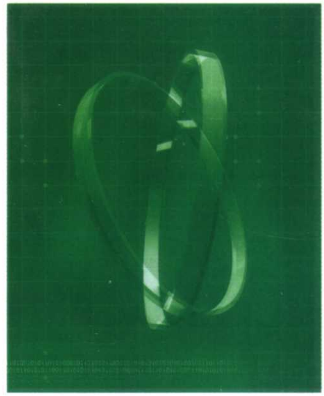

食品科学与技术专业英语

主编　包怡红

English in Food Science and Technology

哈爾濱工業大學出版社

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内 容 提 要

本书共分为4个单元，包括：食品基础科学、食品工业技术、食品安全和食品生物技术，不仅涉及食品科学、三大能量物质（蛋白质、脂肪、碳水化合物）、食品营养、食品工艺、食品工程，还涉及食品微生物和生物技术在食品中的应用等内容。为进一步扩大读者视野，每课后均设有与课文内容相关的拓展阅读。本书以食品科学前沿知识为主线，可帮助读者掌握食品科学专业英语的基本术语和表达方式，提高食品工作者实际运用专业英语的能力。

本书既可作为高等院校食品科学及相关专业的专业英语教材，也可作为相关领域研究人员的参考用书。

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序

食品科学是生物学科的一个分支，同时也是发展迅速的新兴学科。中华民族的食品业就是中华民族历史的真实写照。随着我国改革开放的蓬勃发展，古老的中华民族食品业发生了翻天覆地的变化。它由家庭个体手工作坊，走向社会，走进市场，走出国门。同时，世界各地的“洋食品”也涌入中国市场，摆上家庭餐桌。食品业的现代化生产成为当今经济发展的主要渠道，从业人员不断增多，专业科技人员不断扩大，全国各高校纷纷建立食品学科。由于国际间的食品工业与技术方面的合作日益频繁，基于学术的交流、技术的更新、科技的提高等方面的需求，对食品专业人员的外语水平要求越来越高。

包怡红副教授在总结专业英语和双语教学的经验和成果之上，应哈尔滨工业大学出版社之邀，主编了《食品科学与技术专业英语》一书。该书的编写主要是按照国家教育部《大学英语教学大纲》的要求和原则，既注意基础外语水平的培养，又结合专业外语的特征，贯彻了听、说、读、写、译“五会”能力培养的要求。该书还是学生完成基础英语学习向实际应用的双语教材过渡的蓝本，通过学习，可使学生深入掌握英文文献阅读、英语资料翻译、科技论文及英文摘要的撰写能力，系统而全面的夯实英语的专业应用技能。

是为之序。

杨传平

2007 年 8 月 10 日

前　　言

随着人类社会的进步和经济的发展，食品业由家庭制作走向个体作坊，由个体作坊走向社会加工，由单一品种转变成多元品种，由手工操作转变成现代化加工，从而集约化不断加强并升级为食品工业。在我国，食品工业已成为新兴的支柱型产业，成为世人公认的朝阳产业。因此，要想更好地发展食品工业，就需要更多的专业人士。

由于国际间的食品工业与技术方面的合作日益频繁，英语语言交际能力成为专业人士必备的能力之一。为此，在哈尔滨工业大学出版社组织下，我们编写了《食品科学与技术专业英语》一书，为培养和提高专业人士的英语水平提供参考。

本书特点如下：

第一，加强基础，突出专业。本书内容与食品专业紧密相结合，不仅涉及食品科学、食品工艺、食品工程，还涉及食品安全与食品生物技术。

第二，选材权威，内容前沿。本书选材均参考权威性中外刊物及经典著作，科学性强，内容新，很多内容目前仍属于前沿科学，具有英语语言学习和食品专业学习的双重功效。

第三，单词习题，译文解析。不仅每课配有新单词注释、课后练习题，而且还设置了相关内容的拓展阅读，并在书后附有参考译文和习题参考答案。读者通过阅读，既可积累食品专业的基本词汇，培养对英文资料的阅读与理解能力，又可以扩大专业知识面。

