amino acids, transfer of proteins from sunflowers into maize, etc.). Thus, dangers of heart diseases, allergies are diminished and malignancy prevented.

1) Health Risk of Genetically Modified Organisms

Several animal studies indicate serious health risks associated with GM food, including infertility, immune problems, accelerated aging, insulin regulation, and changes in major organs and the gastrointestinal system.

2) GMOs are Inherently Unsafe

There are several reasons why GM plants present unique dangers. The first is that the process of genetic engineering itself creates unpredicted alterations, irrespective of which gene is transferred. This creates mutations in and around the insertion site and elsewhere. The biotech industry confidently asserted that gene transfer from GM foods was not possible; the only human feeding study on GM foods later proved that it does take place. The genetic material in soybeans that make them herbicide tolerant transferred into the DNA of human gut bacteria and continued to function. That means that long after we stop eating a GM crop, its foreign GM proteins may be produced inside our intestines.

3) Reproductive Failure and Infant Motality

The testicles of both mice and rats fed roundup ready soybeans showed dramatic changes. In rats, the organs were dark blue instead of pink. In mice, young sperm cells were altered. Embryos of GM soy-fed mice also showed temporary changes in their DNA function, compared to those whose parents were fed non-GM soy.

3 Conclusions

The latest development of biotechnology, particularly molecular biology, genetic engineering and transgenic technology has a very large number of potential applications in food production, including micro-organisms, plants and animals. Transgenesis is much more difficult to apply to farm animals than to plants or micro-organisms. Genetic modification has increased production in some crops. But the technology has too few challenges in few crops. Genetic modification is not a good in itself but it is a tool where public &private science can balance each other. Genetically modified foods have various advantages like high yield, salinity tolerant, insect resistance etc. GM foods have a lot of health effects on living beings. GM foods have both positive and negative effects. These may be either direct effects, on organisms that feed on or interact with the crops, or wider effects on food chains produced by increases or decreases in the numbers of other organisms. As an example of benefits, insect-resistant Bt-expressing crops will reduce the number of pest insects feeding on these plants, but as there are fewer pests, farmers do not have to apply as much insecticide, which in turn tends to increase the number of non-pest insects in these fields. Other possible effects might come from the spread of genes from modified plants to unmodified relatives, which might produce species of weeds resistant to herbicides. Conclusively, the present article is the compilation of various selective studies presenting both positive and negative impacts of GM foods on human health.

2.2 参考翻译

转基因食品对人类健康的影响综述

摘要：转基因生物（GMOs）被定义为遗传物质不经过自然杂交和/或自然重组就发生改变的生物（人类除外）。转基因生物被广泛的应用在生物学和医学研究、生产药品、实验医学和农业。由于对食品数量和质量的需求不断增加，基因技术在食品生产中的应用已引起重视。相较于传统选择，人类可以通过对植物和动物采取基因技术而更快的实现上述目标。结果，关于转基因食品可能产生的负面影响也陷入一个伦理困境。添加营养品、食用野生食物，以及天然的生活方式虽然对身体有保护作用，但是，西方的饮食和生活方式可能也增加了与慢性疾病有关的基因的显现。我们的基因一般由 microRNA 调控。多因素多基因遗传性疾病例如高血压、冠状动脉疾病（CAD）、糖尿病和癌症的患病率及死亡率根据遗传易感性和环境前体变化，因为这些疾病均有可识别的孟德尔亚单位。饮食和生活方式的快速变化可能影响到依赖于保健品或功能性食品供给量的不同表型的遗传率。人类有可能认识到特定保健品和所有有核细胞具备的遗传密码之间的相互影响。有证据显示，南亚人民对冠状动脉疾病、糖尿病、向心性肥胖和胰岛素抗性的易感率呈现低龄化，这可能是由于基因和保健品，环境之间相互作用的结果。

关键词：苏云金芽孢杆菌，转基因食品，基因技术，人类健康，药品，转基因植株

1 转基因生物的生产技术

几种生产转基因生物（GMO）的方法是已知的。嵌入一个微生物细胞，植物或动物的外源基因称为转入基因。该基因被整合至受体基因组的过程称为转基因过程。转入基因具有已知的特征或具有突变。在大多数情况下，由于是转基因生物的身份证明，标记基因也被用来作为转入基因。转入基因整合入细胞中的方法有以下几种：①利用噬菌体转导；②利用显微注射法注入转入基因；③利用重组病毒或质粒转入基因；④通过高渗透细胞膜电穿孔法。

人工染色体或染色体片段也可以用于外源基因的转入。转入基因可以由包含其染色体片段的精子转移入卵细胞中。具有物力和智能能力的发达国家领导着以增加食物产量和质量为目标的转基因技术。事实上，发达国家不仅有足够的食物，甚至有过量的食物。然而，需要此项技术来战胜食品短缺的发展中国家却无法负担起该技术的研究。因此，基因技术不是一个阻止世界远离饥饿的补救措施。发达国家可以提供给发展中国家转基因种子以减少营养不良率，这似乎是基因工程的最佳意图。对害虫有抗性的转基因植物将导致害虫更高的抗性，因此将来会需要更强力的除草剂和杀虫剂。最后，已经有人提出转基因食品能引起某些过敏症状。

1）为什么要提倡转基因食品

术语“转基因食品”或“转基因生物”最常被用于指利用最新的分子生物学技术生产出的用于人类或动物消费的农作物。这些植物在实验室中被改良，以增强人类需要的

性状，如增加对除草剂的抗性或增加营养成分。基因工程可以非常迅速并确切的创造出具有所需特征的植物。例如，植物遗传学家可以分离出耐旱基因并将该基因迁入到另一种植物中。新的转基因植物也将获得耐旱性征。基因不仅可以从一个植物转移到另一个植物，非植物生物的基因也可以被运用。最广泛被了解的例子是在玉米及其他农作物中使用 B. t. 基因，即苏云金芽孢杆菌，这是一种天然存在的，产生对昆虫幼虫有致命性的晶体蛋白的细菌。B. t. 晶体蛋白基因转入玉米并使玉米生产针对昆虫的杀虫剂。

2）转基因食品的优点

（1）抗虫性

每年农民都要使用许多吨化学农药。因为潜在的健康危害，消费者不希望食用使用过农药的食物，除此之外，由于过度使用农药和化肥而产生的农业废弃物会污染供水系统并引起环境危害。不断增加的转基因食物例如 B. t. 玉米能帮助减少化学农药的使用并降低农作物进入市场的成本。

（2）除草剂耐受性

能够抵抗强力除草剂的转基因农作物可以通过降低除草剂用量而防止环境破坏。

（3）抗病性

有很多病毒，真菌和细菌会引起植物病害。植物生物学家正在努力创造可抵抗这些疾病的基因工程植物。

（4）耐寒性

一种从冷水鱼类中的抗冻基因已经被引入到烟草和马铃薯等植物中。拥有这种抗冻基因的植物就可以抵抗一般情况下会杀死未修饰的植物幼苗的低温环境。

（5）耐寒性/耐盐性

随着世界人口的增长，更多的土地被用于居住而不是粮食生产，农民需要在之前并不适合植物栽培的土地上种植农作物。创造出可以抵抗长时间干旱或土壤和地下水中高浓度盐分的农作物将会帮助人类在从前荒凉的地方种植农作物。

（6）营养性

第三世界国家的贫困人民饮食中的主食依赖于单一农作物如大米，因此营养不良很常见。大米不含有足够量的可防止营养不良的所有营养素。如果大米可以通过基因工程改造成含有其他的维生素和矿物质，那么营养缺乏就可以得到缓解。例如，由于维生素 A 缺乏症导致的失明在第三世界国家中广泛存在。瑞士联邦植物技术研究所的研究人员已经研发出一种“黄金大米”，这种大米中含有高浓度的 β-胡萝卜素（维生素 A）。开发高浓度铁元素的计划也在进展中。

药物和疫苗生产成本往往很高，有时还需要特殊的储存条件。研究人员正在研究开发存在于番茄和土豆中的可使用的疫苗。比起传统的注射疫苗，这样的疫苗更容易运输、贮藏和管理。

（7）植物修复

经过基因工程改造，杨树等植物已经可以清理土壤中重金属污染。

3）对转基因食品的一些反对意见

对转基因食品的批评主要有环境危害和人类健康的风险等。

（1）环境危害

意外伤害其他生物：B. t. 玉米的花粉可造成黑脉金斑蝶毛虫的高死亡率。黑脉金斑蝶毛虫以马利筋植物为食，而不是玉米，令人担心的是，如果 B. t. 玉米的花粉被风吹到邻近领域的马利筋叶片上，毛毛虫就会吃掉花粉并灭亡。农药的效果在减弱，例如一些蚊子种群可以抵抗农药 DDT（现已禁用）；人们担心昆虫可也抵抗 B. t. 玉米或其他经过基因工程改造来产生抗虫性的农作物。基因被嵌入至目标物种是另一个关注点，因为经过基因工程改造的抗除草剂的农作物和野草会杂交，从而导致抗虫草剂基因从农作物转移进入杂草中。这些“超级杂草”也将有耐除草剂的特性。

（2）人类健康风险

致敏性：美国和欧洲的很多孩子都因为花生等食物过敏而危及到生命。其中一种可能性是引入某种基因进入植物可能在易感个体中造成了一种新型过敏原或者引起了一种过敏反应。一项从巴西坚果中合并基因进入黄豆的提案因为怕造成意外的过敏反应而被放弃。

2 转基因植物在人类营养中的应用

根据它们的用法和法律法规的规定，转基因食品分为以下三类。

（1）转基因食品（马铃薯，番茄，大豆，玉米，向日葵，水稻，南瓜，甜瓜，油菜等）。

（2）食物中含有转基因作物成分（淀粉，油，糖，氨基酸，维生素等）。

（3）食品含有转基因有机物（酸奶中含有转基因微生物）。

基因技术使植物产量提高、抵抗害虫和冰冻，以及提高水果的机械性能等。我们还可以通过修改物理和化学成分以提高食品的营养和生理价值。转基因植物也能提高更多健康食品的产量（较多的不饱和脂肪酸，从豆类转移到小麦的蛋白质，增加人体必需的氨基酸含量，从向日葵转移蛋白质到玉米等等）。因此，心脏疾病的危险性和过敏都会减少，恶性肿瘤也会被防止。

1）转基因生物的健康风险

一些动物研究表明，很多严重的健康风险都与转基因食品有关，包括不育、免疫问题、加速老化、胰岛素的调节，和主要器官及胃肠系统的变化。

2）转基因生物本质上的不安全性

转基因植物表现出独特的危险性有几个原因。第一个是不管是哪个基因转移，基因工程本身的过程中产生的不可预知的变化。这将在基因嵌入点及其周围产生突变。生物技术产业信心知足的声称转基因食品中是不可能有基因转移的，然而后来的人类喂养研究证明这一现象确实存在。大豆中耐除草剂的遗传物质转移到人体肠道细菌的 DNA 上并继续活动。这意味着即使在我们停止食用转基因作物很长一段时间后，外源的转基因蛋

白质可能仍会在我们的肠道内产生。

3) 繁殖障碍和婴儿病死率

喂食基因改造大豆的小鼠和大鼠的睾丸出现了戏剧性的变化。大鼠的器官是蓝色的，而不是粉红色。小鼠的精子细胞发生变化。相比那些父母被饲喂非转基因大豆的老鼠胚胎，转基因大豆喂养中的老鼠胚胎的 DNA 功能也表现出临时性的变化。

3 结论

生物技术的最新发展，特别是分子生物学，基因工程和转基因技术在食品生产，包括微生物，植物和动物的生产中，有非常大的潜在应用价值。相比较于植物或微生物，转基因技术更难适用于农场动物。基因改造技术已经增加了一些农作物的产量，但是该技术仅在很少的作物上做出了改变。遗传修饰技术本质上并不是一件事物，而是一个让公共科学与私人科学相互平衡的工具。转基因食品有各种各样的优势，如高产，耐盐性，抗虫性等。转基因食品对生物也有保健作用。转基因食品有正面和负面的影响。这些影响可以是直接的，例如对以其为食的生物体；这些影响还可以是间接的，例如对农作物；这些影响还可能是更广泛的，例如通过增加或减少其他生物体的数量而对食物链造成影响。举一个正面影响的例子：表达抗虫 Bt 基因的农作物可以减少以这种农作物为食的害虫的数量，然而由于害虫的减少，农民就不必施用同样多的杀虫剂，这反过来就会有增加这一区域非害虫昆虫的数量。其他可能的影响也许来自基因修饰的植物向修饰的亲缘植物的传播，这可能会产生抗除草剂的杂草物种。综上所述，本文汇编了各种不同的优秀的研究成果，这些研究针对转基因食品对人体健康的影响提出了正面和负面意见。

3 阅读链接

[1] http://europa.eu.int/comm/food/food/biotechnology/gmfood/index_en.htm

[2] http://www.who.int/mediacentre/news/releases/2005/pr29/en/index.html

[3] http://www.who.int/foodsafety/publications/biotech/20questions/en/

[4] http://organicconsumers.org/neweng.html

4 课后作业

4.1 句子翻译

4.1.1 原句

(1) Rabbits fed GM soy showed altered enzyme production in their livers as well as higher metabolic activity.

(2) However, if the product has no natural equivalent, or shows significant differences from the unmodified food, then further safety testing is carried out.

(3) Worldwide, reports of allergies to all kinds of foods, particularly nuts, fish and shellfish, seem to be increasing, but it is not known if this reflects a genuine change in the risk of allergy, or an increased awareness of food allergies by the public.

(4) Some sound requirements on adequate labeling of the genetically transformed food in EU have been passed so that consumers can choose according to believes (religious, ethic, medical).

(5) It has been discussed whether the consumption of DNA in approved novel foods and novel foods ingredients can be regarded as safe as consumption of DNA in existing form.

(6) Dr. Pusztai believes that the digestive tract, which is the first and largest point of contact with foods, can reveal various reactions to toxins and should be the first target of GM food risk assessment.

(7) Genes which cause expression of desirable traits (e. g. modified starch production and disease resistance in potato) were selected from organisms, such as bacteria, and transferred into plants, to alter their genetic material (DNA) in order to produce these desirable characteristics.

(8) Today the use genetic modification has already shown that an increased biological resistance to specific pests and diseases, including those caused by viruses, can reduce the need for chemical pesticides and decreasing the risk of crop failure.

(9) In the future it will also be possible to enhance the nutritive value of crops by improving desirable functional characteristics, such as reduced allergenicity or toxicity as well as altered protein or fat content and increased phytochemical or nutrient content.

(10) No adverse effects on human health have been scientifically recorded in commercialised GM foods, though there have been unconfirmed reports from various sources, some of which have been scientifically investigated and found not to be associated with GMOs.

4.1.2 参考翻译

(1) 喂食转基因大豆的兔子肝脏酶产量发生变化，与此同时，代谢活动也升高了。

(2) 然而，如果产品没有自然对等物，或者与未加工的食品有显著的不同之处，那么将进行进一步的安全测试。

(3) 在全球范围内，关于对于各个种类的食物，特别是坚果、鱼类和贝类的过敏报告在增加。但这究竟反应了过敏的风险的真实的变化，还是公众对食物过敏的认知的增加，目前还不得而知。

(4) 在欧盟，一些要求在转基因食物上标有足够的标签的正当要求已经通过。这样一来消费者就可以根据他们的信仰（宗教，伦理，医疗）来选择食物。

(5) 在已获准的新兴食品和新型食品成分中的 DNA 能否与自然存在于食品中的 DNA 一样食用安全，这一问题仍在讨论中。

(6) 普兹泰博士认为，消化道作为与食品的第一个也是最大的接触点，可以显示出对于毒素的各种反应，并因此应该成为转基因食物风险评估的第一个目标。

（7）产生理想特性的基因（例如改性淀粉和马铃薯的抗病性）均是从有机体如细菌中选择并嵌入作物中，以改变作物的遗传物质（DNA）并产生这些理想的特性。

（8）如今基因改造的应用已经表明不断增长的针对特定害虫和疾病的生物阻抗（包括那些由病毒引起的）可以减少对化学农药的需求及减少颗粒无收的风险。

（9）在未来，通过提高理想的功能特性而增加农作物的营养价值也是有可能的。具体方式诸如降低致敏性或毒性、改变蛋白质或脂肪含量，和增加植物化学物质或营养素含量等。

（10）尽管有一些关于商业化转基因食品对人体健康的不良影响的报道，但是其中一些已经得到科学调查并发现与转基因生物没有关系。目前尚未有转基因食品对人体健康有不良影响的科学记录。

4.2 科技论文常见句型

1）文章内容与作者观点

常用词：deal with，describe，explain，illustrate（vt.），introduce，present，report 等。

【例句】This article provided some descriptions of the API，along with some sample code to illustrate how to make use of them.

这篇文章提供了应用程序编程接口的一些描述以及一些样本代码来阐明如何使用他们。

2）综述某一个领域的研究课题

常用词：abstract，outline，review，summarize 等。

【例句】The influence which arose to the many kinds of disease does the outline on the trace element selenium.

就微量元素硒对多种疾病的发病的影响做了概述。

3）评估与比较

常用词：agree with，assess，compare，evaluate 等。

【例句】This paper will evaluate the development level of farmer vocational education and its influence factors by using the analytic hierarchy process and the ingredient analytic method.

文章通过运用层次分析法和主成分分析法对我国农民职业教育的发展水平及其影响因素进行评价。

4）论证与依据

常用词：be based on，take as reference 等。

【例句】Methods you take natural calculus bovis as reference，the mainc ontent of cholic acid and bilirubin was determined by spectrophotometry.

方法以天然牛黄为对照品，采用分光光度法测定其主要成分胆酸、胆红素的含量。

5）观察与指示

常用词：demonstrate，exhibit，find，indicate，observe，point out，show 等。

【例句】Theoretical analysis and test research demonstrate that the two measures are effective ways to increase sticking strength between concrete interfaces as well as other performances.

理论分析与试验研究证明，这两种方法是提高混凝土界面粘结强度及其他性质的有效途径。

6）运算与测量

常用词：calculate，determine，estimate，measure 等。

【例句】In this paper，parameter estimate algorithms is used to diagnose the burst fault in power system of carrier rocket.

文中研究了参数估计的方法在运载火箭动力系统突发故障诊断中的应用。

7）成果的获取

常用词：achieve，construct，derive，design，develop，establish，give，improve，obtain，produce，provide，realize，record，reduce，solve 等。

【例句】The results show that both by chemical and physical methods of combining decentralized fumed silica，can obtain good decentralized results，the best dosage of A200 for 34 percent.

结果表明：用化学和物理两种相结合的方法分散气相二氧化硅，可以获得很好的分散效果，A200 的最佳用量为 34%。

8）应用与运用

常用词：apply，employ，use 等。

【例句】To employ TLC for identifying Radix Paeoniae Alba，Radix Scutellariae，Radix Angelicae Dahuricae，Radix Notoginseng in precipitation.

采用薄层色谱法对方中白芍、黄芩、白芷、三七进行定性鉴别。

9）实验与试验

常用词：experiment，test 等。

【例句】In this paper，we carry on experiment of comparing in 4℃，25℃，37℃ and 45℃ with natural thawing and vacuum thawing methods.

本文采用自然解冻和真空解冻方式，在 4、25、37 和 45℃四种温度下进行实验比较。

10）结论

常用词：arrive at，conclude 等。

【例句】So，the authors conclude that the stratabound skarn of the Jiama deposit has nothing to do with magma hydrothermal solution，and however，has likely something to do with the hot brine in the basin.

因此，推断甲马矿床层状矽卡岩的形成与岩浆热液没有直接的成因联系，而很有可能是与盆地演化过程中热（卤）水的活动有关。

Unit 2 GMP and SSOP

1 专业词汇分析

（1）sanitation n. 卫生，卫生设施

［记忆窍门］“sanit-healthy”意为“健康的”，“-ation”名词后缀；消费者健康的保障。

（2）procedure n. 程序，手续，步骤

［记忆窍门］“pro-”往前，“ced-”走，“-ure”名词后缀；往前走的过程，进行下去的过程。

（3）poultry n. 家禽

［记忆窍门］“poul”发剖的音，“try”意为“尝试”，尝试剖，家禽注定是要被宰割的。

（4）manufacture n. 制造，加工

［记忆窍门］“manu-”手，“fact-”作，制作，“-ure”名词后缀；用手制作，古时生产全用手操作。

（5）pesticide n. 杀虫剂

［记忆窍门］“pest”意为“害虫”，“cide”意为“切开，杀”；杀灭害虫。

（6）hygiene n. 卫生，卫生学

［记忆窍门］源于希腊神话中的健康女神 Hygeia（黑吉尼亚）。“high”+“gene”，具有很“high”的“gene”（基因），因为很注意个人卫生。

（7）adulteration n. 掺杂，掺假

［记忆窍门］“adult”意为“成年人”，“er”音似“儿”，“at”（e）为“eat”过去时“吃”，“ation”为名词后缀；成年人吃饭喜掺假。成年人吃饭常有酒，但不是人人都能喝，所以总有人偷偷向酒里掺点儿茶、水什么的。

（8）contamination n. 污染

［记忆窍门］“con”（共同），“tamin”（拼音）：他们，“at”（e）为“eat”过去时：吃，“tion”为名词后缀；他们共同用一份餐具吃饭——污染自己；吃完了还乱扔——污染环境。

（9）disinfectant n. 消毒剂，杀菌剂 adj. 消毒的，杀菌的

［记忆窍门］“dis”（不），“in”（向内部），“fect”—“make”，“ant”（试剂）；防止微生物等向内部扩散的试剂。

（10）concentration n. 浓缩，浓度

［记忆窍门］“con”意为“共同的”，“centr”—“center”（中心），“ation”（名词后缀）向共同的中心聚集。

2 课文

2.1 原文

Safe Food Guidelines for Small Meat and Poultry Processors SSOP and GMP Practices and Programs

1 Introduction

A small meat processor must understand the basic principles behind Sanitation Standard Operating Procedures (SSOPs) and Good Manufacturing Practices (GMPs) and how to comply with them. For meat and poultry processors, SSOPs are the foundation of the plant's many food safety programs. Creating and complying with SSOPs can be challenging for the small processor. And understanding the similarities and differences between SSOPs and GMPs is difficult. This fact sheet provides a basic understanding of these two food safety regulations and guidelines for complying.

2 What are GMPs

Good Manufacturing Practices (GMPs) contain both requirements and guidelines for manufacturing of food and drug products in a sanitary environment. The Food and Drug Administration has developed GMPs for all foods, and that agency enforces those GMPs for all foods except meat, poultry, and egg products. The U. S. Department of Agriculture's Food Safety Inspection Service has regulatory authority for those products. USDA-FSIS has developed a Sanitation regulation to address sanitary requirements for processing of meat and poultry products. Within the Sanitation regulations are requirements to produce wholesome foods under sanitary conditions and specific Sanitation Standard Operating Procedures (SSOPs). When developing SSOPs to meet USDA-FSIS requirements, it is helpful to review GMPs for nonmeat products, since FDA includes extensive details on defining sanitary conditions and allowable practices.

Good Manufacturing Practice (GMP) regulations were first introduced in 1969 by the FDA as Part 128 of the Code of Federal Regulations to further implement the Foods, Drug and Cosmetic Act. In 1977 this was recoded as Part 110, and it was further revised and updated in 1986, to what is now regarded as cGMPs (current GMPs).

1) GMPs Categories

(1) General maintenance of physical facilities.

(2) Cleaning and sanitizing of equipment and utensils.

(3) Storage and handling of clean equipment and utensils.

(4) Pest control.

(5) Proper use and storage of cleaning compounds, sanitizers, and pesticides.

(6) Employee training.

(7) Plant design.

(8) Quality assurance assessment.

These are the umbrella GMPs for all FDA-inspected food processing establishments regardless of size. Specific GMPs establish regulations for particular industries and products and are in addition to the umbrella GMPs. For example, there are specific GMPs for seafood processors and dairy processors.

Meat and poultry processors are required to adhere to Sanitation program requirements in 9 CFR 416. USDA enforces 9 CFR 416, while FDA enforces 21 CFR 110. Meat and poultry plants are responsible for preventing adulteration of their products through their written Sanitation program. Practically speaking, the meat and poultry processor should understand and know GMPs, because they can serve as a valuable guide and tool when formulating the plant's Sanitation program.

3 Let's Look at Some cGMPs

Let's look at the Code of Federal Regulations (CFR) under Title 21 and Part 110. Title 21 covers Food and Drugs; Part 110 is Current Good Manufacturing Practice in manufacturing, packing, and holding human foods.

1) cGMPs and Personal Hygiene

Cross-contamination of food by foodhandlers is the most frequent cause of contamination. Employee hygiene is essential, because the hygienic condition and habits of workers determine the amount of cross-contamination from worker to food products. It cannot be overemphasized that clean, sanitary workers are necessary to produce clean, sanitary food products.

Many cGMPs focus directly on reducing foodhandler contamination. Look at Code of Federal Regulations (CFR) Title 21, Part 110. 10. Examples of personal hygiene include washing hands, removing jewelry, and maintaining personal cleanliness. Also, the food processor should provide training for new employees in personal hygiene based on cGMPs, and that training should be part of a formal, written training program that consists of instruction in proper hand washing, personal cleanliness, and sanitary hygiene.

One small processor teaches correct hand washing to each employee by describing, in detail, the correct amount of soap to use, the correct water temperature, and the amount of lathering time, which is equal to the time needed to say the ABC's. Each aspect of this employee training is written in the processor's employee training program, with documentation that the materials were taught to employees. The GMPs about hand washing and facilities-such as sinks, toilets and towel racks—are presented in detail.

2) Employer's Responsibilities

(1) Provide training in food handling and personal hygiene.

(2) Conduct regular inspections of employees'hygiene and hygienic work habits. Violations

should be handled as disciplinary violations, and incentives for superior hygiene should also be provided.

(3) Properly maintained sanitary facilities and supplies. This includes ample quantities of soap, disinfectant, working sinks, hairnets, etc.

4 Complying with cGMP Regulations

As you may have noticed while browsing through the GMPs, some regulations are written so that compliance is easily evaluated. For instance, the regulation that 'no pests shall be allowed in any area of the food plant' is clearly defined. If an inspector found a pest, such as a mouse, or evidence of a pest in the food plant, then there obviously is a violation of the regulation.

However, some GMPs contain phrases such as 'clean as frequently as necessary to protect against the contamination of the food'. This vague regulatory language obviously is subjective. How often is it 'necessary' to clean the processing line: daily, every two shifts, or when we think it needs it? Other GMPs might use the terms 'adequately' or 'sufficient,' which are both subjective terms. These issues highlight the potential problems of determining how often to clean and sanitize. USDA-FSIS has developed more prescriptive requirements for meat and poultry processing. The SSOPs require processors to document that the sanitation program and personal hygiene practices are adequate to ensure that foods are produced under sanitary conditions. As a processor changes technologies or practices, changes in the SSOPs are necessary and must be documented with appropriate validation.

5 What are SSOPs

Sanitation Standard Operating Procedures (SSOPs) are the specific, written procedures necessary to ensure sanitary conditions in the food plant. They include written steps for cleaning and sanitizing to prevent product adulteration. SSOPs are required in all meat and poultry processing plants. The cGMPs can help guide the plant when the plant's SSOPs are being developed. The SSOP procedures are specific to a particular plant, but may be similar to plants in the same or a similar industry. All SSOP procedures must be appropriately documented and validated.

Both pre-operational (before daily processing begins) and operational (during processing) sanitation needs are included in SSOPs to prevent direct product contamination or adulteration. Therefore, the decision about how often to clean the processing line would be addressed in the plant's SSOPs and supporting documentation.

1) Pre-operational SSOPs

These are established procedures that describe the daily, routine sanitary procedures that occur before processing begins. The procedures must include the cleaning of product contact surfaces of facilities, equipment, and utensils to prevent direct product contamination or adulteration. These might include: ①Descriptions of equipment disassembly, reassembly after cleaning, use of

acceptable chemicals according to label direction, and cleaning techniques. ②Application instructions, including concentrations, for sanitizers applied to product contact surfaces after cleaning.

2) Operational SSOPs

These are established procedures that describe the daily, routine sanitary procedures that will be conducted during operations to prevent direct product contamination or adulteration. Established procedures for operational sanitation must result in a sanitary environment for preparing, storing, or handling any meat or poultry food product. Established procedures during operations might include, where applicable: ①Equipment and utensil cleaning/sanitizing/disinfecting during production, as appropriate, at breaks, between shifts, and at mid-shift cleanup. ②Procedures for employee hygiene, such as cleanliness of outer garments and gloves, hair restraints, hand washing, health, etc. ③Product handling in raw and in cooked product areas.

Meat and poultry plants are unique because they are required to develop, maintain, and adhere to written SSOPs. The plant must identify, by position, the officials who monitor daily sanitation activities, evaluate and document whether the SSOPs are effective, and take appropriate corrective action when needed. Finally, SSOPs must be routinely verified to ensure that they are working properly. Microbiological testing should be done periodically on food and noncontact surfaces to verify the effectiveness of the established procedures.

SSOP records must be maintained on-site for 48 hours and maintained for a minimum of six months.

6 Meat and Poultry SSOPs

The SSOPs for meat and poultry plants must meet the following regulatory requirements:

(1) The plant has written SSOPs describing daily procedures that will be conducted before and during operations to prevent direct product contamination or adulteration. At a minimum, these procedures must address the cleaning of food contact surfaces, equipment, and utensils. The SSOPs state the frequency at which each procedure will be verified.

(2) The SSOPs are signed and dated by plant management or plant owner. SSOPs should be reviewed periodically.

(3) The plant must identify individual(s) who will be responsible for implementing and monitoring SSOPs and the daily sanitation activities.

(4) Written records of SSOP activities along with corrective actions must be maintained for a minimum of six months (48 hours on-site).

7 Action Steps for the Small Processor

Find, read, and retain a copy of the cGMPs for the specific type of food plant. These regulations are located in the Code of Federal Regulations (CFR).

Find, read, and retain a copy of the SSOP requirements for meat and poultry processing.

Develop written policies for personal hygiene that address SSOPs in the plant including hand washing, gloves, jewelry, hairnets, policies for sick employees, etc.

Include written SSOPs in the employee training program, specifically those associated with personal hygiene and the plant's policies on checking that employees are following the established procedures.

Include all sanitation procedures in the SSOPs. Ensure that all sanitation procedures document the verification frequencies, identify responsible persons and supervisory personnel, and describe in detail all verification activities.

2.2 参考翻译

针对小型肉类及禽类制品加工的食品安全指导
卫生标准操作规程、良好操作规范及相关项目

1 引言

一个小型的肉品生产商需要理解卫生标准操作规范（SSOPs）、良好操作规范（GMPs）的基本原则，并知晓如何遵守这些规范。对于肉类及禽类生产商，SSOPs 是车间中许多食品安全项目的基础。建立和遵守 SSOPs 对于小型生产商而言，是具有挑战的。了解 SSOPs 与 GMPs 的相同点和不同点是有一定难度的。本文为理解这两种食品安全规范提供了基础。

2 什么是 GMPs

良好操作规范（GMPs）提供了在一个卫生的环境下生产食品和药品的要求和指南。食品药品监督管理局对所有食品均制定了 GMPs，并对除肉类、禽类、蛋类制品外的其它食品设定了相关实施机构。美国农业部食品安全监测局具有对这些食品的管理机构。USDA-FSIS 制定了卫生细则以介绍加工肉制品和禽类制品的卫生要求。这个卫生细则要求在符合特定卫生标准操作规范（SSOPs）的条件下生产健康食品。在制定符合 USDA-FSIS 要求的 SSOPs 时，非肉类食品的 GMPs 是有益的，因为 FDA 包含了全面定义卫生条件及可行性操作的细节。

1969 年，FDA 根据美国食品药品化妆品法的细则（CFR part 128）首次提出了良好操作规范（GMP）细则。1977 年，该细则在第 110 部进行了记录。1986 年，对该细则进行了修改和更新，并被称为现行良好操作规范（cGMPs）。

1）GMPs 类别

（1）物理设备的一般维护。

（2）设备、器具的清洗和消毒。

（3）清洗的设备和器具的存放和管理。

（4）虫害监控。

（5）用于清洗的化合物、消毒剂、农药的合理使用和贮藏。

（6）员工培训。

（7）车间设计。

（8）品质评鉴。

以上是与规模无关的，对所有 FDA 检测的食品加工而建立的“伞形” GMPs。除此之外，GMPs 还对特定的工业和产品建立了特定的 GMPs。例如，对于海产品加工和乳品加工就有特定的 GMPs。

要求肉类和禽类产品生产商遵守 9 CFR 416 中的卫生标准要求。USDA 实施 9 CFR 416，而 FDA 则实施 21 CFR 110。肉类和禽类生产车间需通过对其书面的卫生规范负责来防止其产品的掺杂。实事求是的讲，肉类和禽类生产商需要理解并懂得 GMPs，因为 GMPs 在规范车间卫生准则时是一个有价值的指南和工具。

3 一些 cGMPs

让我们学习一下美国联邦法规（CFR）第 21 篇 110 部。第 21 篇涵盖了关于食品和药品的相关细则，第 110 部是关于制作、包装、贮藏食品的现行良好操作规范。

1）cGMPs 与个人卫生

由食品从业人员造成的交叉污染是引起食品污染的最主要原因。食品从业人员的个人卫生状况和习惯决定了由工人对食品引起的交叉污染的程度，因此必须注意员工的卫生。再怎么强调工人的干净、卫生对生产干净卫生食品的必要性也不过分。

许多 cGMPs 直接注重减少由食品从业人员造成的污染，如 21 CFR part 110.10 以个人卫生为例，就包含洗手，摘除首饰，保持个人卫生等。同时，食品加工者必须根据 cGMPs 对新雇员进行关于个人卫生的培训，该培训应列入包含有合理洗手、个人清洁、卫生消毒等方面的正式的书面培训项目中。

小型生产商要详细教授每一位雇员正确的洗手方法，如肥皂的使用量，正确的水温，与念 ABC's 相同的气泡时间等。要将雇员培训的每个方面以及需要教授员工的其他文件都写在员工培训项目中。cGMPs 对于清洗用品和相关设备具有具体说明——如水槽、马桶、毛巾架等。

2）雇主的责任

（1）提供关于食品处理和个人卫生的培训。

（2）定期检查员工的卫生及工作卫生习惯。对违反者应进行违纪处理，对优秀卫生保持者应给予激励。

（3）合理存放卫生设施及用品。包括充足的肥皂、消毒剂、工作洗涤槽、发套等。

4 遵守 cGMP 细则

在浏览 GMPs 时，你可能注意到一些细则是以容易评估的语言撰写的。例如，细则中明确指出“在食品生产车间的任何地方均不能有害虫”。如果检查员在食品生产车间中发现害虫（如老鼠）或任何害虫的痕迹，该车间则明显违反了这一细则。

然而，一些 GMPs 则使用如“应按照必要的频率进行清洗以防止对食品的污染”的

说法。这类不明确的语言明显是具有主观性的。对于清洗生产线而言，多长时间一次是必要的？每天？每两班？还是当我们认为该清洗的时候？其它 GMPs 还可能使用“足够的”或“充分的”等主管术语。这些内容突显了判断清洗和消毒频率的难度。USDA-FSIS 对肉类和禽类生产商补充了更多的要求。SSOPs 要求生产商证实其卫生计划和个人卫生规范对于确保在卫生的条件下生产食品是足够的。一旦生产商改变其生产技术或操作，他们必须调整 SSOPs 并且获得批准。

5 什么是 SSOPs

卫生标准操作规范（SSOPs）是确保食品生产车间卫生条件的具体的书面准则。SSOPs 包含清洗、消毒等，避免产品掺杂的书面步骤。所有的肉品和禽类产品生产车间都要求遵守 SSOPs。当车间制定 SSOPs 时，cGMPs 可以为其提供指南。对于不同的车间，SSOP 细则是不同的。但是在相同或相似的工业会有相似的 SSOPs。所有的 SSOP 细则必须合理制定并具有有效性。

SSOP 细则中需要包含操作前（日常加工开始前）及操作时（加工期间）消毒需求以避免直接产品污染和掺杂。因此，清洗生产线的频率需要写入车间的 SSOPs 和辅助文件中。

1）操作前 SSOPs

在操作前应有制定好的描述其日常常规卫生措施的细则。该措施必须包含对与产品表面接触的设备、仪器、用具等的清洗以避免对产品的直接污染或掺杂。包括：①对仪器拆装、清洗后的重新组装、根据标签说明使用合适的化学品、清洗技术等的描述；②使用指南：包含与清洗后的产品表面接触用的浓缩剂、消毒剂等。

2）操作时的 SSOPs

在操作时应有制定好的描述日常常规卫生措施以避免对产品的直接污染或掺杂。建立的操作卫生措施必须为肉类或禽类制品的准备、贮藏、处理提供一个卫生的环境。该措施包含：①在生产时对仪器和用具进行适当的清洗、消毒、净化，如在加工中断时、换班间、以及每班次间的清洗等。②雇员卫生细则，如外工作服和手套的清洗，头发的束缚、洗手、健康情况等。③原材料和产品加工区的产品处理。

肉类和禽类制品生产车间由于需要制定、保持、遵守书面 SSOPs 而具有一定的独特性。车间必须由监管日常卫生活动的行政人员判别、评估、验证 SSOPs 是否有效，并在需要的时候进行适当的修正。最后，必须定期检查 SSOPs 以确保其适用性。对食品和非接触表面必须进行定期地微生物检测，以检测建立措施的有效性。SSOP 记录必须现场放置 48h，并且存放至少 6 个月。

6 肉类和禽类制品 SSOPs

肉类和禽类制品生产车间的 SSOPs 必须符合以下监管要求：①为避免直接产品污染或掺杂，生产车间要具有可指导操作前和操作时日常卫生措施的书面 SSOPs。这些措施至少要描述接触食品表面、仪器、用具的清洗。SSOPs 描述了检测每个措施的频率。

②SSOPs必须由车间管理者或工厂业主签署并且注明日期。SSOPs 需要定期修改。③生产车间必须明确负责实施和监管 SSOPs 以及日常卫生活动的个人。④修订的书面 SSOP 记录必须至少保存 6 个月（当场保存 48h）。

7 小生产商的行为步骤

（1）查找、阅读、保留一份适用于特定食品工厂的 cGMPs 的复印本。

（2）查找、阅读、保留一份适用于肉类和禽类制品加工的 SSOP 复印本。

（3）编撰书面的包含洗手、手套、首饰、发套、对生病员工的相关政策等的描述车间个人卫生细则书面 SSOPs。

（4）含有员工培训，特别是员工个人卫生和相关监管政策的书面 SSOPs。

（5）在 SSOPs 中包含所有卫生措施。确保定期检查和评价所有的卫生措施，明确相关负责人和监管团队，并且具体描述所有的监管程序。

3 阅读链接

[1] www. access. gpo. gov/nara/cfr/waisidx_07/9cfr416_07. html

[2] www. access. gpo. gov/nara/cfr/waisidx_02/21cfr110_02. html

[3] http://a257. g. akamaitech. net/7/257/2422/10apr20061500/edocket. access. gpo. gov/cfr_2006/aprqtr/21cfr110. 10htm

4 课后作业

4.1 参考翻译

4.1.1 原句

(1) There should be an appropriate person/persons (preferably manager) assigned responsibility for the facility food safety program.

(2) Highly visible and understood signs supporting appropriate Good Manufacturing Practices (GMPs) e. g. not eating, chewing, drinking or smoking, hand washing, and specific clothing requirements etc. should be posted to remind workers of proper practices

(3) Any evidence of insects, rodents, birds; reptiles or mammals in products or ingredients are indicators of contamination, posting physical and microbiological hazards.

(4) A pest control program is required to provide the basic environmental and operating conditions necessary for the production of safe, wholesome food.

(5) To avoid any adulteration or possible cross contamination from other items only essential products, packaging, chemicals and equipment should be stored in the facility.