第四，一线教师，一流作者。本书由工作在食品专业教学第一线的专业教师编写，教学经验丰富，全部具有博士学位，大部分具有出国深造经历，了解国外的最新研究进展，并具有很强的语言基本功。

全书分为4个单元，由东北林业大学包怡红主编，具体分工为：包怡红编写第1单元，赵晓丹、孙庆申编写第2单元，赵凯、孙庆申编写第3单元，王远亮编写第4单元。研究生李雪龙、石丹、王恩福、余萍、关晓月在本书的资料整理、翻译过程中做了大量的工作。本书既可作为高等院校食品科学、食品加工、食品工程、食品安全和食品生物技术、食品营养与卫生等专业本科生的专业英语教材或参考书，也可供从事食品科研和食品加工的科研人员参考使用。

由于编者水平有限，书中难免有许多不足之处，敬请广大读者批评指正，以便再版时补充修正。

包怡红

2007年6月

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1

Food Basic Science

1.1 Enzymatic Protein Hydrolysates in Human Nutrition

Medical diets are designed to provide complete or supplemental nutritional support to individuals who are unable to ingest adequate amounts of food in a conventional form, or to provide specialised nutritional support to patients with particular physiological and nutritional needs. They supply all the required protein, fat, carbohydrates, vitamins and minerals in quantities sufficient to maintain the nutritional status of individuals receiving no other source of nourishment. Such formulations are designed to reduce or control diet-related chronic diseases such as atherosclerosis, cancer or liver failure, and also form the basis of special foods designed for the treatment of very different diseases such as phenylketonuria (PKU), cystic fibrosis, Crohn's disease.

Great interest has been shown in the role played by dietary proteins in clinical diets and their use in specific formulations. Progress in the knowledge of food composition and biochemical analysis permitting validation of dietary methods has been extensively reported. However, there are still significant difficulties in defining the relationships between protein requirements, nutrition and disease. Specific diseases affect protein requirements to different extents, and each disease process varies in intensity from individual to individual. It is known that adequate amounts of intact proteins can not be administrated to patients with impaired hydrolysis, reduced absorptive capacity and specific stomach or hepatic failure. In allergic patients, the presence of intact or partially hydrolyzed proteins can provoke immune mediated hypersensitive reactions. Two main ways to supply tailored amounts of amino acids are available: enzymatic protein hydrolysates and a mixture of synthetic amino acids. Enzymatic hydrolysis seems to be the most appropriate method for preparation of tailormade peptides, not only because of their large-scale commercial availability and moderate cost, but also because of the high quality of such products.

Enzymatic protein hydrolysates containing short-chain peptides with characteristic amino acid composition and defined molecular size are highly desired for specific formulations. They show important advantages with respect to elemental diets, in which the protein component consists exclusively of a mixture of free amino acids. Protein absorption can occur as peptides as well as amino acids, indeed absorption as short-chain peptides is considered to be a more efficient method of amino acid absorption compared with an equivalent amount of free amino acids. This is due to the availability of peptide specific transport systems and the subsequent terminal phase of peptide digestion into amino acids by the action of cytoplasmic peptidases within the enterocytes, before transport to the circulation. On the other hand, peptides are less hypertonic than free amino acid mixtures, enabling good absorption of other dietary components and eliminating osmotic problems. Moreover, because of chemical instability or insolubility in water, several amino acids (e.g., glutamine, tyrosine, cysteine) cannot easily be given in the free form.

The inclusion of protein hydrolysates in specific formulations is an area of growing interest. Uses include clinical applications, such as geriatric products, high-energy supplements, weight-control and therapeutic or enteric diets. The use of protein hydrolysates for the clinical treatment of patients with specific disorders of digestion, absorption and amino acid metabolism has been extended to patients with malnutrition associated with cancer, trauma, burns, and hepatic encephalopathies.