(6) Materials should be clearly marked or labeled with some kind of rotation coding that is

understood by all stuff, in order to ensure FIFO and effective traceback/recall procedures.

(7) There should be written SSOPs covering good manufacturing practice topics such as goods receiving/supplier spproval, temperature controls, pest control, food safety training, shipping, foreign material control, etc.

(8) Equipment microbiological testing is used to determine effectiveness of cleaning and sanitization programs.

(9) Meetings that are either devoted to or mention food safety issues should be recorded as proof of company's ongoing commitment to food safety (minimum quarterly frequency).

(10) Employees should be issued a list GMP rules in the relevant languages and confirm by signing they understand and agree to abide by the company's food safety policy rules regarding personal hygiene/GMPs and health requirements.

4.1.2 翻译

(1) 应该指派一个合适的人/多人（最好是经理）负责工厂的食品安全计划。

(2) 应在各处张贴良好操作规范（GMPs）相关标识提醒工人，标识需清晰可见并容易理解。如：请勿进食，请勿咀嚼，请勿饮酒，请勿吸烟，洗手要求，以及具体着装要求等。

(3) 产品或配料中出现任何昆虫，啮齿动物，禽鸟类，爬行动物或哺乳动物的痕迹，都是污染源，将造成物理和微生物危害。

(4) 虫害监控计划提供的基本环境和操作条件是安全生产卫生食品的必需条件。

(5) 为了避免任何掺杂或潜在较差污染，核心产品、包装材料、化学品和设施设备应存贮于仓储区域内。

(6) 材料应采用所有员工能理解的相关周转代码明确标记或标明。这些代码应确保FIFO（先进先出）和有效的追踪/回收程序。

(7) 应当有书面的卫生标准操作规范，以覆盖良好操作规范的主题要求，例如：货物接收/供应商许可，温度控制，虫害监控，食品安全培训，运输，异物控制等。

(8) 设备的微生物检测用来确定清洁和消毒程序的有效性。

(9) 无论是专项食品安全会议或是在会议上提及的食品安全问题，都应记录在案，证明公司的一贯食品安全承诺（至少每季一次）。

(10) 应给予员工其可理解语言的GMP规则，确认他们签署理解并同意遵守本公司的关于个人卫生要求和GMP食品安全政策的相关协议。

4.2 科技论文常见基本句型

4.2.1 表示研究目的的常见基本句型

(1) The purpose of the study was …

(2) The aim of this study was to …

(3) This study attempted to answer the following questions to test the hypothesis …

(4) This study focused on the …

(5) Our task in /of this article was to …

(6) Our job in this paper was to …

(7) The goal of this research was to …

4.2.2 介绍其他科学家研究成果的常见基本句型

(1) In … (year), … (somebody) reported in his study that …

(2) In … (year), … (somebody) found that …

(3) In … (year), … (somebody) discovered that …

(4) In … (year), … (somebody) concluded that …

4.2.3 介绍研究意义的常见基本句型

(1) … is important from the viewpoint that …

(2) … is valuable from the viewpoint that …

4.2.4 介绍需要解决的研究难题的常见基本句型

(1) The problems to be solved are …

(2) The largely unsolved problems are …

4.2.5 介绍图(表)的常见基本句型

(1) As shown in Table (Fig.) 1, …

(2) We can find in Table (Fig.) 1 that …

(3) Table (Fig.) 1 summarized that …

Unit 3 HACCP

1 专业词汇分析

(1) legislation n. 立法

[记忆窍门] "legal" 意思是 "合法的"。

(2) suitability n. 适宜性

[记忆窍门] "suit" 意思是 "合适的"。

(3) food hygiene n. 食品卫生

(4) implement n. 实施执行

[记忆窍门] complete 完成; implementation 执行。

(5) FAO (Food And Agriculture Organization) 联合国粮农组织

(6) WHO (World Health Organization) 世界卫生组织

(7) CAC (Codex Alimentarius Commission) 食品法典委员会

(8) prerequisite programs n. 必备程序

[记忆窍门] "pre-" 前缀表示 "预先的、在…之前"。"require" 表示 "要求、需要"。

(9) intrinsic n. 内在的

[记忆窍门] "in-" 前缀表示 "在…里面的"。

(10) obligatory adj. 必须的, 必备的

[记忆窍门] "oblige" 表示 "要求"。

(11) quality management system 质量管理体系。

(12) certifying bodies n. 认证机构

[记忆窍门] "certify" 表示 "证明, 保证"。

(13) specifications n. 规范

[记忆窍门] "specify" 表示 "指定, 说明"。

(14) surveillance n. 监督

[记忆窍门] "surveille" 表示 "对…实行监督"。

(15) criteria n. 条款, 标准

[记忆窍门] "criticise" 表示 "批评, 评论"。

(16) accredited n. 认可

[记忆窍门] "credit" 表示 "名誉"。

(17) accreditation body 认证体系

(18) deduced from prep. 推断, 从…得出结论

[记忆窍门]“de-”前缀表示“减去，除去”，“deduce”表示“演绎”，“induce”表示“归纳”。

(19) flow diagram n. 流程图

(20) slaughter n. 屠宰

(21) outsourced services n. 外包服务

[记忆窍门]“out”表示“在…之外”。“source”表示“来源”。

(22) co-ordinate n. 协调；co-ordinator n. 协调人

(23) performance n. 执行情况

(24) schematic adj. 概要的

[记忆窍门]“scheme”表示“计划，策划”。

(25) interim adj. 临时的

[记忆窍门]“intern”表示“实习生”。

(26) loops n. 循环

[记忆窍门]“loop”表示“圆圈”的意思。

(27) disinfection n. 消毒

[记忆窍门]“dis-”前缀表示“否定”，“infect”是动词，意思是“感染”。

(28) cleaning-in-place n. 就地清洗

(29) infrastructure n. 基础设施

[记忆窍门]“infra-”前缀表示“在…以下”；“structure”表示“结构，建筑”。

(30) cross contamination n. 交叉污染

[记忆窍门]“cross”有“交叉”的意思。“contaminate”意思是“感染”。

(31) pallets n. 货盘、托盘

(32) chlorine n. 氯

(33) non-conforming products n. 不合格品

[记忆窍门]“non-”前缀表示“否定”，“conform”意思是“符合，遵守”。

2 课文

2.1 原文

Requirements for A HACCP Based Food Safety System

1 Introduction

Food safety is a global concern. Not only because of the continuing importance for public health, but also because of its impact on international trade. Effective Food Safety Systems shall therefore manage and ensure the safety and suitability of foodstuffs. In many countries world-wide, legislation on the safety and suitability of foodstuffs requires 'HACCP' to be put in place by

any food business or organisation, whether profit-making or not and whether public or private, carrying out any or all of the following activities: preparation, processing, manufacturing, packaging, storage, transportation, distribution, handling or offering for sale or supply of foodstuffs.

The Joint FAO/WHO Codex Alimentarius Commission describes a series of steps, including the 7 HACCP principles giving guidance for the application of the HACCP system. Also, Codex advises that minimum hygiene measures should be in place before HACCP is implemented: 'Prior to application of HACCP to any sector of the food chain, that sector should be operating according to the Codex General Principles of Food Hygiene, the appropriate Codex Codes of Practice, and appropriate food safety legislation.'

For confidence the Certifying Body must use the published 'Requirements' and the 'Certification Regulations' in an agreed manner. The 'Requirements' are documented in such a way to allow an effective assessment of the status and performance of the HACCP-based Food Safety System, as implemented by the food business operator. In the 'Certification Regulations', specific criteria are stated which have to be met by the Certifying Body when selecting a competent HACCP audit team, and rules which govern the way the certification process is designed and offered (e.g. the minimum auditor time) have to be followed. Authority is obtained when the Certifying Body is formally accredited by a recognised Body to operate the certification system for HACCP based Food Safety Systems and is audited regularly by this Accreditation Body. Accreditation concerns the reliability and competence of the Certifying Body. The document 'Requirements for Certification Bodies' elaborates the accreditation requirements. It must be understood that certification of a HACCP-based Food Safety System is not a guarantee of a food business operator's continuous food safety performance. The value added to a food business operator with a certified HACCP-based Food Safety System lies in the efforts made by the operating company to maintain that HACCP system and its commitment to continuously improve its food safety performance.

2 Scope of Application

In this document, requirements have been specified to be used during the assessment of operational HACCP systems (HACCP-based Food Safety Systems) which ensure the safety of foodstuffs during preparation, processing, manufacturing, packaging, storage, transportation, distribution, handling or offering for sale or supply in any sector of the food chain. The 'Requirements' are basically applicable to all food businesses or organisations, whether profit-making or not, and whether public or private.

Obviously, the food business operators shall have identified any step in their activities which is critical to ensure food safety and shall have developed, implemented, maintained and reviewed adequate safety procedures, applying the principles of HACCP, including the general principles of food hygiene, and where appropriate the relevant codes of practice and the food safety legislation.

These 'Requirements' are not intended for application by suppliers and /or service companies to food businesses, like suppliers of packaging materials, food equipment, industrial cleaning services, etc.

3 HACCP System Requirements

1) Management Responsibility

The food business operator is responsible for the safety (and suitability) of the produced food. Therefore, the food business operator shall include the policy with respect to food safety in the policy of the organisation. The food business operator has ultimate responsibility for the policy of the organisation and shall document, support and communicate this policy.

Periodically, the Food business operator shall verify the implementation of the policy and review the outcome. The HACCP system enables the food business operator to demonstrate his commitment and his responsibility with respect to the supply of safe products. The HACCP system ensures that all required activities are effectively defined, implemented and maintained.

(1) Policy

The food business operator shall define and document (in writing) the policy of the organisation with regards to food safety. It will demonstrate the commitment of the organisation to safe food. The policy shall demonstrate that the organisation is fully aware of its position in the food chain. It will reflect the 'farm-to-fork' approach, starting with the purchase and acceptance of raw materials. The policy shall be focused on the safety of foodstuffs and shall respond to the expectations and needs of its customers and consumers. The policy shall include concrete objectives (proposed actions) to ensure and improve food safety for the period under consideration. The food business operator shall ensure that the policy is understood, implemented and maintained at all levels in the organisation.

(2) Scope of the HACCP System

The food business operator shall define the extent (the scope) of the HACCP system. The scope shall comprise that part of the food chain and those activities of the food business for which the food operator is responsible and can be held liable.

The part of the food chain for which the food business operator is responsible begins where the responsibility of the suppliers of raw materials and ingredients ends; the responsibility of the food business operator ends where another food business in the food chain takes over the responsibility. The scope shall therefore conform to purchase and sales contracts.

All locations and process lines where food is manufactured and/or stored by the food business shall be properly indicated and be available for assessment.

All products which are supplied to the market by the food business, whether processed or handled, shall be properly specified.

All subcontracted activities outsourced services, like packaging, storage, transport shall be properly dealt with.

A key principle is that no part of the operation of the food business can be excluded from the scope of the HACCP system; all activities must be available for assessment.

(3) Tasks, Responsibilities and Authorities

The food business operator shall provide appropriate documentation with respect to the tasks, responsibilities and authorities of food business operator's employees who are in positions which involve handling food and/or controlling and ensuring the safety and suitability of the food. An organisation chart and the organisation's reporting structure shall be documented.

(4) HACCP Team(s)

The food business operator shall assemble a HACCP team (or various HACCP teams if so required). The HACCP team shall develop, implement and maintain the HACCP system. The organisation shall demonstrate that the members of the HACCP team have the knowledge, expertise and different disciplines available which are required to develop, implement and maintain a HACCP system covering the total scope of the HACCP system. Minimum qualification criteria, including required expertise, shall be defined and documented for all members of the HACCP team. In addition, the assignment (including tasks, responsibilities and authorities) shall be documented for the team members. Whenever more than one HACCP team has been assembled, a co-ordinator shall be appointed to co-ordinate the development, implementation and maintenance of the HACCP system.

(5) Resources

The food business operator shall examine the requests and provide, in a timely manner, all the resources needed by the HACCP team(s) to develop, implement and maintain the HACCP system. When corrective actions, verification procedures or customers indicate that operational improvements are necessary, the food business operator shall examine the issues and provide appropriate resources to ensure food safety.

(6) Management Review

The food business operator shall review the HACCP system at planned intervals, of no more than 12 months, to ensure continuing suitability, adequacy and effectiveness. The review shall evaluate the need for changes to the HACCP system, including product safety, policy and objectives. The review shall provide evidence of the commitment to improve the HACCP system and its performance.

2) Product Information

(1) Product Characteristics

Each product (or a group of similar products) shall be fully specified and documented, in-

cluding its sensitivity to and potential for safety risks. This description of the safety of the product shall encompass the food chain, ranging from raw materials used to the distribution of the finished products. The traceability of the raw materials up to and including final supply shall be described.

An extensive specification of the end products is required to ensure a comprehensive assessment of the food safety procedures.

(2) Intended Use

The intended use of the product shall be identified and documented since it has a direct influence on the required product characteristics.

The intended use of the product shall be continually reviewed; relevant legislation and regulations shall be documented. When necessary, the product characteristics and manufacturing processes may need to be adapted to conform to special legislation. Information on the label, including directions for use, may also need to be adapted. These changes shall be recorded.

3) Process Information

(1) Flow Diagrams

The food business operator shall make available a complete and actual description of the operation in the form of flow diagrams (process steps) and layouts (production facilities). When applying HACCP to a given operation, consideration shall be given to steps preceding and follow the specified operation. These descriptions shall be drawn up and verified by the HACCP team.

(2) Layout

All facilities which are part of the infrastructure of the food business, such as the production lines, storage areas and personnel facilities shall be depicted in a layout plan.

(3) Control and Verification of Process Information

Prior to the execution of changes in the production process and layout that could adversely affect food safety, these changes shall be reported to the HACCP team in order to evaluate potential hazards to food safety and take preventive actions accordingly.

In any case the accuracy and actuality of the flow diagrams and layout shall be verified by the HACCP team for compliance with the documented situation. This verification shall be repeated periodically (at least annually) in order to identify and document modifications to the process installation and layout. These periodic verifications shall be part of the verification procedure.

4) Pre-requisite Program

The food business operator shall make available a complete and actual description of the pre-requisite program (PRP) of the organisation. The procedures belonging to the PRP shall be well established (appropriately specified and documented), fully operational and integrated in the HACCP system, and be verified.

The Codex General Principles of Food Hygiene lay a firm foundation for ensuring food safety and suitability. The food business operator shall decide which food hygiene principles, good manufacturing practices and food legislation must be included in the PRP of the organisation.

5) Hazard Analysis

The food business operator (HACCP team) shall identify, analyse and evaluate all potential (biological, chemical and physical) hazards that can have an adverse effect on the safety of the products. Whenever the food business operation changes in a manner could adversely affect food safety, all relevant steps of the Hazard Analysis shall be up-dated.

(1) Hazard Identification

The food business operator (HACCP team) shall identify and register all potential (biological, chemical and physical) hazards that can have an adverse effect on the safety of the products. The identification shall include all aspects of the operations within the scope of the HACCP system.

The operations to be evaluated include all products, all processes and the pre-requisite program of the legal owner of the products. For service organisations (not legal owner, but holder of the products), the hazard identification and analysis is restricted to the services provided, for instance, cold/frozen storage, packaging and transport.

(2) HACCP Analysis (risk)

The food business operator (HACCP team) shall conduct a HACCP analysis to identify which hazards are of such a nature that their elimination or reduction and control at acceptable levels is essential to the production of safe food. The results of the analysis shall be documented, including the concepts and principles utilised for determining/estimating the risks.

The food business operator shall define permissible levels of risks. These levels (concentrations, product or process criteria) must comply, as a minimum, with legal requirements. When conducting the HACCP analysis, practical experiences, experimental data, professional literature, etc., shall be taken into account and be documented.

6) Control Measures

The HACCP team shall identify and document the control measures that are to be applied or implemented when the hazard identification and HACCP analysis concludes that the risk of an identified hazard is significant and needs to be eliminated or reduced and controlled at an acceptable level.

The HACCP team shall conduct an assessment of every step in the process, for example with the use of a decision tree. The assessment shall be based on, amongst other things, the differing expertise within the team and shall utilise external and internal information. For each step, including all products, all processes and all parts of the Pre-Requisite Program the assessed aspects

shall be identified. The reasons for deciding whether it is a CCP (critical control point) or not, shall be documented and traceable.

More than one control measure may be required to control a hazard and more than one hazard may be controlled by a control measure. Control measures shall be classified as specific or general control measures.

(1) Specific Control Measures

Control measures related to CCP's shall be classified as specific control measures. Specific control measures are actions or activities, often measurable in terms of physical or chemical parameters such as temperature, time, moisture, pH, A_w, available chlorine, and sensory parameters such as visual appearance and texture.

Specific control measures based on subjective parameters, as in the case of visual inspection of a product, process, handling, etc., shall be supported by instructions or specifications, education and training.

Specific control measures shall be monitored, be provided with corrective actions, validated and verified (see subsequent paragraphs).

(2) General Control Measures

Control measures not related to CCP's shall be classified as general control measures. General control measures are actions or activities which are part of the prerequisite program. In general, these measures will achieve control at acceptable levels.

General control measures shall be documented in specifications (raw materials, products, process, etc.), instructions (process, control, operations) and procedures or plans, e. g. purchase plan, hygiene plan (including personal), maintenance plan, cleaning and disinfection plan, and supported by education and training plans, operator-specific aspects, supervision, etc..

General control measures shall be validated in order to demonstrate the proper functioning of (the specific part of) the PRP and will subsequently be approved by the HACCP team.

The effectiveness in controlling the identified hazards of the general control measures shall be verified at pre-defined, regular intervals.

7) Parameters and Critical Limits

(1) Critical Process and Product Parameters

For each specific control measure related to a CCP the process and/or product parameters must be identified which are meant to demonstrate that control at the step is being maintained.

The food business operator shall document the parameters to be applied as well as the arguments for using these parameters.

(2) Target Values, Action-Limit Values and Critical Limits

Further, the food business operator shall define for the various parameters the critical limit

which must be met at all times during the operation. Also, normal operational target values are indicated for the various parameters as well as the action-limit values which indicate when intervention in the operation is required in order to continuously meet the critical limits.

When determining the critical limits and the deduced action-limit and target values, the requirements of the relevant legislation and regulations and/or internal risk analysis for the safety of foodstuffs must be considered as (contractual) requirements.

The food business operator must establish and maintain adequate provisions/procedures for the monitoring of the target values and the corrective actions to be executed whenever the critical limits are exceeded.

In addition the effectiveness of the established parameters and operational values shall be validated to ensure food safety.

8) Monitoring and Measuring

The food business operator shall establish and maintain a monitoring (measuring) system for effective and efficient control of the Critical Control Points. The system includes all planned measurements, observations and analysis of the control parameters determining that the CCP's are under control.

The justification for the development of the monitoring system shall be documented. The monitoring (measuring) devices shall be identified. The methodology of measurement and/or the instructions for measuring and recording of measurements shall be documented. In addition, the method for establishing the reliability of the measurements and/or the equipment (calibration) shall be documented.

9) Corrective Actions

For each Critical Control Point, the food business operator shall document the corrective actions to be taken in case an action-limit value or critical limit is exceeded. The procedure will include the process to investigate the cause of the deviation.

A documented justification for the corrective action to be taken shall be available, including the responsibilities and authorities of the personnel which are involved. The actions to be taken must be established in advance. This could also involve the formation of a so-called 'emergency team'. This team shall evaluate the causes of the deviation and shall decide which additional preventive actions are to be taken.

The food business operator shall also establish arrangements that provide procedures for recall of the products from the market place and/or from end consumers. Proper product identification and a 'tracing &tracking' system shall be operational.

All corrective actions taken, the causes and consequences, and the individuals involved in the corrective actions shall be recorded.

The effectiveness of the corrective actions, for both the process and the product, shall be evaluated.

10) Validation

Validation is not a part of verification, but a separate activity prior to authorising the HACCP plan.

The objective of validation is to ensure that the hazards originally identified by the HACCP team are complete and correct and that they will be effectively controlled under the proposed plan. To meet the objectives of validation it is necessary to review the effectiveness of the supporting evidence used in the HACCP study as well as the general and specific control measures, the monitoring system and corrective actions. Each time when the food business operation changes in a manner that could adversely affect food safety this review shall be up-dated.

To ensure absence of bias, the food business operator shall form a validation team. The validation team may include members of the HACCP team, but must also include independent reviewers e. g. from within the food business operation, who have not been directly involved in the establishment of the HACCP plan.

Food business operators may have produced safe food for many years before the introduction of the HACCP system. Therefore, historical results from on-line Quality Control monitoring, end product testing, customer or consumer complaints may be used as evidence when validating HACCP plans. It is important to note that the data must be quantifiable and objective if it is to be useful.

The composition of the validation team and the activities undertaken shall be clearly documented. The food business operator shall demonstrate satisfactory completion of validation.

11) Verification

The food business operator shall establish, document and implement procedures for verification of the HACCP system. The main purpose of verification is to determine compliance with the specifications of the HACCP system and to confirm that the HACCP system is working effectively through the application of (auditing) methods, procedures, tests (including random sampling and analysis) and other evaluations, in addition to monitoring.

The food business operator shall plan an internal audit scheme, taking into consideration the status and importance of the processes and areas to be audited, as well as the results of previous audits. The audit criteria, scope, frequency and methods shall be defined, taking into consideration the status and importance of the processes and area's to be audited, as well as the results of previous audits.

Selection of auditors and the conduct of audits shall ensure objectivity and impartiality of the audit process. Auditors shall not audit their own work.

The responsibilities and requirements for planning and conducting audits, for reporting re-

sults and maintaining records shall be defined in a documented procedure.

Management review: The food business operator shall review and evaluate the results of the entire verification process at planned intervals, of no more than 12 months. Therefore, the frequency of verification and internal audits shall be such that the food business operator can ensure continuing suitability, adequacy and effectiveness of the HACCP-based Food Safety System. Some requirements are to be verified with a higher frequency than other requirements. For instance, the effective control of CCP's may be evaluated with a frequency of at least twice a year, whereas a frequency of once a year may be sufficient to verify the actuality of process lines and layout.

The food business operator shall collect and analyse the resulting data to evaluate where improvement is needed.

The food business operator shall ensure that preventive actions are taken without undue delay to eliminate the causes of (potential) non-conformities in order to prevent recurrence (occurrence). The preventive actions shall be appropriate to the effects of the (potential) non-conformities encountered. The effectiveness of the preventive actions taken shall be validated.

12) Documentation and Records

(1) Documents and Document Control

The food business operator shall establish a documented HACCP system and shall maintain the HACCP system and corresponding documentation in order to ensure conformity with the requirements of this specification and the applicable legislation and regulations.

Documentation should be appropriate to the nature and size of operation.

(2) Records

Efficient and accurate record-keeping is essential to the application of a HACCP System.

Records shall be established and maintained to provide evidence of conformity with the requirements and with the effective operation of the HACCP-based Food Safety System. Records shall remain legible, readily identifiable and retrievable. A documented procedure shall be established to define the controls needed for identification, storage, protection, retrieval, retention time and disposal of records.

2.2 参考翻译

食品安全体系规范（HACCP）

1 绪论

食品安全是一个全球关注的问题。不仅仅是因为食品安全关系到公众的健康，还因为它对国际贸易有很大的影响。有效的食品安全体系将因此设法并确保食品的安全性与适宜性。目前，全世界已经有许多国家对食品的安全性与适宜性进行立法，要求规定，任何食品企业、食品组织，不论是否赢利，不管是公共的还是私人的，都必须执行 HAC-

CP 法则，并应用在食品预备、加工、生产、包装、贮存、运输、销售的全过程。

联合国粮农组织/世界卫生组织下属的国际食品法典委员会描述了一个包括 HACCP 七项原则在内的系列步骤，用来指导 HACCP 体系的运用。同时，法典指出，在应用 HACCP 体系之前，还必须制订一定的卫生标准，在食品链的任意环节应用 HACCP 之前，都必须根据法典实施食品卫生的一般原则、法典中适当的条款以及食品安全法规。

认证机构必须以可接受的方式使用公开出版的“必备条件”或者是“认证法规”。“必备条件”以文件的方式来证实对食品经营者执行 HACCP 体系的情况的有效评估。在认证规则当中，规定了一些特别条款，比如，认证机构选择一个有资格的 HACCP 审核小组时必须符合的标准以及必须遵循的指导预定的认证过程（如最短审核时间）的规则。当认证机构通过官方认证机构基于食品安全体系的认证体系的定期审核，通过这种方式，认证机构得到了权威的认可。官方认证的内容包括认证机构的可靠性与能力。“认证机构导则”详细阐述了一些公认的准则。我们必须明白，通过了食品安全保证体系（HACCP）的认证，并不代表食品经营者的食品安全就能永远得到保证。对于食品经营者来说，通过食品安全体系 HACCP 认证的意义在于为维持该体系所做的工作，并致力于持续改进食品的安全的行为。

2 应用范围

在本标准当中，详细规定了评估 HACCP 体系，在执行 HACCP 时，确保在准备、处理、加工、包装、贮藏、运输、配送、销售等食品链的任何环节的食品安全时所必须具备的条件。“规定”主要适用于所有从事食品的企业或机构，不论他是否赢利，也不论他是公共的还是私营的。

很明显，食品经营者应该能够鉴别出他们食品生产过程中的能确保食品安全的所有的步骤，并在应用 HACCP 原理、包括食品卫生的一般原理以及一些适当的相关的食品安全法规的基础上建立、贯彻实施、保持并确认所采取的安全措施。该“规定”并不适用于食品经营业的一些配套的服务行业，像包装材料供应商、食品设备行业、工业清洗行业等等。

3 HACCP 体系要求

1）管理职责

食品经营者应该对所生产产品的安全性（和适宜性）负责。因此，食品经营者应该在企业的方针里面涵盖预期的食品安全方针。管理者应制定组织的方针，支持、宣传该方针，并对此负有最终责任。

管理者还应该周期性地检查、评估该方针的实施成果。通过 HACCP 体系，能够证明食品经营企业提供预期的安全产品的承诺和责任。HACCP 体系亦保证了所有必要的措施都得到了有效的建立、执行和维持。

（1）方针

食品经营者应该详细的说明本企业关于食品安全的方针，并将它文件化。它体现了

组织对食品安全的承诺。方针应该能够体现企业已经充分意识到本身在食品链中的位置。它反映了“农场到餐叉”的途径，原料从购进到接收的过程。方针应当以食品的安全、顾客或消费者的期望和需求为关注焦点。方针应该包括具体的保证和提高食品安全的周期性目标。管理者应该确保组织内的所有人员都能理解、执行并维持该企业方针。

（2）HACCP 体系的范围

管理者应该界定 HACCP 体系的范围。HACCP 体系的范围应该包括食品链的环节和在食品交易中食品经营者应该负责任并能负责任的一些活动。

食品经营者应负责任的食品链的环节包括原材料供应到成品，成品以后责任由另外的食品经营者来承担。所以 HACCP 体系的范围应该包含购买和销售合同。

食品经营者用来生产和/或贮存食品的场所和生产线都应该正确的标示出来并经过有效的评估。

所有供应市场的产品，无论是加工的还是处理的，都应该正确的说明。

所有转包活动（像包装、贮存、运输一类的外包服务）都应该正确的处理。

一个关键原则是食品经营操作的所有环节都应该包括在 HACCP 体系范围之内；所有的活动必须得到可靠的评估。

（3）任务、职责和权利

食品企业的管理者应该提供适当的文件以用来考虑在食品操作、控制并能保证食品安全性与适宜性的这些岗位上的员工应承担的任务、职责和应享有的权利。

（4）HACCP 小组

食品管理者应该组织一个 HACCP 小组（如果有必要，可以组织多个 HACCP 小组）。HACCP 小组应该负责 HACCP 体系的建立、执行和维护。企业必须能够保证 HACCP 小组的成员具备建立、执行和维持 HACCP 体系所需所有的相关的多学科的知识、专业技术并经过适当的培训。HACCP 小组所有成员应具备的包括专业技术在内的最基本的资格条件，应该明确加以说明并形成文件。此外，小组成员的分工（包括任务、职责和权力）都应该文件化。不管什么时候，一旦成立 HACCP 小组，就应该指定一个协调人负责协调 HACCP 体系的建立、执行和保持。

（5）资源

管理者必须及时的掌握和提供建立、运行和维护 HACCP 体系所需的所有资源。当纠正措施、验证过程或者是顾客认为生产水平有待提高时，管理者应该了解相关的问题，并提供适当的资源来保证食品安全。

（6）管理评审

管理者应该按一定的计划好的间隔时间对 HACCP 体系进行评审，间隔时间一般不超过 12 个月，以保证体系的持续适宜、充分、有效。评审应该评估体系变更的需要，包括产品的安全、方针和目标等。评审应该提供改善 HACCP 体系和执行情况的承诺的证明。

2）产品信息

（1）产品特性

每个产品都应该有足够详细的产品描述并形成文件，包括它对安全风险的敏感性和可能性。产品安全性的描述应该包含整个食品链，范围涉及使用的原材料到最终产品的销售。原材料的追溯，一直到最终供应都应该被描述。

成品的比较完备的说明需要保证产品安全程序经过了广泛的、全面的评估。

（2）预期用途

产品预期用途应该明确，因为他直接影响所需产品的特性。

产品的预期用途应该经常评价，相关的法律和规章应该形成文件。必要时，产品特性和生产过程必须进行调节以符合特定的法律。标签上的信息，包括使用说明，也需要与相关法律相适应。以上的内容，其变化需要有记录。

3）过程信息

（1）流程图

管理者应该以流程图（过程步骤）和规划设计（生产设备）的形式制订一套完整的可操作的操作规范。当对一个给定的操作步骤应用 HACCP 体系时，应该考虑该操作步骤的前后的相关步骤。这些描述通过有关流程图由 HACCP 小组拟订和验证。

（2）规划

食品企业的基础设施中的所有设施，例如生产线、贮藏区域和个人设施，都应该在布局计划中描述。

（3）过程信息的控制和验证

在执行对食品安全有不利影响的生产过程和规划的调整之前，该调整并且应该报知 HACCP 小组，由 HACCP 小组来评估由此而产生的对食品安全的潜在危害并采取相应的预防措施。

无论如何，流程图和规划的准确性和真实性都应该由 HACCP 小组来验证其与文件体系的符合性。验证应该周期性（至少一年一次）地重复进行以确定并记录过程装置和布局的更改情况。周期性的验证是验证程序的一部分。

4）必备程序

管理者应该制订一套切实可行的、完整的组织必备程序。组织应该建立良好的必备程序（恰当的规范和文件），与 HACCP 体系融为一体，良好运作并验证。

食品卫生法规的一般原理为确保食品的安全性和适宜性奠定了坚实的基础。管理者应该将食品卫生学的原理、良好操作规范和食品法规包含在企业的必备程序里。

5）危害分析

企业经营者（HACCP 小组）应该能够鉴别、分析、评价所有的潜在的对产品安全产生不利影响的（生物的、化学的和物理的）危害。无论何时，食品经营运作发生变更，危害分析中所有对食品安全产生不良影响的步骤都应该及时更改。

（1）危害的识别

企业经营者（HACCP 小组）应该能够鉴别并记录所有潜在的对产品安全产生不良影响的（生物的、化学的、物理的）危害。鉴别应该涵盖 HACCP 体系范围内的所有操作。评价应包括所有产品、所有过程和法规规定的必备程序。

对服务机构（不是法规规定的，但是产品提供者），危害的鉴别和分析就包括服务的提供，比方说，冷藏/冻藏、包装及运输。

（2）HACCP 分析（风险评估）

企业经营者（HACCP 小组）应该指导 HACCP 分析以鉴别那些可以消除或者降低及控制在食品安全可接受的水平内的危害。

分析的结果应该形成文件，包括对风险识别和评估时应用的概念和原理。

食品经营者应确定可接受的风险水平。风险水平（产品或过程的标准）必须与法规要求的最低限度相符。当进行 HACCP 的危害分析时，必须充分考虑实践经验、实验数据、专业文献等。

6）控制措施

当已识别的食品安全危害显著和 HACCP 分析需要消除或将危害降低或控制在可接受的水平之内时，HACCP 小组应该鉴别并制订控制措施以便实施。

HACCP 小组应该对过程的所有步骤进行评估，例如判断树的使用。评估应该建立并不限于下面一些条件之上，不同的专业知识，对内部和外部信息的利用等。对每一步骤，包括所有产品、过程和必备程序的评估都必须进行确认。应该对关键控制点的判断理由进行确定并可追溯。

控制一个危害可能需要多个控制措施，一个控制措施有时也可以控制多个危害。控制措施应该分为一般控制措施和特殊控制措施。

（1）特殊控制措施

有关关键控制点的控制措施应该归类为特殊控制措施。特殊控制措施所采取的具体的行动或行为，常常是根据一些化学的或物理的参数来测量，例如温度、时间、湿度、pH、水分活度、可用氯、以及一些感官参数，例如外观和质地。

特殊的控制措施建立在一些主观参数之上，例如，产品、过程、搬运等的目测，应该通过指令或者是说明以及教育、培训等来支撑这些参数。

应该对特殊控制措施进行监控，采取纠正措施，确认并验证（参见后面的章节）。

（2）一般控制措施

不是针对关键控制点的控制措施应该归类为一般控制措施。一般控制措施中的行为活动是必备程序的一部分。一般来说，这些控制措施能够将危害控制在可接受水平之内。

一般控制措施应该制订规范（原材料、产品、过程等）、指令（过程、控制、操作）和程序或者是计划，例如，采购计划、卫生计划（包括个人卫生）、维护保养计划、清洁和消毒计划，以及通过教育和培训计划、详细的操作、监督管理等对以上计划进行支撑。

一般控制措施应该进行确认从而证明必备程序（细节部分）的正确的作用，然后还应该由 HACCP 小组批准后方可实施。

对已识别的危害所采取的一般控制措施的效果，应该预确认并定期的验证。

7）参数和关键限值

（1）关键过程和产品的参数

针对关键控制点的特殊控制措施的过程和/或产品的参数都必须认真鉴定，从而证明得到了持续控制。

食品经营者应该能证明应用的参数和实际参数是吻合的。

（2）目标值、操作限值和关键限值

此外，食品经营者应该详细说明在操作中一直存在的关键限值的不同参数。同样地，常规操作的目标值和操作限值之间不同参数的识别，指出了生产中需要涉及的参数从而持续满足关键限值。

当制订关键限值并据此制订操作限值和目标值时，相关的食品安全法规及内部的风险分析都必须当作必要条件来加以考虑。企业还应该就目标值建立并保持适当的监控程序或规定，并制定纠正措施以在关键限值失控时加以实施。

另外，企业所确定的参数和操作限值的效果应该得到确认从而保证食品安全。

8）监控和测量

企业应当针对关键控制点的有效性建立并保持一套监控（测量）系统。系统应当包括测量计划、观察活动以及控制参数的分析，从而确定关键控制点处于控制之中。

建立监控系统的依据应该形成文件，监控装置应该经过确认。测量方法和/或测量说明、测量结果的记录都应该制订相应的文件。此外，建立的方式、测量的可靠性及设备的校准等都应该文件化。

9）纠正措施

对每个关键控制点，企业都应该制定当操作限值或关键限值失控时使用的纠正措施。这个程序应当包括对偏差原因调查的过程。

所采取的纠正措施的依据应该是有效的，它包含了人员职责和权力。所采取的纠正行动必须预先建立。这当中也就包含了所谓的“应急小组”的构成。小组成员应该能够指出发生偏差的原因，并能够决定采用何种预防措施。

企业还应该建立从市场或者消费者手中召回产品的预备程序。执行适当的产品识别和“追溯 & 跟踪”体系。

所采取的所有措施，起因和结果以及包含在纠正措施当中的一些个案都应该记录在册。纠正措施的有效性，不管是针对过程还是针对产品，都应该进行评价。

10）确认

确认不是验证的一部分，而是在批准 HACCP 计划之前的一个独立的活动。

确认的目的是为了保证由 HACCP 小组做出的最初的危害识别是完整而准确的，并处

于计划的有效控制下。为了达到确认的目的，就必须对 HACCP 计划中的特殊和一般的控制措施、监控系统和纠正措施的有效性进行审查。任何时候，当食品的生产发生某种程度的变化并可能对食品安全产生不良影响时，评审必须能及时跟进。

为了保证没有偏见，食品企业应该有确认小组。确认小组可以包括 HACCP 小组的成员，但是还应该包括独立的审核人士，例如，从事生产操作的，没有直接包含在 HACCP 计划内的人员。

企业在引入 HACCP 体系之前可能已经生产安全食品许多年了。因此，在线质量控制的监控，成品的测试，顾客或消费者的投诉等等，这些历史记录都可以用作 HACCP 计划确认的依据。如果使用这些历史记录的数据的话，这些数据的可计量和客观性是很重要的。

确认小组的组成以及所采取的行动都应该以文件形式清楚地加以说明。企业应该能够证明确认工作圆满完成。

11）验证

企业应该建立、制订并执行 HACCP 体系的验证程序。验证的主要目的是通过 HACCP 体系的规范来确定体系的符合性，并通过（审核）方法、程序、（随机抽样并分析）测试及其他的除监控以外的一些评价方法的应用，来确定 HACCP 体系工作的有效性。

企业应该安排内审计划，同时应该明确审核的标准、范围、频率和方法，并充分考虑被审核过程和范围的重要性和审核情况，以及上次审核的结果。

选择审核员，并对审核进行管理从而确保审核过程的客观和公正。审核员不得审核本部门的工作。

对审核计划及审核过程的职责和要求以及报告的结论和记录的保持，应该在程序文件中明确。

管理评审：管理者应该按一定的间隔时间对验证的全过程进行审核和评估，最长不超过 12 个月。因此验证和内审的频率应该让企业能够确保食品安全保证体系的持续适宜性、充分性和有效性。一些必备条件应该比别的一些条件的验证频率高。例如，关键控制点控制的有效性应该在一年之内最少验证两次，反之，实际的工艺流程和规划一年只要验证一次就足够了。

企业应该收集、分析这些结论并评估那些需要的重要内容。

企业应该确保及时的采取预防措施以消除（潜在的）不符合的因素，从而防止不符合项的重复发生。预防措施对碰到的潜在不合格的影响是恰当的。采取的预防措施的有效性还应该得到确认。后续的行动应该包括对所采取的行动的验证和评估。

12）文件和记录

（1）文件和文件控制

为了保证规范的必备文件，适用的法律法规的适宜性，企业应该建立并保持 HACCP 体系文件和相关文件。文件应该与操作本身的特性相适应。

（2）记录

对于 HACCP 体系而言，有效的、准确的记录是十分必要的。应该建立并保持记录，以提供有效运行 HACCP 体系所需必备文件的符合性的证据。记录保存完好、容易辨认并容易获取。应该建立一套程序文件，就记录的鉴定、保存、保护、挽救、保存时间及处理等需要控制的环节做出明确的规定。

3 阅读链接

[1] http://www.haccp-nrm.org/

[2] http://www.haccp.com.au/index.php/

4 课后作业

4.1 句子翻译

4.1.1 原句

(1) The food operation shall assure that the appropriate product specific knowledge and expertise is available for the development of an effective HACCP plan. This may best be accomplished by assembling a multi-disciplinary team.

(2) The scope of the HACCP plan shall be identified. The scope shall describe which segment of the food chain is involved and the general classes of hazards to be addressed.

(3) The HACCP team shall create the flow diagram. The flow diagram shall cover all steps in the operation. When applying HACCP to a given operation, consideration shall be given to steps preceding and follow the specified operation.

(4) List all potential hazards associated with each step, conduct a hazard analysis, and consider any measures to control identified hazards. The HACCP team shall list all hazards which may reasonably be expected to occur at each step, from primary production, processing, manufacture and distribution until the point of consumption.

(5) If a hazard has been identified at a step where control is necessary for safety, and no control measure exists at that step or any other, then the product or process shall be modified at that step, or at any earlier or later stage, to include a control measure.

(6) Critical limits must be specified and validated, if possible, for each Critical Control Point. In some cases more than one critical limit will be elaborated at a particular step.

(7) Managers and supervisors of food processes shall have the necessary knowledge of food hygiene principles and practices to be able to judge potential risks and take the necessary action to remedy deficiencies.

(8) Food handlers shall have the necessary knowledge and skills to enable them to handle food hygienically. Those who handle strong cleaning chemicals or other potentially hazardous chemicals shall be instructed in safe handling techniques.

(9) Cleaning chemicals shall be stored, where necessary, separately from food, in clearly identified containers to avoid the risk of (malicious or accidental) contamination of food.

(10) Specific corrective actions must be developed for each CCP in the HACCP system in order to deal with deviations when they occur. The actions must ensure that the CCP has been brought under control.

4.1.2 参考翻译

(1) 食品从业者应该确保有恰当的产品、特定的知识和专业技术从而建立和实施一个有效的 HACCP 计划。HACCP 计划最好是由一个多学科的小组来完成。

(2) HACCP 体系的范围应该明确。范围应该描述即将要分析的危害的一般分类和食品链的每个环节。

(3) HACCP 小组要制定流程图。流程图应覆盖所有的操作步骤。当在生产中应用 HACCP 体系的时候，应该考虑操作之前和之后的相关步骤。

(4) 列出每步骤相关的所有的潜在危害，做一个危害分析，并针对所识别的危害考虑一切控制措施。HACCP 小组应该列出每一步中所有可能发生的危害，应包括从原料的生产、加工、制造、销售直到消费者使用。

(5) 如果某一步骤的危害已经识别，为了安全，必须有控制措施，但实际上并没有实施控制措施，这个时候，该步骤或其前后相关步骤的产品或过程就必须更改，并有控制措施。

(6) 如有可能，每个 CCP 的关键限值必须明确并进行验证，一些情况下，一个特别步骤可能制订了不止一个关键限值。

(7) 食品加工主管必须有足够的食品卫生学知识和实践技能，能够判断食品生产过程中的潜在风险，并能采取有效措施弥补缺陷。

(8) 食品操作人员有必要掌握保证食品卫生的知识与技能，那些使用强效化学药品清洁剂与有潜在危害化学品的操作人员应进行安全操作技巧的培训。

(9) 用于清洁的化学药品要根据需要与食品分开储藏，并在存放器皿上清楚标识，以避免给食品带来（有意的或意外的）污染的风险。

(10) 在 HACCP 体系中，必须针对每个 CCP 建立具体的纠正措施来处理偏离情况的发生。纠正措施必须保证 CCP 处于受控状态。

4.2 科技论文常见句型

1）前言中阐明目的

常用句型：Our task（job/mission/etc.）in/of this article（paper/work）is to …

The purpose（objective/goal/）of this study（research）is to …

【例句】The purpose of this study is to investigate the relationship between changes in leakage of the seeds and seed ageing and to search for an indicator of seed vigor based on it.

本文研究了种子渗漏物质的变化与种子老化之间的关系并藉此预测种子活力的方法。

2）前言说明讨论范围、焦点

常用句型：This study deals mainly with …

The emphasis of this paper is put on …

【例句】This study mainly deals with the influence of working memory capacity on the generation of predictive inference during text reading.

本研究通过操纵读者信息加工的时间量考察了工作记忆容量对预期推理生成的影响性质。

3）前言中表示有待解决的问题

常用句型：The problem to be solved is …

The main problem seems to be …

【例句】But the main problem seems to be demand for goods and energy, as lorries carrying coal crawl endlessly towards the city.

但是最主要的问题的似乎是对产品和能源的需求，导致运煤货车不断地向北京缓慢前进。

4）表示试验结果的句型

常用句型：The experiments reported here showed（suggested /indicated）a correlation between …

The highest（lowest/best/80%）yield was obtained（came from/caused）the treatment of …

The yield was highest with the treatment of …

【例句】The experiments showed that the conversion ratio was concerned with reaction temperature, concentration of alkali and reaction time.

实验表明，转化率与反应温度、碱液浓度以及反应时间有关。

5）表示结论的句型

常用句型：From the experiment, it can be concluded that …

The problem requires further research（study/investigation）in this area.

【例句】Compared to other method, it can be concluded that the application of fuzzy matter-element model method for evaluating region water environment is feasible and reliable.

并与其他方法加以比较，进一步说明模糊物元分析法更具有可信度。

6）图表、公式的说明

常用句型：As shown in Table 1.

We can find in Figure 1 that …

【例句】As shown in Table E, this year the percentage of hoteliers who find there to be major restrictions is slowly but surely creeping back up.

从表格 E 中可看出，今年认为在线营销工作受到品牌限制的酒店业者的比例回升速度缓慢，但肯定会回升。

7）前言中在叙述前人成果之后，如何提出一种新方法或新方向。

常用句型：However, little information (little attention/little work/little data/little research…) (or few studies/few investigations/few researchers/few attempts…) (or no/none of these studies…) has (have) been done on [focused on/attempted to/conducted/investigated/studied (with respect to)]。

【例句】However, there is little information on how different environmental conditions and materials affect H5N1's survival.

然而，对于环境和物品表面对 H5N1 病毒的存活的影响还没有相关的信息。

8）前言中研究方法和方向与前人一样时，如何强调自己工作。

常用句型：We need to (aim to, have to) provide more documents (data, records, studies, increase the dataset) …

Further studies are still necessary (essential) …

【例句】However, you still need to provide more configuration data to achieve the deployment goals listed earlier.

但是，为了实现前面列出的部署目标，还需要提供一些配置数据。

9）连接词与逻辑

常用连接词：However, also, in addition, consequently, afterwards, moreover, Furthermore, further, although, unlike, in contrast, Similarly, Unfortunately, alternatively, parallel results, In order to, despite, For example, Compared with, other results, thus, therefore …

【例句】Compared with Europeans, Americans are more likely to receive medication if they have heart disease, high cholesterol, lung disease or osteoporosis.

和欧洲相比，美国人有更多的机会受到心脏病、高胆固醇、肺病和骨质疏松症方面的药物治疗。

10）讨论部分中的说明论证

常用词汇：Support, provide, indicate, identify, find, demonstrate, confirm …

Chapter 5 Writing

Unit 1 Food Science and Technology English Papers Translation Methods and Techniques

1 专业词汇分析

伴随着不断涌现的新发现、发明与创造成果，新的科技词语随时在产生，仅化学专业词汇已增至数十万。科技工作者为了表达这些新物质与新概念，除创造出全新的科技词汇，如基因、克隆、飞秒等等之外，绝大多数均通过派生与合成新的词语来实现。

在食品科技英语中，合成词和派生词等也不容忽视。许多单词是由词缀和词根构成的。通过拆解单词，识别其词缀和词根，可把握其意义，并能够领略英语单词的构造奥妙。掌握构词技巧可极大地减轻记忆单词的负担，若真正领悟并进而拓展这种方法所蕴含的思路，将能触类旁通。

将两个独立的单词合并一起。这种构词法称为“合成词构词法”。通过不同词的合成可以构成名词、动词、形容词等新的合成词（compound words）（表1）。

表1 合成词列举

名词+名词	cheese-cloth	干酪包布，一种干粗布
	self-life	货架期、货架寿命
	dough-nut	面团坚果
	butter-fat	乳脂肪
	lemon-drop	柠檬糖
	blast-room	鼓风室
名词+形容词	water-soluble	水溶性的
	gas-tight	气密性的
	heat-sensitive	热敏性的
	enzyme-resistant	酶抗性的
	oxygen-impermeable	隔氧的
名词+动名词	photocopying	复印
	mouth-watering	润口的
	film-forming	成膜的
	milk-handling	乳处理的
	water-holding	持水的
名词+动词过去分词	center-filled	夹心的
	candy-coated	糖心的
	spray-dried	喷雾干燥的
	alkali-modified	碱法改性的
	enzyme-catalyzed	酶促催化的
	ion-exchanged	离子交换的

续表

名词+动词	mouth-feel taste texture	口感
	essence-recovery	芳香物回收
	air-flow	空气流
	mold-release	脱模
形容词+名词	counter-current	逆流的
	high-speed	高速的
	semi-solid	半固体的
	Low-viscosity	低粘度的
	double-helical	双螺旋的
	macro-ingredient	宏量组分
动词 ing 形式+名词	linking-device	连接装置
	boiling-water	沸水
形容词+动名词	fast-setting	快凝
	super-cooling	过冷
	dehydro-freezing	脱水冷冻法
	deep-chilling	深冷
动词过去分词+名词	superheated steam	过热蒸汽
	fluidized-bed	流化床
	reduced-fat	降脂
	scraped-surface	刮板式
副词+名词	up-date	更新
	post-mortem	宰后
	under-season	欠味
	by-product	副产物
介词+动词	through-put	吞吐量
	off-cut	下脚料
	in-container	灌装后
	off-flavor	异味
	on-line	在线
副词或形容词+动词过去分词	immediately-connected	直接连接地
	weak-bodied	体弱的
	under-blanched	漂烫不足的

派生词（derivatives）指在已存在的某个词根基础上加上前缀或者后缀从而组成一个新词，通过派生法组成的词在科技英语词汇中占大多数。前缀或者后缀词数量很大，因而掌握一定的前缀和后缀的词素对掌握食品科技英语单词有很大的帮助。

一般情况下，词根加上前缀不会改变词性，只会改变该单词的词义。

有些前缀表示数量多寡、大小，比如 oligosaccharides（低聚糖，寡糖）、polysaccharides（多糖）、monosaccharide（单糖）、polyalcohol（多元醇）、diploe（偶极）、multiple（多样的）。

有些前缀表示否定的意思，比如 im-、in-、ir-、un-、mis、non-：impossible（不可能的）；insoluble（不溶解的）；irregularity（不规则）；unsaturated（不饱和的）；misinter-

pretation（误释）；non-homogenized（未经均质的）。

有的前缀表示重复的意思，如 re-：refreshment（提神，精神恢复）。有的前缀表示去除的意思，比如 depolymerization（解聚）、debranching（去枝）、dissolution（溶解）、dehydrate（脱水）。有的前缀表示过度、超过的意思，比如 supersaturated（过饱和）、overinversion（过度转化）。有的前缀表示一些专业领域的意思，比如 biopolymer（生物聚合物）、electrostatic（静电的）等。有的前缀表示上下级属性的意思，如 subion（次离子）、subnetwork（子网络）等。有些表示相互关系 inter-：intervening（介于中间的）、interdependence（相互依赖）等。有些会将词根构成动词，表示“使”的意思，如 en-：enlarge（使增大）、encode（编码）、enforce（使生效）、encapsulation（胶囊化）等。

通常情况下，词根加上后缀就会改变词性，但是原词义基本不会变化，当然也存在少数改变词根原词义的后缀，因而后缀多以词性来区分。有形容词性后缀，如-al：graphical（图解的）；-able：applicable（适用的）、objectionable（令人不快的、反感的）；-less：odorless（无嗅）、colorless（无色）、-y：auxiliary（辅助的）；-ic：electronic（电子的）、dynamic（动力的）等；有动词后缀，如-fy：satisfy（使满意）、specify（指定）、verify（核实）、simplify（简化）等；有副词词缀，如-ly：additionally（此外）、permanently（永久地）、arbitrarily（任意地）等；也有名词词缀，如-ment：measurement（测量）、nourishment（滋养、营养）；-tion：nutrition（营养）、communication（通信）、如-ant：antioxidant；-ability：traceability（溯源性，可追溯性）等。

2 课文

食品科技英语翻译不是科技专业词汇和英语语法的简单结合，对译者有很高的要求，需要比较系统地了解食品科技英语的特点、翻译方法和翻译技巧。

食品科技英语除具有普通英语的特征外，还具有用词严谨准确、陈述客观朴素、内容精炼确切、时代感强与国际化文体等特点。食品科技英语的翻译有别于其他英语文体的翻译，必须遵循其特定的翻译标准，采取特定的翻译方法和技巧。

2.1 食品科技英语中语言结构的特点

2.1.1 大量使用无人称句

由于食品科技英语文章所表述和探讨的都是客观事实或者发现等，主要是为了介绍或者说明这些事实或者发现本身，而不是为了突出强调这些事实或者发现是由哪些人或者组织发现和研究出来的，因而文章中多采用无人称句，物称的应用多于人称的应用。例如：Hold the casing back a little so that there are as few air bubbles as possible in the compact coil（将肠衣往回拿一点，这样就使得塞紧的香肠卷中的空气泡尽量少）。

2.1.2 广泛使用被动句

因为科技文章侧重叙事推理，强调客观准确，尽量使用第三人称叙述，采用被动语态。避免因使用主动语态句的主观性而带来的弊端。The eggs are likely to be washed before they are broken（打蛋前一般都先进行洗蛋）。

2.1.3 经常使用名词化结构

食品科技英语文章中，在普通英语中用动词表达的内容在科技英语中常用名词表达，常用一个名词词组“表示动作意义的名词+of+名词+修饰语”代替一个句子，即名词化结构。例如：Archimedes first discovered the principle of displacement of water by solid bodies（阿基米德最先发展固体排水的原理）。句中“of displacement of water by solid bodies”是一个介词短语结构，一方面代替了同位语从句（that water was displaced by solid bodies），另一方面强调了“displacement”这一事实。

2.1.4 常使用非限定性动词代替从句或并列分句

食品科技文章要求行文简练、结构紧凑，为此常常使用非限定性动词代替各种从句或并列分句，达到精简了句子结构的目的。例如：To be a suitable substrate to support growth of micro-organisms, a food must have free water available for the micro-organisms（如果要成为支持微生物生长的适宜基质，食品就必须有可供微生物利用的游离水）。在上述的例句中，动词不定式短语“To be…of microorganisms”作目的状语，代替了目的状语从句“If it is a suitable substrate …of microorganisms”。

2.1.5 广泛使用后置定语

在食品科技文章中，由于对语言简练和内容准确要求较高，所以后置定语经常被使用。过去分词短语、不定式短语、介词短语、形容词及形容词短语均可作后置定语。例如：The estimated beef yield (in pounds), adequate to feed one individual for one year, from 10 acres of land devoted to raising cattle［10 英亩专用于养牛的土地，预计它所产的牛肉（磅）足供一人一年食用］。在句中，分词短语“devoted to growing cattle”作定语，修饰“10 acres of land”。动词不定式短语“to feed one individual for one year”作定语，修饰“beef”。又如：Even so, yields of both protein and of essential amino acids per acre of cultivated land are several times greater from corn when the seed is used directly as food rather than from animals fed the same amount of corn（即使如此，当把玉米直接作为食物用时，每英亩耕地所获得的蛋白质和必需氨基酸得率均比来自同量玉米喂饲动物的得率要高出好几倍）。其中，介词短语“from corn …as food”作后置定语，修饰主语 yields …cultivated land。

2.1.6 长句多，结构复杂

为了表述一个复杂概念，使之逻辑严密、结构紧凑，科技英语文章中经常使用结构复杂的长句。由于句子很长，常常带有短语、独立成分、后置修饰语、非限定性动词结构，以及各种从句，句子呈扩展型。因此，在翻译时，首先要对长句进行语法分析，弄清原文的语法结构，找出句子的中心内容，由几部分组成，连接它们的纽带及其修饰成分；再进行逻辑分析，分析各部分之间的逻辑关系，思维发展，分清其层次、重点及形式等，然后使用翻译方法和技巧以及规范、流畅、简练的汉语表达原文的思想内容。例如：The person who seeks the answer to the question 'What should eat for good nutrition' might easily become lost in the maze of informational corridors, confused by the wealth of technical information provided by scientists or misled by simplistic answers provided by those with products to sell（凡是渴望找到“应该吃什么才会有良好营养”这一问题答案的人也许很容易会堕入复杂的知识迷宫，很容易被科学家所提供的丰富技术信息所迷惑，也很容易被售货员的三言二语弄得昏头转向）。该句是一个结构复杂的长句，主句的主语是“the person”。who seeks the answer to the question 'What should one eat for good nutrition' 为主语“the person”的定语从句，其中“What should one eat for good nutrition”是“the question”的同位语从句，说明“the question”。“might easily become lost”及被略去“might easily become”以后的“confused”和“misled”则是主句的三个并列谓语，其动词形式都是被动语态。

2.2 食品科技英语的翻译方法

普通英语翻译的方法包括直译与意译、增减词译法、词类转换法等等都适用于科技英语翻译中。同时，食品科技英语文献有其自身的特点，食品科技英语的翻译也应该有其独特的翻译方法和技巧。

例如：Until the factors operative in the thermal resistance of bacteria are understood, it will not be possible to control, other than by empirical means, the processes which are required for their success- the destruction of bacteria（直到认识到这些对细菌耐热性起作用的因素之后，人们才能用经验方法以外的方法来成功地控制杀菌过程）。该句是一个结构复杂的长句。主句的形式主语是“it”，其逻辑主语是不定式短语谓语是“to control…of bacteria”。主语的介词短语“other than by empirical means”为状语，修饰“control, the processes… of bacteria”是“control”的宾语。“Until the factors…are understood”是时间状语从句，作状语修饰主句中的谓语部分“will not be possible”。“Which”引导的从句是定语从句，修饰“the processes”。该从句中，“for their success”是状语，修饰从句谓语“require”，而“the destruction of bacteria”是从句“require”的宾语。

在大多数情况下，对于科技文章中出现的，通过复合、派生等构词方式形成的技术

术语，一般采用意译的方法进行翻译，而翻译的基础是对原文的思想内容有充分的理解。

例如：The term ‘fatis’ applicable to all triglycerides regardless of whether they are normally non-liquid or liquid at ambient temperatures. “油脂”一词适用于一切甘油三酸脂，而不论它们在室温下是固态或液态。

对于像计量单位、科技发明、材料、化学品名称等这样的技术术语，一般应使用音译法进行翻译。例如：The Maillard browning reaction occurs between a carbonyl found in a reducing sugar and an amine found in proteins and amino acids（美拉德褐变反应发生在还原糖羰基与蛋白质和氨基酸的氨基之间）。再如：cocoa（可可），ohm（欧姆），calorie（卡路里），joule（焦耳），nylon（尼龙），Vaseline（凡士林），sonar（声纳），quark（夸克），logic（逻辑）等。

对于有些技术术语来说，它们既有意译名，又有音译名，二者同时使用，翻译选择任何一个都可以。但应该注意到这样一种趋势，那就是意译逐渐取代音译。如：Fudge is a soft brown sweet that is made from butter, cream, and sugar（其中乳脂软糖（福奇糖）是由黄油、奶油和糖制备得到的柔软的、棕色的糖果）。再如：vitamin［维生素（意）/维他命（音）］，jelly［凝胶糖果（意）/啫喱（音）］，fondant［软糖（意）/方登糖（音）］，penicillin［青霉素（意）/盘尼西林（音）］，engine［发动机（意）/引擎（音）］，marshmallow［棉花糖（意）/马希马洛糖（音）］，laser［激光（意）/镭射（音）］。

此外，形译法也是科技词汇翻译常用的方法，此方法多用于用字母表示其外形的技术术语的翻译，可以选用近似该字母形状的汉语来翻译；也可保留原英文字母不作翻译，但保留的字母有时表示形状，有时表示概念，应注意区分。例如：T square（丁字尺），U steel（槽形钢），O ring（O 型环），A frame（A 型架），P/N region［P 区（电子不足区）/N 区（电子剩余区）］，L electron［L 层电子（原子核第二层电子）］。

有些技术术语在翻译中部分使用音译，部分使用意译，二者兼顾。例如：topology（拓扑学），motorcycle（摩托车），ampere meter（安培表），tannic acid（丹宁酸），neon sign（霓虹灯），Franklin antenna（弗兰克林天线），chocolate（巧克力）。

还有一些情况，在译文中直接用原英文，不作翻译，例如：Windows 98，Word 2000，Office star 等。

食品科技英语翻译具有其独特之处，主要表现在食品科技英语中出现的，通过复合、派生等构词方式形成的技术术语，一般采用意译，而准确的翻译要求对原文的技术内容、原理等科技因素有充分的理解这一点比普通英语文体要求与难度更大了一些。很多科技英语术语或词汇都看似普通英语，但往往具有另外的科技领域方面的含义，翻译起来必须随行就市，不能望文生义。总之，食品科技英语翻译既要熟悉普通英语的翻译方法和技巧，也要了解科技内涵，熟悉科技原理，掌握相关术语与准术语。

3 课后作业

3.1 句子翻译

(1) Food science has been defined as the application of the physical, biological, and behavioral science to the processing and marketing of foods.

食品科学可以定义为物理科学、生物科学和行为科学在食品加工及食品销售中的应用。

(2) All of these concerns fall within the realm of food science—a science that deals with the physical, chemical, and biological properties of foods as they relate to stability, cost, quality, processing, safety, nutritive value, wholesomeness, and convenience.

所有这些关注都落在食品科学领域——这是一门论述食品的物理、化学和生物性质的科学。而这些性质涉及食品的稳定性、成本、品质、加工、安全、营养价值、卫生和便利。

(3) For example, conditions suitable for sustaining residual life processes are of concern to food chemists during the marketing of fresh fruits and vegetables, whereas conditions incompatible with life processes are of major interest when long-term preservation of food is attempted.

例如，食品化学家关注在销售新鲜水果和蔬菜期间能维持残余生命的合适条件，当企图长期保藏食品时，主要关注的是与生命过程不相容的条件。

(4) Having before us a description of the attributes of high-quality, safe foods, the significant chemical reactions involved in the deterioration of food, and the relationship between the two, we can now begin to consider how to apply this information to situations encountered during the storage and processing of food.

已对高质量、安全食品的属性、与食品变质有关的重要化学反应以及两者之间的关系作了描述，目前我们能开始考虑如何将此信息应用于食品贮藏和加工期间出现的情况。

(5) Of greater interest is the fact that the thermal conductivity of ice at 0°C is approximately four times that of water at the same temperature, indicating that ice will conduct heat energy at a much greater rate than will immobilized water (e. g. in tissue).

最有意义的实验事实是在0℃时冰的热导率为同温下水的热导率的4倍，这意味着冰传导热能比非流动水（例如在组织中）快得多。

(6) The highly electronegative oxygen of the water molecule can be visualized as partially drawing away the single electrons from the two covalently bonded hydrogen atoms, thereby leaving each hydrogen atom with a partial positive charge and a minimal electron shield; that is, each hydrogen atom assumes some characteristics of a bare proton.

可以将水分子中电负性高的氧设想为从两个共价结合的氢原子部分地引取单个电子，

这样使得每个氢原子都带有部分正电荷，而且电子屏蔽达到最小，也就是说，每个氢原子具有一些赤裸质子的特性。

(7) Starch, lactose, and sucrose are digestible by humans, and they, along with D-glucose and D-fructose, and human energy sources, providing 70% ~80% of the calories in the human diet worldwide.

淀粉、乳糖和蔗糖是可被人消化的，它们同 D-葡萄糖、D-果糖一起，都是人类能源，为世界人类膳食提供 70% ~80% 热量。

(8) When aldoses or ketoses are heated in solution with amines, a variety of reactions ensue, producing numerous compounds, some of which are flavors, aromas, and dark-colored polymeric materials, but both reactants, disappear only slowly.

当醛糖或酮糖在胺溶液中加热时，各种各样反应接着发生，产生许多化合物，其中有些是风味物、香气以及暗色的高聚物材料，但是两种反应物消失非常慢。

(9) Maltose is produced during malting of grains, especially barley, and commercially by the specific enzyme-catalyzed hydrolysis of starch using β-amylase from Bacillus bacteria, although the β-amylases from barley seed, soybeans, and sweet potatoes may be used.

谷物（特别是大麦麦粒）发芽时产生麦芽糖，但是工业上采用杆菌属的细菌 β-淀粉酶催化淀粉的水解，尽管也可以使用来自于大麦种子、大豆和甜薯的 β-淀粉酶。

(10) Although gel-like or salve-like materials can be formed by high concentrations of particles (much like tomato paste), to form a true gel, the polymer molecules or aggregates of molecules must first be in solution, then partially come out of solution in junction zone regions to form the three-dimensional gel network structure.

虽然类凝胶或者膏状物质可由高浓度颗粒（例如番茄酱）形成，为了形成真正的凝胶，聚合物分子或者分子聚集体必须首先存在于溶液中，然后部分从结合区溶液中出来形成三维凝胶网状结构。

(11) Also, the amount of starch used in the preparation of food products, without counting that present in flours used to make bread and other bakery products, that naturally occurring in grains used to make breakfast cereals, or that naturally consumed in fruits and vegetables, greatly exceeds the combined use of all other food hydrocolloids.

淀粉存在于制造早餐谷物食品的谷物、制造面包和其他焙烤食品的面粉、水果及蔬菜中，制造食品产品消耗的淀粉量远远超过所有其他的食品亲水胶体。

3.2 Reading Material

Want to Live 100 Years? Eat Bulgarian Yoghurt

Lactobacillus bulgaricus sounds like a nasty infectious disease but the organism that curdles milk may be the reason Maria Shopova recently celebrated her 100th birthday. The lively cente-

narian, who kept a cow until she was 80, has lived on dairy products-yoghurt in particular-most of her life in the picturesque mountain village of Momchilovtsi in southern Bulgaria.

Now found at supermarkets around the world, it wasn't until the early 1900s that Russian scientist Ilya Mechnikov, a 1908 Noble Prize winner, linked yoghurt with longevity. He compiled statistics from 36 countries to discover more people lived to the age of 100 in Bulgaria than in any other. He attributed this to the country's most traditional food-home-made yoghurt. Later, numerous scientific studies in Europe, Japan and the United States proved the bacteria in yoghurt help maintain good health by protecting the human body from toxins, infections, allergies and some types of cancer.

The traditional Bulgarian yoghurt is a unique product because of Bulgaria's unique microclimate. It has its own specific taste and properties. It is sour and thick so that when you turn the pot over, yoghurt sticks and does not fall. Bulgaricus can grow only in Bulgaria, elsewhere it mutates. The strains of Bulgaricus are found in soil, on some trees'bark, in blossoms and even in ant-hills in Bulgaria's most environmentally clean regions such as Momchilovtsi in the southern Rhodopa Mountains. Experiments showed that a wooden stick left over an ant-hill for a while and then dipped into boiled and cooled milk would ferment and turn into yoghurt, as would antique silver coins. A good source of vitamin B, calcium and protein, yoghurt's virtue as a health food has defined do you mean 'defied' time? Time. Apart from having a reputation for being kind to the digestive system, it is also an excellent face cleansing mask, a soother for sunburn and douche for a thrush attack. Numerous researches have shown that fermented milk has strong anti-tumor effect, which is due to its lactic acid bacteria. International food giants such as France's Danone, Swiss Nestle and Japan's Meiji milk Products have been using friendly bacteria to produce health food known as probiotics over the past few decades.

Economy Ministry officials told Reuters Sofia wanted the World Trade Organisation to prevent other countries from describing their yoghurt as 'Bulgarian' or 'Bulgarian-style'. 'It is going to be the food of the new millennium, the world is gradually getting crazy about healthy food' said Georgiev.

想当百岁寿星吗？喝保加利亚酸奶

保加利亚乳酸杆菌虽然听起来是一种讨厌的传染病菌，然而这种使牛奶凝集的微生物可能就是玛利亚·绍波娃不久前庆祝她百岁华诞的理由。这位精力旺盛的百岁老人居住在保加利亚南部莫姆奇洛夫齐风景如画的山村里。老人在80岁前饲养了一头奶牛，一生大部分时间都以乳制品（特别是酸奶）为主食。

直到20世纪初，1908年诺贝尔奖获得者、俄罗斯科学家伊利亚·米奇尼科夫才把酸奶和长寿联系起来。如今酸奶在世界各地超市上比比皆是。随后，欧洲、日本、美国均以大量的科研成果证明酸奶内的细菌能保护人体免受毒素、过敏症以及某种癌症的侵袭，

从而保持良好的健康状况。

由于保加利亚独特的小气候，所以制成的这种传统的保加利亚酸奶也是一种独特的食品。这种酸奶的味道和特性均不同于一般。它既酸又浓，即使把奶瓶倒过来，酸奶依然黏在瓶上不会落下。保加利亚乳酸杆菌只能在保加利亚本国培养，在别处就会引起突变。在保加利亚环境最洁净的地区，如罗多手帕山脉南部的莫姆奇洛夫齐的土壤里、某几种树皮上、盛开的花丛中、甚至蚁丘内均已发现有保加利亚菌株。实验显示，将一根木棍在蚁丘上放一会儿，再浸入煮沸并放凉了的牛奶中，就会使牛奶发酵而将其转化为酸奶，就像古代银币的作用一样。酸奶是维生素 B、钙和蛋白质的可靠来源，作为一种保健食品，它的优点是经受得住时间考验的。酸奶除了以有利于消化系统而著称外，也是清洁面部极好的面膜、晒斑的缓解剂和鹅口疮的冲洗物。许多研究人员已指出，发酵牛奶之所以具有极强的抗癌效果，乃是由于其乳酸菌的作用。国际食品业巨头如法国达能、瑞士雀巢和日本明治乳制品等，过去几十年来一直利用有益健康的细菌生产所谓的益生菌保健食品。

保加利亚经济部官员告知路透社，索菲亚当局要求世界贸易组织（WTO）制止其他国家将它们国内生产的酸奶说成是“保加利亚的”或“保加利亚式”酸奶。格奥尔基耶夫说：“酸奶将成为新千年的食品，世界逐渐对保健食品益发迷恋”。

3.3 相关阅读资料链接

[1] http://iddba.org

Unit 2 Introduction to Research Paper Writing in Food science and technology

1 课文

食品科技论文是食品专业以及相关工作和研究人员相互交流的重要媒介，在互联网迅速普及，英语已经成为国际性语言的今天，食品专业大学生有必要熟悉英语食品科技论文的写作规范，以便为今后的学习深造和研究工作打下一定的基础。

文章一般都是由段落构成，食品科技论文也不例外，写好段落是写好食品科技论文的基础。

1.1 Basic Elements of the Paragraph

段落有长有短，但一般由主题句（Topic Sentence）、支撑句（Supporting Sentences）和结论句（Concluding Sentence）三个部分组成。

1.1.1 Topic Sentence

主题句是一个段落中最重要的句子，它用来阐述段落的中心思想，同时也指出了这一段文字内容的发展方向与方式。作为科技英语的段落写作往往把主题句放在段首，然后通过扩展细节和提供依据对主题句的内容进行论述。有时主题句也可放在中间或结尾，甚至没有明确的主题句，而是隐含在段落内容中。

主题句的结构通常包括两个都分，即中心议题（Topic/Subject Part）和控制部分（Controlling Idea）。主题句的中心议题是该段文字所要涉及的人、事或问题，整个段落的文字内容都要围绕着这个人、这件事或这个问题展开；控制部分是决定该段文字的发展方向或扩展方法，它可能是一个词、短语或从句。

1.1.2 Supporting Sentences

支撑句也叫扩展句（Developing Sentences），用来对主题句作具体阐述。在扩展句中所要使用的是事实、理由、原因、说明、图表、比较、对比、定义等方式来阐述主题句中控制部分的思想内容。一个段落一般都有两个以上的支撑句，从而可以从多个方面支撑和说明主题句。

1.1.3 Concluding Sentence

结论句主要用来总结要点和提出供读者思考的一些见解等，同时表明段落的结束。要写结论句，就要抓住主题句中的关键词，或回答主题句中所暗示的提问。要总结一段

的要点，有时会用到 to sum up，in short，in conclusion 等词组或词汇。需要指出的是，结论句并不是在所有的段落文体中均要表示出来。

1.2 Key Features of the Paragraph

1.2.1 Unity

一段好的文字最重要的特点是一致性，意思是一个段落只能有一个主题，段落中的所有句子都是用来解释和说明这个主题的。一切与该段落无直接关系的句子都不应该包括在其中，如果一个段落中包含了与主题无关的句子，就意味着该段落缺乏一致性。

1.2.2 Coherence

连贯性就是要在一段文字中将所有的句子清楚地、有逻辑地并按先后顺序联系在一起，共同说明这一段的主题。如果说一致性主要与段落内容相关，那么连贯性则主要关系到段落的形式或组织，写作手法上可采用按重要性顺序、时间顺序、空间顺序、实验过程、分类标准、因果关系、比较和对照、演绎和归纳法等展开段落。另外，通过使用相应的过渡词或短语可更好地把全段的意思连贯起来。

1.2.3 Completeness

所谓段落的完整性体现在两个方面，一是在内容上完整，按照主题句所要求表示的内容来提供具体、翔实和具有说服力的事实，充分说明段落的主题，从而满足读者的需求；二是在形式上完整，要运用好各种写作技巧，使文章段落结构严谨，一般应包含主题句、支撑句和结论句三个基本成分。段落的完整性不是用字数多少来进行衡量，如果主题句限制的内容较小，所写的段落就应较短；如果主题句限制的内容较大，那么该段的文字也就会较长。

2 The Paper

食品科技论文主要部分包括引言、材料与方法、结果与讨论、结论等几部分，在此之后的辅助部分一般还有致谢、参考文献和附录等。

2.1 Main Elements of the Scientific Paper about Food

2.1.1 Introduction

引言又称前言或绪论，是食品科技论文正文的第一部分，主要内容包括主题和目的，前人在本领域内的研究情况，必要的背景知识，以及本课题的研究价值和意义等，通过引言的初步介绍使读者便于阅读文章。例如：

It has been suggested that an intake of potassium below 70 ~ 120 mmol/day may encourage the development of several diseases, such as hypertension, cardiovascular diseases and osteoporosis (Morris et al. 2006). Raising dietary potassium has been shown to reduce blood pressure (Whelton et al. 1997) even at a low supplementary level and in young normotensive individuals (Naismith and Braschi 2003).

From an analysis of the urinary excretion of potassium, it is reported that 84% of females and 66% of males do not reach the Reference Nutrient Intake of 90 mmol/day. Furthermore 27% of females and 17% of males consume less than 50 mmol/day, the Lower Reference Nutrient Intake (Henderson et al. 2003). Potassium inadequacy is particularly striking in the elderly (Bates et al. 1999) and amongst the poorest members of the population (Smith and Brunner 1997; Henderson et al. 2003), and has also been noted in young people (Gregory and Lowe 2000).

The aim of the present study was to explore the extent to which NaCl in white bread could be reduced and the potassium content raised, and to assess the bioavailability of the potassium incorporated in bread. To this end, acceptability trials employing various salts of potassium partially substituting wheat flour with Defatted soy flour (DSF) or a combination of both were carried out. This was followed by a feeding study to estimate the bioavailability of supplemental potassium added to a standard bread formula.

上面几段引言中，第一段介绍了论文研究的一些背景知识，即钾摄取量与某些疾病的发病率存在很大关系；第二段介绍前人在本领域内的研究情况，据报道的结果发现人群中缺钾比例很高，尤其是老年人和穷人；第三段是介绍针对以上提到的缺钾问题，本研究的目的是探索在白面包中减少氯化钠的量，提高钾盐的量，并简述了实现的手段。

2.1.2 Materials and Methods

材料与方法部分主要包括实验条件、材料、设计或使用的方法等。一般是先交代试验的时间、地点、材料、数量、条件、环境；然后描述实验的设计、基本过程和步骤；最后还要说明本试验的统计方法。如果偏理论模型的研究，要说明各参数、假设和理论模型，以便在后文中讨论。材料与方法写作时可以根据情况列出相应的小标题，例如：

Plant materials

Individually quick-frozen (I. Q. F.) strawberries (Fragaria anannassa cv., Totem) were supplied by Conroy Packing Inc. (Salem, OR). Orange nasturtium flowers (Tropaeolum majus) were collected from local gardens during the summer season (Corvallis, OR). Stems and leaves were separated from the petals, which were then frozen with liquid nitrogen. Red radishes (Raphanus sativus L. cv., fuego) were obtained from the local market in Corvallis, OR. The radishes were peeled manually; the peel was washed and frozen under liquid nitrogen. All frozen materials were stored at −23℃ until further processing.

Chemicals and reagents

Glycerol was supplied by Mallinckrodt Chemical, Inc. (Paris, KY), citric acid monohydrate was purchased from J. T. Baker (Phillipsburg, NJ), sodium citrate was obtained from Archer Daniels Midland (Faries Parkway, Decatur, IL), sodium benzoate was purchased from Chemical Works (St. Louis, MO), and potassium sorbate was acquired from Monsanto Company (St. Louis, MO).

Microbiological analysis

Sausage samples (10 g) were homogenized with 90 ml maximum recovery diluent (LAB M, Bury, UK) using a laboratory blender, (Stomacher 400, Seward, London, UK) for 2 min and decimal dilutions prepared. Lactic acid bacteria (lactobacilli) counts were determined by the overlay technique using MRS agar (LAB M, Bury, UK) and colonies counted after incubation at 30℃ for 5 days. The numbers of staphylococci were determined on Baird-Parker agar (LAB M, Bury, UK) supplemented with Egg Yolk Tellurite Emulsion (Oxoid, Hampshire, UK) after incubation at 37℃ for 2 days; and black colonies were counted.

Statistical analysis

Data were analysed using the Statistical Analysis System (SAS, 1990). To compare drip loss and colour measurements for different pH and CO_2 'snow' treatment, the General Linear Models procedure was used to perform analysis of variance. Significance level was set at $P<0.05$.

上面摘录的几段食品科技论文中有关材料与方法的内容，第一段介绍了试验材料，第二段是化学药品和试剂，第三段是研究中采用的微生物分析方法，第四段是数据统计分析方法。

材料与方法是食品科技论文中较容易写作的部分，基本要求是既完整又简洁，使专业同行根据你写的内容能够重复你的实验过程，同时还可以评价你实验结果的科学性。在时态和语态方面，主要使用一般过去时和被动语态，因为所叙述的是已经发生过的客观事实。

2.1.3 Results and Discussion

结果与讨论是食品科技论文的主要部分，篇幅往往要占全文的一半以上。这一部分也可以将“Results”和“Discussion”两个部分分别写，特别是在结果和讨论可以明显区分开的情况下。结果部分主要是报告你的研究发现，所以应当全面客观，适当使用图表可使结果的报道更为简洁、有效和直观。讨论部分主要是对试验结果的阐释，与前人研究的比较，以及本研究的局限性等，要注意分析实验结果的机理。例如：

The effects of the incorporation of three different commercial starch samples into the bread formulation were investigated in this research. Resistant starch (RS) contents of the HylonVII, Novelose330 and CrystaLean samples were 59.8%, 46.4% and 44.9%, respectively.

Loaf volume values and quality characteristics of the breads supplemented with different levels of the commercial starch samples are presented in Table II. Loaf volume values of HylonVII-supplemented and CrystaLean-supplemented breads did not show significant differences as the addition level increased up to the 20% supplementation level. Significant decreases were observed in the loaf volume values of the Novelose330-supplemented breads above the 10% replacement level ($P<0.05$).

Firmness values and RS contents of breads supplemented with different levels of commercial starch samples are presented in Table III. Within each storage day, the firmness values of HylonVII-supplemented and CrystaLean-supplemented bread samples did not significantly change up to the 20% addition level, but Novelose330 addition caused increases in firmness values above the 10% level. Although at 7 days of storage the firmness values of the breads increased with increasing levels of starch supplementation, there were no statistically significant differences between the firmness values of the starch-supplemented breads (all levels) and control bread (0%) within each commercial starch supplementation group. Their firmness values were all high (including the control samples) and significantly higher than day 1 values, probably due to staling during extended storage.

在上面几个有关结果与讨论的段落中，第一段介绍了三种商业淀粉样品中抗性淀粉的含量。第二段介绍了表 2 中添加不同量的三种商业淀粉产品后面包体积的变化情况。第三段介绍了表 3 中添加了不同商业淀粉样品后面包的硬度与抗性淀粉含量随面包贮藏时间之间的变化关系。在用文字介绍研究结果时，切记完全重复图表中的内容，要注意突出重点。

针对文中不同的试验或不同的研究模型，可以在结果和讨论中加入小标题分别加以论述。有时，在结果和讨论的最后就结束论文，因为在分析讨论本试验或研究的各项结果时，结论就已经得出了。

2.1.4 Conclusions

结论是文章逻辑发展的必然和自然结果，是作者通过正文的论述而形成的总的观念。结论应该全面、明确、合乎逻辑，但要突出论文的发现，它可以让读者在此基础上进一步思考或做进一步研究。例如：

The findings of this study show that indigenous enzymes are primarily responsible for the initial degradation of the sarcoplasmic proteins. However, bacterial enzymes also contributed to the initial breakdown of myofibrillar proteins, particularly myosin and actin. Furthermore, the RP-HPLC profiles showed that the release of hydrophilic 2% TCA-soluble peptides from both protein fractions was due to indigenous proteinases, while bacterial peptidases contributed significantly to the release of free amino acids. This study has also conclusively shown that many small hydrophil-

ic peptides produced in fermented sausages originate from both the sarcoplasmic and myofibrillar proteins.

This study has demonstrated that common salt in white bread may be significantly reduced with the substitution of both chloride and non-chloride salts of potassium without compromising acceptability. This change in the dietary sodium-potassium ratio would have a beneficial effect on blood pressure. Similar modifications to the composition of popular processed foods that contribute a considerable amount of sodium to the diet might also be considered.

在上面这两个结论段中，第一段重点列举了本研究的主要发现，第二段在总结论文研究发现的基础上，最后一句自然地提出了合理的建议。

结论部分一般加标题 Conclusions，也有的不加结论标题，而在 Results and Discussion 中加以论述，得出结论。一般来说，这一部分只有一两小段的长度。

2.2 Supplementary Elements of the Scientific Paper about Food

2.2.1 Acknowledgements

感谢一般写在正文之后，由于科学研究工作常常不是一个人或几个人的力量所能完成的，有时需要有关单位和个人的指导和支援，所以这一部分是作者向为本研究提供帮助、指导、资助的单位和个人表示感谢。例如：

The authors would like to thank Dr Fabien Puglia and Jaqueline Wynne for their help with blood sampling, Dr Hooshang Izadi for statistical advice, and all our volunteers for taking part.

The authors gratefully acknowledge the enthusiastic interest in the work and the skilled assistance of Annette A. M. Spanjer, Hanne L. M. Tjeerdsma-van Bokhoven, and Gert Keizer. Many thanks to Dr. Maria Schipper for her guidance and support with the statistical analysis. (space) This study was partly financed by Senter at The Hague.

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常用来表示感谢的表达式有 "would like to thank…for…, be grateful to…for…, Many thanks to…for…, supported by…, acknowledge…" 等。

2.2.2 References

根据英语科技论文写作的规定，凡是引用其他作者的文章、观点或研究成果，都应

标明，并在参考文献栏中说明出处。参考文献可以引用杂志论文、专利、毕业论文、专著及未出版的著作。引用要完整、清楚，以便读者需要阅读该文献时可以找到。参考文献顺序的排列有两种形式。一种是按姓的首字母在字母表中的顺序进行排列；另一种是按在正文中引用的顺序排列。

(1) 按姓的首字母顺序排列

这是一种传统的排列方式，论文正文中不注明引文号码，在参考文献中依照作者的姓的首字母顺序排列，不编号码。例如：

Abers, J. , &Wrolstad, R. E. (1979). Causative factors of color deterioration in strawberry preserves during processing and storage. Journal of Food Science, 44(1), 75-81.

Baublis, A. , Spomer, A. , &Berber-Jimenez, M. D. (1994). Anthocyanin pigments: comparison of extract stability. Journal of Food Science, 59(6), 1219-1221, 1233.

Cemeroglu, B. , Velioglu, S. , &Isik, S. (1994). Degradation kinetics of anthocyanins in sour cherry juice and concentrate. Journal of Food Science, 59, 1216-1218.

Erlandson, J. A. , &Wrolstad, R. E. (1972). Degradation of anthocyanins at limited water concentration. Journal of Food Science, 37(4), 592-595.

(2) 按数字标号列出的参考文献

论文中的引文出处按出现先后编上号码，所列出的参考文献应与论文中标注的顺序一致。例如：

[1] L. Lehane, J. Olley, Histamine (Scombroid) Fish Poisoning: a review and risk-assessment framework, National Office of Animal and Plant Health, Canberra, Australia, 1999.

[2] W. F. Staruskiewicz, E. M. Waldron, J. F. Bond, J. AOAC. 60 (1977) 1125.

[3] V. Frattini, C. Lionetti, J. Chromatogr. A. 809 (1988) 241.

[4] M. T. Salazar, T. K. Smith, A. Harris, J. Agric. Food Chem. 48 (2000) 1708.

不论哪种排列法，都要规范一致，不能混用。投稿时，必须按照所投刊物要求的文献规范排序。

2.2.3 Appendix

附录一般放在论文的最后。与论文主题关系密切，但如包括在正文中会影响文章的连贯性的内容可放在附录内，这些内容包括复杂的计算、公式的推导、校核用的数表等项目。如果附录不止一个，可用 Appendix A 或 I，Appendix B 或 Ⅱ 等对其编号。

附录并不是每篇论文必备的，食品科技论文中大都没有附录，这一部分在有的论文中放在“致谢”之后。

Unit 3 The Writhing of Title, Abstract and Chart Title in Food Science and Techwology English Papers

1 英文标题的写作

标题又称题名或题目，是文章的总纲，是能反映文章最重要的特定内容的词语逻辑组合，它是一篇论文给出的涉及论文范围与水平的第一个重要信息。为便于检索，标题一定要含有反映文章内容的关键词。论文标题十分重要，必须用心斟酌选定。对论文标题的要求是：准确得体，恰当反映所研究的范围和深度，避免过于笼统，题不扣文；简短精炼，一般为 8～15 个英文实词；外延和内涵恰如其分；醒目，不使用非共知公认的缩写词、字符、代号等。

1.1 标题的结构

英文标题以短语为主要形式，尤以名词短语最常见，即标题基本上由一个或几个名词加上其前置和（或）后置定语构成。例如：Advances in immunotherapy for food allergy（食物过敏免疫疗法研究进展），Principles of food safety risk management（食品安全风险管理原则）。短语型题名要确定好中心词，再进行前后修饰，各个词的顺序很重要，词序不当会导致表达不准。对于较长的标题，可采取增加副标题的形式作补充解释以缩短主标题的长度。如：Consumer preferences and willingness to pay for food labeling: a discussion of empirical studies（关于消费者对食品标识的偏好与支付意愿的实证研究探讨）。对于一些研究型论文，名词短语的标题不能给读者一个确切的观点，需要读者去阅读文章，而陈述句构成的标题能更准确地表达作者的观点和文章的结论，让读者和编者一目了然。如：Standardised Mangifera indica extract is an ideal antioxidant（标准化的芒果提取物是一种理想的抗氧化剂）。少数情况（评述性、综述性和驳斥性）下可以用疑问句做题名，因为疑问句可有探讨性语气，易引起读者兴趣。例如：Can guava fruit intake decrease blood pressure and blood lipids（番石榴摄入能够降血压血脂么）。

1.2 标题的字数

对于综述类论文，标题应确切、简练、醒目，在能准确反映论文特定内容的前提下，词数越少越好，一般不宜超过 10 个英文实词。而对于研究类论文，虽然对其标题的要求与综述类论文一致，但由于现代的高水平研究涵盖的内容越来越多，简单的几个词已经难以表达论文的主题，因此现代的研究性论文所用词数有大幅增加的趋势。最近几年发表的研究类论文，其英文实词数一般为 13～15 个，远大于十九世纪五、六十年代论文的 8～12 个。

1.3 标题中的大小写

标题字母的大小写有以下三种格式：①全部字母大写，例如：NMR STUDY OF HYDRATION OF NAVY BEAN DURING COOKING（菜豆烹调时水合作用的核磁共振研究）。②每个词的首字母大写，但三个或四个字母以下的冠词、连词、介词全部小写。例如：Assessing Caffeine Intake in the United Kingdom Diet（英国日常饮食中咖啡因摄入的评估）。③标题第一个词的首字母大写，其余字母均小写，例如：In vitro antioxidant properties of rutin（芦丁的体外抗氧化特性）。一般采用第二种格式。

1.4 标题实例

1.4.1 综述类标题

（1）A review of the health benefits of raisins

葡萄干健康益处的综述

（2）An overview of citric acid production

柠檬酸生产综述

（3）Brazil nuts and associated health benefits: A review

巴西胡桃及其相关健康益处的综述

（4）Advances in rapid detection techniques for fish meat

鱼肉鲜度快速检测技术研究进展

（5）Recent advances in phosphorylation of food proteins: A review

食物蛋白磷酸化近期研究进展综述

（6）Research development of beer staling flavor evaluation

啤酒风味老化评价的研究进展

（7）Research progress of phenylalanine ammonia lyase

苯丙氨酸解氨酶（PAL）的研究进展

（8）Newest research on Saccharomyces cerevisiae in fermentation

酿酒酵母 S. cerevisiae 发酵研究新进展

（9）Perspectives for chitosan based antimicrobial films in food applications

壳聚糖抑菌膜在食品中的应用前景

（10）Current trends in traditional Turkish meat products and cuisine

传统土耳其肉制品及其烹饪的现状

（11）Research status and the trend of development of sweetness agent

甜味剂的研究现状和发展趋势

（12）Present situation and application prospect of immersion chilling and freezing in food

processing

直接浸渍冷冻在食品加工中的应用现状与前景

(13) Mechanisms of oxidative browning of wine

葡萄酒氧化褐变的作用机理

(14) Applications for supercritical fluid technology in food processing

超临界流体技术在食品加工上的应用

(15) Rheological properties of milkfat and butter

乳脂与黄油的流变学特性

(16) Chemistry and reactions of reactive oxygen species in foods

食品中活性氧的化学过程与反应

(17) Coffee and its consumption: benefits and risks

咖啡及其消费：益处与风险

(18) Antioxidant activity of proteins and peptides

蛋白与肽的抗氧化活性

(19) Physiological function and application of milk basic protein

乳碱性蛋白的生理学功能及应用

1.4.2 研究类标题

(1) Studies on cake quality made of wheat-chickpea flour blends

小麦-鹰嘴豆混合面蛋糕质量研究

(2) Preliminary study of the production of apple pomace and quince jelly

苹果渣与柑橘果冻生产的初步研究

(3) Pharmacokinetic study of mangiferin in human plasma after oral administration

口服后芒果苷在人血浆中的药物代谢动力学研究

(4) A comparative study of lipid and hypochlorous acid induced oxidation of soybean proteins

油脂与次氯酸诱导大豆蛋白氧化的比较研究

(5) In vitro antioxidant study of vegetable oils containing conjugated linolenic acid isomers

含有共轭亚麻酸异构体的蔬菜油脂的体外抗氧化研究

(6) Research on the preparation of antioxidant peptides derived from egg white with assisting of high-intensity pulsed electric field

高强脉冲电场辅助蛋白抗氧化肽的制备研究

(7) Analysis of nutrient and antinutrient content of underutilized green leafy vegetables

未充分利用绿叶蔬菜的营养及抗营养成分分析

(8) Investigation of α-glucosidase inhibitory activity of wheat bran and germ

麦麸与胚芽的 α-葡萄糖苷酶的抑制活性调查

(9) Evaluation of quality during storage of apple leather

苹果泥干储藏期间的质量评价

(10) Detection of H_2O_2 in food samples by FTIR

食物样品中过氧化氢的傅里叶变换红外光谱检测

(11) Determination of melamine concentrations in dairy samples

乳样品中三聚氰胺浓度的测定

(12) Assessment of the melatonin production in pomegranate wines

石榴酒中褪黑素生成的评估

(13) Extraction of α-tocopherol and γ-oryzanol from rice bran

米糠 α-生育酚与 γ-谷维素的提取

(14) Purification of soluble rice bran fiber using ultrafiltration technology

超滤法米糠可溶性纤维的纯化

(15) Classification of Italian honeys by mid-infrared diffuse reflectance spectroscopy

中红外漫反射光谱法分类意大利蜂蜜

(16) Effects of extraction solvent on wheat bran antioxidant activity estimation

萃取剂对麦麸抗氧化活性评估的影响

(17) Influence of flour particle size on quality of gluten-free rice bread

面粉颗粒大小对无谷蛋白大米面包质量的影响

(18) The impact of Ca^{2+} combination with organic acids on green tea infusions

钙离子与有机酸结合对绿茶汤的影响

(19) Properties of extruded expandable breadfruit products

面包果挤压膨化产品的特性

(20) Characterization of juice in fruits of different *Chaenomeles* species

不同木瓜果实汁液的特征描述

(21) Use of a free radical method to evaluate antioxidant activity

使用一种自由基方法来评估抗氧化活性

(22) Relationship of acid phosphatase activity and Brix/acid ratio in cherries

樱桃中酸性磷酸酶活性与糖酸比的关系

(23) Modifications of Kyoho grape berry quality under long-term NaCl treatment

长期氯化钠处理调控巨峰葡萄果实质量

(24) Distribution of carotenoids in endosperm, germ, and aleurone fractions of cereal grain kernels

类胡萝卜素在谷粒的胚乳、胚芽及糊粉层中的分布

(25) Removal of three kinds of phthalates from sweet orange oil by molecular distillation

分子蒸馏法除去甜橙油中三种邻苯二甲酸盐

(26) Optimization of process parameters for continuous kheer-making machine
连续式乳粥生产机的工艺参数优化

(27) Evolution of quality parameters during red wine dealcoholization by osmotic distillation
红酒渗透蒸馏脱醇过程中质量参数的演变

(28) Flavour and texture changes in apple cultivars during storage
储藏中不同苹果品种的风味与质地变化

(29) Protein enrichment and its effects on gluten-free bread characteristics
蛋白强化及其对无谷蛋白面包特性的影响

(30) An innovative technique for extending shelf life of strawberry: Ultrasound
延长草莓货架期的创新方法：超声

(31) Dietary fiber from orange byproducts as a potential fat replacer
柑橘副产物来源的膳食纤维作为潜在的脂肪替代物

(32) Quick cooking rice by high hydrostatic pressure processing
高静水压法速煮米饭

(33) Assessing caffeine intake in the United Kingdom diet
英国饮食的咖啡因摄入评估

(34) Optimizing the texture and color of sous-vide and cook-vide green bean pods
优化真空烹调与厨师烹调绿豆荚的质地与颜色

(35) Modelling of the aqueous debittering process of Lupinus mutabilis Sweet
南美五彩羽扇豆水相脱苦过程建模

(36) Tuning color variation in grape anthocyanins at the molecular scale
在分子尺度调校葡萄花青素的色差

(37) Structuring lipids by aggregation of acidic protein microspheres in W/O emulsions
在油包水乳状液中酸性蛋白微球聚集法构建脂肪

(38) Melatonin is synthesised by yeast during alcoholic fermentation in wines
葡萄酒中酵母在酒精发酵过程中合成褪黑素

(39) Curcumin inhibits invasion and metastasis in K1 papillary thyroid cancer cells
姜黄素抑制乳头状甲状腺癌 K1 细胞的侵袭和转移

(40) Essential rosemary oil protects testicular cells against DNA-damaging effects of H2O2 and DMNQ
迷迭香精油保护睾丸细胞对抗过氧化氢与二甲萘醌（DMNQ）引起的 DNA 损伤

2 英文摘要的写作

摘要又称概要、内容提要，作为题目的补充对论文的内容进行准确、扼要的表达，不加解释和评论，使读者能够了解整篇论文的梗概并判定是否需要通读全文，并为科技

情报文献检索数据库的建设和维护提供方便。几乎所有公开发表的科技论文都要有短小简洁的英文摘要，这是食品科技论文的一般要求。不仅英文论文如此，国内大多数中文科技论文也要求提供英文摘要。此外，论文的关键词是情报检索语言中的一个组成部分，其质量直接影响论文在情报检索系统中的检索效率，一般在科技论文的摘要之后列出4～6个关键词。

2.1 摘要的特点

摘要的特点可以用三个字来概括：全、短、精。全是指摘要应是一篇相对独立的短文，应完整的揭示论文的主要内容；短是指摘要要尽可能言简意赅；精是指摘要应是原文的精华，也就是说它具有完整独立性、高度浓缩性和客观准确性。

2.2 摘要的结构和内容

（1）研究的目的（Objectives or Purposes）

包括研究、研制、调查等工作的前提、背景和任务等，一般在摘要的开头用一到两句话简洁地概括研究范围及目的或研究背景。如：This study examined the effects of freezing temperature and duration of frozen storage on lipid and protein oxidation in chicken leg and breast meat（本研究检测了冷冻温度与冻藏时间对鸡腿及鸡胸肉脂肪与蛋白氧化的影响）。在一些专业性较强的科技刊物论文的英文摘要中，研究目的这一部分常常被略去，把它放在论文的引言中，从而使论文摘要更加精炼。

（2）过程与方法（Process and Methods）

介绍研究的内容和试验过程，包括所用的原理、对象、方法、材料、工艺、手段、装备和软件等。例如：The meat was frozen at three different temperatures（-7，-12 and -18℃）and then stored at -18℃ for up to 6 months（肉在-7，-12 与-18℃3 个温度下冷冻，然后在-18℃条件下冷藏到6个月）。

（3）结果或发现（Results or Findings）

实验或研究所取得的成果，包括观察、实验、研究的结果、数据或发现，得到的效果、性能等。如：A significant effect of frozen storage duration on lipid oxidation was detected in leg and breast meat，whereas freezing temperature had no significant effect.（冻藏时间对腿肉与胸肉的脂类氧化作用显著，而冷冻温度影响不大）。In leg meat，freezing at -7℃ had a significant impact on protein oxidation，measured as the increase in carbonyl groups and the decrease in total sulphydryl groups，after 3 months of frozen storage（冻藏3个月时，-7℃冷冻对腿肉蛋白氧化的影响显著，蛋白氧化检测羰基的增加与总巯基的减少）。

（4）结论或推论（Conclusions or Inferences）

结果的分析、比较、评价、应用，以及存在的问题，今后的课题、启发、建议和预测等。如：Lipid and protein oxidation appeared to occur simultaneously in chicken meat during

frozen storage and was more intense in leg meat than in breast meat（在鸡肉冻藏过程中，脂类与蛋白的氧化似乎同时发生，且在腿肉中比在胸肉中更剧烈）。

2.3 摘要的分类

（1）报道性摘要（Informative Abstract）

也常称作信息性，摘要或资料性摘要，其特点是全面、简要地概括论文的目的、方法、主要数据和结论。通常，这种摘要可以部分地取代阅读全文。

（2）指示性摘要（Indicative Abstract）

也常称为说明性摘要、描述性摘要（Descriptive abstract）或论点摘要（Topic abstract），一般只用二三句话概括论文的主题，而不涉及论据和结论，多用于综述、会议报告等。该类摘要可用于帮助潜在的读者来决定是否需要阅读全文。

（3）报道-指示性摘要（Informative-indicative Abstract）

是将原始文献中信息价值高的部分写成报道性摘要，其余部分则写成指示性摘要，起到检索、报道作用。它兼具报道性文摘和指示性文摘二者特点。

（4）结构式摘要（Structured Abstract）

是报道性摘要的改良版，是将报道性摘要结构化，使其重点突出、条理分明、内容完整，因而近年来被很多杂志所采用。如 Journal of the Science of Food and Agriculture 杂志的结构式摘要分为三部分：背景（Background）、结果（Results）与结论（Conclusion），而 European Journal of Nutrition 杂志的结构式摘要则沿用报道型摘要的四要素：目的（Purpose）、方法（Method）、结果（Results）与结论（Conclusion）。每一部分在文中要用醒目的字体（黑体、全大写或斜体）直接标出，相当于小标题，利于检索和查看。

2.4 摘要的人称

因为摘要是论文不加注释和评论的简短陈述，所以论文的英文摘要撰写多使用第三人称，如：the paper，the essay，this thesis，the author，this study；在需要使用第一人称时，用范指 we，而不用 I。而目前的倾向是采用更简洁的被动语态或原形动词、介词短语、分词或分词短语作为摘要的开头，如：In order to，Based on，On the basis of，By using /analyzing，From the view of，As an example of，With regard to，To understand /overcome /enhance /investigate /analyze /seek，Taking advantage of，Compared with 等。

2.5 摘要的时态

英文摘要的时态以一般现在时、一般过去式为主。一般现在时用于说明摘要开头的研究目的、研究内容与摘要结尾的结论和讨论部分，如：The aim of this study is to investigate the influence of certain factors on the yield，antioxidant activity（AA）and total phenolic content（TPC）of guava leaf extract（本研究的目的是调查某些因素对番石榴叶提取物的产

量、抗氧化活性与总酚含量的影响）。一般过去时用于叙述撰写论文前已完成的工作，如过去某时期的发现、实验、观察、调查、分析等过程，因此常用于摘要中的研究过程和研究结果两部分，如：The effects of pretreatment of leaf sample prior to extract, extraction method, and the leaf age were investigated（调查了提取前预处理、提取方法与叶龄的影响）。

2.6 摘要的语态

英文摘要的语态应视具体情况而定。在不考虑动作的实施者、强调研究结果时采用被动语态，如：The production of low-temperature thermally-dried cells of Saccharomyces cerevisiae at 32℃ is examined in the present investigation（研究了在32℃条件下低温热干燥酿酒酵母细胞的生产）。而由于主动语态较被动语态表达更鲜明有力、严谨易懂，近年来主张摘要中尽量采用主动语态的言论越来越多，特别是在表达作者观点或引用有关专家的观点时，如：We have successfully developed a new process for manufacturing guava leaf tea with a unique polyphenolic profile（我们已经成功地开发出了一种新的含有独特多酚组成的番石榴叶茶的加工工艺）。

2.7 摘要的篇幅

对于英文摘要的篇幅，不同组织的要求不同。国际标准化组织（ISO）建议不少于250个词，最多不超过500个词。美国化学文献和医学文摘规定在300个词以内，而学术会议常要求500个词。根据中国科学技术期刊文献数据库英文版（CSTA）的要求，文摘长度以50～150词为宜。美国工程索引（EI）中国信息部要求报道性摘要一般不超过150词，不少于100词。为使英文摘要的撰写与国际接轨，一般要求指示性摘要与报道-指示性摘要以100～150词为宜，而报道性摘要与结构式摘要长度最好为250～300词。

2.8 常用句型

（1）表示研究目的

The（primary）purpose of this study（paper）is to …

本研究（本文）的（主要）目的是 …

The object（aim）of this study（the present research）is to …

本研究旨在 …

This（The present）study was designed（undertaken）to …

本研究旨在 …

In this study, an attempt was made to（attempts were made to）…

在本研究中，我们试图 …

（2）表示研究方法

The method used in our study is …

我们的研究使用的方法是 …

The technique we have applied is …

我们使用的技术是 …

The procedure can be briefly described as …

这一步骤可以概括描述为 …

The experiment, consisted of three steps, is described in …

这一试验有三个步骤，在…中给以描述。

The fundamental features of this theory are as follows …

这一理论的基本特征如下 …

(3) 表示研究结果

The data obtained suggest that …

所取得的资料表明 …

The analysis strongly suggests that …

这一分析有力地指出 …

These findings indicate that …

这些发现表明 …

In broad terms, the results favor …

宽泛地说，结果对…有利。

The study suggests that…

研究表明 …

(4) 表示研究结论

It is concluded that …

结论是 …

These results demonstrate that …

这些研究结果证明 …

We conclude that …

我们的结论是 …

The authors are of the opinion that …

作者的意见是 …

In conclusion, we state that …

总而言之，我们的结论是 …

2.9 英文摘要实例

(1)报道性摘要

Effect of cooking on the antioxidant properties of coloured peppers(烹饪对彩椒抗氧化特性

的影响）

Abstract: Pepper (*Capsicum annum* L.) has long been recognized as an excellent source of antioxidants, being rich in ascorbic acid and other phytochemicals. This study was conducted to investigate the effect of different cooking methods on the antioxidant properties of coloured peppers. Six varieties of peppers were subjected to different cooking methods, such as microwave heating, stir-frying and boiling in water, for 5 min individually. The cooked and raw peppers were analyzed for radical-scavenging activity (RSA) and total polyphenol content (TP) using 1,1-diphenyl-2-picrylhydrazyl-high-pressure liquid chromatography (DPPH)-HPLC and Folin-Ciocalteu methods, respectively. The samples were also evaluated for ascorbic acid content (AsA) by HPLC. Total carotenoid content was determined spectrophotometrically. Results suggest that there is no significant ($P>0.05$) difference in RSA, TP, AsA and total carotenoid contents between the cooked and raw peppers when processed for 5 min. However, the cooked peppers show marked differences ($P<0.05$) in the RSA, TP and AsA when cooked for 5 min in boiling water with further reduction observed after boiling for 30 min. This may be due to the leaching of antioxidant compounds from the pepper into the cooking water during the prolonged exposure to water and heat. Therefore, it is vital to use less water and cooking time and also to consume the water used for boiling so as to obtain the optimum benefits of bioactive compounds present in peppers. It is concluded that microwave heating and stir-frying without using water are more suitable cooking methods for pepper, to ensure the maximum retention of antioxidant molecules.

彩椒（*Capsicum annum* L.）一直被认为是优秀的抗氧化剂来源，含有丰富的抗坏血酸与其他的植物营养素。本研究旨在调查不同烹饪方法对彩椒抗氧化特性的影响。使用不同的处理来烹饪六种彩椒，比如微波加热、炒与煮各 5 分钟。处理后的彩椒与生彩椒使用 DPPH-HPLC 法检测其清除自由基活性（RSA），使用福林酚法检测其总酚含量（TP），使用 HPLC 法检测其抗坏血酸含量（AsA），使用分光光度法检测其总类胡萝卜素含量。结果显示，对比烹饪与未烹饪的彩椒，烹饪 5 分钟对 RSA、TA、AsA 与总类胡萝卜素含量的影响不显著（$P>0.05$）。然而，经沸水烹饪 5 分钟的彩椒其 RSA，TP 和 AsA 与其他烹饪方法所得彩椒差异显著（$P<0.05$），且煮制 30 分钟后各指标进一步降低。这可能是由于对水与热的暴露的延长，促使彩椒中抗氧化成分浸出到烹饪用水中。因此，可以减少煮制用水量、缩短煮制时间、喝掉煮制用水，以得到彩椒中生物活性成分的最佳效果。实验结果表明，不加水的微波加热与炒更适合彩椒的烹饪，可以确保最大限度地保留抗氧化分子。

（2）指示性摘要

Composition, industrial processing and applications of rice bran γ-oryzanol（米糠 γ-谷维素的组成、工业生产与应用）

Abstract: Rice bran oil (RBO) (20 ~ 25 wt% in rice bran) is a unique rich source of com-

mercially-important bioactive phytochemicals, most of them of interest in nutrition, pharmacy and cosmetics. The unsaponifiable constituents of RBO include mainly tocols (vitamin E, 0.10% ~0.14%) and γ-oryzanol (esters of trans-ferulic acid with sterols and triterpenic alcohols, 0.9% ~2.9%). The following topics concerning γ-oryzanol are reviewed: analytical methods for characterisation and determination; influence of genetic and environmental factors on the composition of rice bran; extraction approaches, including supercritical CO_2 and subcritical water; and biomedical and industrial applications, including food and pharmaceuticals. Concentration ranges of γ-oryzanol, tocopherols and tocotrienols found in rice bran and RBO from different varieties and geographical areas are summarised.

米糠油（RBO）（占米糠重量20% ~25%）富含具有商业价值的生物活性植物营养素，其中大部分可应用于营养、制药和化妆品。米糠油不皂化的组分主要包括母育酚（维生素E 0.10% ~0.14%）与γ-谷维素（带甾醇和三萜醇的反式阿魏酸酯0.9% ~2.9%）。本文综述了以下几个关于γ-谷维素的题目：特征描述与测定的分析方法；遗传及环境因素对米糠构成的影响；提取方法，包括超临界二氧化碳与亚临界水法；生物医学及工业应用，包括食品与制药。总结了不同品种与产地的米糠与米糠油中γ-谷维素、生育酚与生育三烯酚的浓度范围。

（3）报道-指示性摘要

Brazil nuts and associated health benefits: A review（巴西胡桃及其相关健康益处的综述）

Abstract: Epidemiological studies have shown an inverse relationship between nut intakes and chronic diseases such as cardiovascular diseases and cancers. The composition of lipids, minerals, and phytochemicals, and their associated health functions in Brazil nuts are critically reviewed. The nuts have high nutritive food value containing 60% ~70% oil and 17% protein. Brazil nuts contain abundant dietary antioxidants, especially selenium (Se). One single Brazil nut provides 160% of the US Recommended Daily Allowance (RDA) of selenium – perhaps the best source of Se from plant-based foods. Brazil nuts possess phenolics and flavonoids in both free and bound forms and are rich in tocopherol, phytosterols, and squalene. These compounds' possible beneficial effects are due to their antioxidant and antiproliferative activities, which are linked to a reduced risk for developing atherosclerosis and cancer.

流行病学研究已经显示出坚果摄入与慢性病比如冠心病与癌症的逆相关。本文综述了巴西胡桃的脂类，矿物质及植物营养素构成，以及与其相关的保健功能。巴西胡桃具有很高的营养价值，含有60% ~70%油脂与17%的蛋白质。巴西胡桃含有丰富的膳食抗氧化剂，特别是硒。一个巴西胡桃能够提供美国日推荐摄取量160%的硒——也许是植物性食物中的硒的最佳来源。巴西胡桃含有游离与结合的酚醛树脂与黄酮，且富含生育酚、植物甾醇与鲨烯。这些化合物可能的有益作用是由于他们的抗氧化与抗恶性细胞增生活性，这些活性与降低动脉硬化和癌症的风险有关。

（4）结构式摘要

Neuroprotective effects of digested polyphenols from wild blackberry species(野生种黑莓多酚分解物的神经保护作用)。

Abstract

Purpose: Blackberry ingestion has been demonstrated to attenuate brain degenerative processes with the benefits ascribed to the (poly) phenolic components. The aim of this work was to evaluate the neuroprotective potential of two wild blackberry species in a neurodegeneration cell model and compare them with a commercial variety.

Methods: This work encompasses chemical characterization before and after an in vitro digestion and the assessment of neuroprotection by digested metabolites. Some studies targeting redox/cell death systems were also performed to assess possible neuroprotective molecular mechanisms.

Results: The three blackberry extracts presented some quantitative differences in polyphenol composition that could be responsible for the different responses in the neurodegeneration cell model. Commercial blackberry extracts were ineffective but both wild blackberries, Rubus brigantinus and Rubus vagabundus, presented neuroprotective effects. It was verified that a diminishment of intracellular ROS levels, modulation of glutathione levels and activation of caspases occurred during treatment.

Conclusions: This is the first time that metabolites obtained from an in vitro digested food matrix, and tested at levels approaching the concentrations found in human plasma, have been described as inducing an adaptative response.

目的：黑莓的摄入已被证明能减缓脑退化过程，此效果被归于其（多）酚类化合物。本研究的目的在于使用神经变性细胞模型来评估两种野生黑莓的神经保护潜力，并与一种商业黑莓做对比。

方法：本研究包含体外消化前后的化学表征与消化代谢产物的神经保护作用评估。也做了一些涉及氧化还原/细胞凋亡系统的实验来探讨可能的神经保护分子机理。

结果：三种黑莓提取物在神经变性细胞模型中产生了不同的应答，其原因可能是因为他们的多酚组成有一些含量上的差异。商业黑莓提取物被证明无效，而 Rubus brigantinus 与 Rubus vagabundus 两种野生黑莓则具有神经保护效果。且处理期间细胞内的活性氧水平下降，谷胱甘肽水平被调整，半胱天冬酶家族被激活。

结论：这是第一次得到体外消化食物模型的代谢产物，并以其在人血浆中相近的浓度进行了测试，且被认为诱导了适应应答。

3 英文图表标题的写作

论文中精心设计的图和表能客观地展示作者的研究成果，起到文字叙述难以达到的效果，因此图表以其简明直观的表现形式深受读者喜爱，而一个好的图表标题更能吸引

读者并提高读者阅读的兴趣，让读者在最短的时间内对图表内容有最全面的了解。通常撰写图表标题要求准确得体、简明精练，具有较好的说明性和专指性。不仅英文论文如此，国内一些高水平的中文科技论文也要求提供英文图表标题，以便国外专家学者能通过英文摘要和图表尽可能多地了解文章的内容，也有助于权威文献检索系统审查和收录。

3.1 书写格式

图题一般位于图的底部，题末使用英文句号，部分杂志要求加粗表示。如有相关的文字性描述，直接附在标题的后面即可。表题则一般位于表的上方，题末不用标点符号，相关注释则附在表的下方。论文中，如有多个图表，应按顺序标 Figure 1，Figure 2（Fig. 1，Fig. 2）或Table 1，Table 2 等。如果全文只有一个图或表，也要标Figure 1 或Table 1。标题书写规则主要有以下两种：一是标题首词的第一个字母大写，其他词首均小写；二是标题中每个词的首字母大写，但冠词、连词和介词要小写。例如：Table 1. Total phenolic content and antioxidative activity of different parts of the yellow，red，and white onion cultivars /Table 1. Total Phenolic Content and Antioxidative Activity of Different Parts of the Yellow，Red，and White Onion Cultivars（表1 黄、红、白洋葱品种不同部分的总酚含量与抗氧化活性）。论文作者向杂志投稿时，应事先了解其编写要求。

3.2 语法结构

标题一般以短语形式表达，多以名词加前位或后位修饰语构成，常见的前置定语有名词、形容词和分词，后置定语有介词短语、分词短语等。例如：Fig. 1 Total ion chromatogram of derivatized phytosterols in GC-MS.（图1 气质联用中植物甾醇衍生物的总离子色谱图）/Table 4 Main characteristic ions with relative abundances and retention times of the derivatized phytosterols in the GC-MS full-scan mass spectra.（表4 气质联用全扫描质谱中植物甾醇衍生物主要的特征离子的相对丰度与保留时间）。

3.3 中心词位置

中心词是指明图表的主题或要点，应放在首位。有的中心词可根据需要决定用单数还是用复数。例如：Table 2 Sterol levels（mg/100 g of oil）during storage at 60℃（表2 在60℃储存时的甾醇水平）中，Sterol levels 指明了该表的要点。

3.4 常用句式

如果图表用于说明通过一定的手段检测和观察某个变量的变化结果（效果、作用、影响），其规范的标题格式是：effect /influence of A on B in C；B in response to A in C；B during A in C；B before and after A in C；对于提供背景资料的图表，其格式为：B of C 或 B in C。其中 A 表示研究操作的因素（自变量），B 表示观察、测定的项目或背景资料的

名称（因变量），C 表示被研究的对象，如动物、实验人群以及材料。如果研究对象是整个人群，不是某一特定的亚群，实验对象可以省略。例如：Table 1 Effects of cooking on the total carotenoids content of coloured pepper（表 1 烹饪对彩椒总类胡萝卜素含量的影响）/Fig. 1 Sensory evaluation of argan oil during storage at 20℃.（图 1 在 20℃储存时摩洛哥坚果油的感官评价）。

除上述句式外，常见的句型还有：观察（an observation/observations of/on/in）；调查（survey/investigation of/on）；关系/相关/比较/对照（relationship/correlation/association/comparison/contrast）等作中心词，后接“of…and /with”或“between…and”；特征/结果/证据（property/characteristics/feature/result/evidence/proof），后接介词“for，of，to，in”。

3.5 图表标题实例

3.5.1 图题实例

（1）Fig. 1 Formation of allicin and pyruvic acid from alliin

图 1 蒜碱由来的蒜素与丙酮酸的形成

（2）Fig. 5 Amount of acrylamide formed in the crust

图 5 面包皮中丙烯酰胺形成的量

（3）Fig. 2 Change in total polyphenol content of coloured peppers after 5 and 30 min of boiling

图 2 煮制 5 分钟与 30 分钟后彩椒总酚含量的变化

（4）Fig. 7 Texture profile analysis of the protein isolates studied

图 7 所研究的分离蛋白的质地剖面分析

（5）Fig. 1 Schematic representation of the manufacturing procedure for synbiotic ice cream in this study

图 1 本研究中益生菌冰淇淋制造工序的图示

（6）Fig. 3 Percentage contribution of ascorbic acid content to the radical/scavenging activity of raw coloured peppers

图 3 生彩椒抗坏血酸含量对其自由基清除能力的贡献率

（7）Fig. 3 Comparison between oil content of product fried in vacuum and traditional fryers

图 3 真空与传统油炸锅所得产品的含油量比较

（8）Fig. 7 Relationship between crust colour, acrylamide formation, crust temperature and water content

图 7 面包皮颜色、丙烯酰胺形成、面包皮温度与含水量之间的关系

（9）Fig. 5 Principal components analysis of ice creams (sensory attributes data) as they

affected by hydrocolloids, κ-carrageenan presence and storage time

图5 水状胶、卡拉胶及储存时间对冰淇淋（感官性状数据）影响的主成分分析

(10) Fig. 3 Pyruvic acid concentration as a function of water content in garlic slices dried by 40 ~ 60℃ cycling and at constant temperatures

图3 40 ~ 60℃循环干燥与恒温干燥蒜片不同水分含量下的丙酮酸含量

3.5.2 表题实例

(1) Table 1 Cyclic drying conditions

表1 循环干燥条件

(2) Table 1 Composition of spelt and common wheat bread formulas

表1 斯佩尔特小麦与普通小麦面包配方的构成

(3) Table 1 Comparison of thermal properties of isolates prepared from soybeans stored under various conditions

表1 不同储藏条件下大豆所得分离蛋白的热力特性比较

(4) Table 2 Effect of soaking, cooking and dehulling on protein, starch and ash content of peas

表2 浸泡、烹饪和脱壳对豌豆蛋白、淀粉及灰分含量的影响

(5) Table 2 Interaction of fining treatment with storage time on quality attributes of clarified banana juice during storage

表2 澄清处理与储藏时间对储藏期内透明香蕉汁的品质特性的交互作用

(6) Table 1 Analysis of variance of variety and treatment (soaking, cooking and dehulling) on composition of field peas

表1 品种与处理（浸泡、烹饪和脱壳）对紫化豌豆构成的方差分析

(7) Table 2 Physicochemical properties of rice starches and flours

表2 米淀粉与面粉的物化特性

(8) Table 3 Cholesterol biosynthesis inhibitory effects of lovastatin and tea polyphenols

表3 洛伐他汀（一种降脂药）与茶多酚的抑制胆固醇生物合成作用

(9) Table 1 Parameters for kinetic model of oil content development in chicken nugget during deep fat frying

表1 油炸时鸡块中油含量变化的动力学模型参数

(10) Table 4 Regression analysis for loss factors of pre-cooked and liquid egg whites and whole eggs

表4 预烹饪与液态蛋白与全蛋损耗系数的回归分析

(11) Table 1 Particle size distribution data for starch and starch-cassia gum pastes

表1 淀粉与淀粉-肉桂胶面团的粒度分布数据

(12) Table 9 Correlation coefficients between starch fractions and digestion parameters

表9 淀粉分数与其消化参数的相关系数

(13) Table 1 Standard references and ratings used in descriptive analysis of raw shrimp samples

表1 生虾样品描述性分析的参考标准与评级

3.6 阅读链接

[1] http://www.tandfonline.com/toc/bfsn20/current

[2] http://link.springer.com/journal/394

[3] http://www.journals.elsevier.com/food-chemistry

[4] http://www.journals.elsevier.com/lwt-food-science-and-technology

[5] http://pubs.acs.org/journal/jafcau

[6] http://onlinelibrary.wiley.com/journal/10.1111/(ISSN)1750-3841

[7] http://onlinelibrary.wiley.com/journal/10.1002/(ISSN)1097-0010

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