1.1.1 Enzymatic hydrolysis as a technological process

Proteins are broken down into peptides of different sizes and free amino acids as a result of the cleavage of peptide bonds. This degradation, termed hydrolysis, can be carried out by enzymes, acids or alkali. Acid and alkaline hydrolysis tends to be a difficult process to control and yields products with reduced nutritional qualities. Chemical hydrolysis can destroy L-form amino acids, produce D-form amino acids, and can form toxic substances. Enzymatic hydrolysis is developed under mild conditions of pH (6 ~ 8) and temperature (40 ~ 60℃), avoiding the extremes usually required for chemical and physical treatments and minimising side reactions. The overall amino acid composition of enzymatic protein hydrolysates is similar to that of the starting material. Besides, protein hydrolysates show technological advantages such as improved solubility, heat stability and relatively high resistance to precipitation such as pH or metal ions.

To develop commercial protein hydrolysates with defined physical, chemical and nutritional characteristics, many different factors must be taken into account. Among them, choice of suitable protein source, proteolytic enzymes and the development of post-hydrolysis processes have special relevance.

1.1.2 Protein source

1.1.2.1 *Milk*

Milk contains two major protein groups, caseins and whey proteins, which differ greatly with regard to their physicochemical and biological properties. Caseins, which account for 80% of the total protein in bovine milk, exist primarily in large complexes termed micelles. The multiple functional properties of caseinate derivatives allow them to be used in several food products, e.g. bakery and meat products, soups. The caseins are known to exhibit biological activity, such as carrying of calcium, zinc, copper, iron and phosphate ions in the body. Also, the caseins act as precursors of a number of different bioactive peptides.

The whey proteins, which account for 20% of total milk protein, represent an excellent source of both functional and nutritious proteins. The main whey protein constituents are β-lactoglobulin and α-lactalbumin, two small globular proteins that account for some 70% ~ 80% of total whey protein. Minor whey protein components include the immunoglobulins, glycomacropeptide, serum albumin, lactoferrin, proteose-peptones and numerous enzymes. Native α-lactalbumin has good emulsifying properties, but its gelation ability is poor. By contrast, native β-lactoglobulin has excellent gelling and foaming properties.

Cow's milk protein is the most important protein source used in the development of protein hydrolysates designed for nutritional support of patients. They are produced from isolated casein or from whey protein concentrate by using food-grade proteases. Because of their outstanding nutritional value, amino acid composition, commercial availability in large quantities and moderate cost, casein and whey hydrolyzed formulas have been marketed for several decades.

1.1.2.2 *Colostrum*

In bovine colostrum, the protein content is 4 ~ 5 times (higher up to

150 g/L) vs (30 ~ 40 g/L) than that in normal milk. This is primarily attributed to a high concentration of whey proteins. Among colostral whey proteins, the immunoglobulin(Igs) represent up to 75% of total protein in the first milking compared with 10% in normal milk. Igs enriched preparations have been introduced to the market in many countries as calf milk replacers. It has been suggested that infant formulas could be fortified with colostral Igs and lactoferrin. Also, preparations containing specific colostral Igs produced in colostrum by hyperimmunization of pregnant cows may, in the future, find applications in the prevention and treatment of human microbial diseases. A preventive or therapeutic efficacy of such products has been demonstrated against different gastrointestinal infections. A few so-called immune milk products are already on the market in the USA and Australia. Since bovine colostrum also contains other biologically active compounds such as growth-promoting factors and essential nutrients, research in this field seems highly promising.

1.1.2.3 *Egg*

A hen's egg consists of 13% protein (shell, 3%; egg white, 11% and yolk, 17%). Eggs are a rich source of proteins with different physicochemical and biological characteristics. Egg white possesses multiple functionalities such as gelation, emulsification, foaming, water binding and heat coagulation, which makes it a highly desirable protein in many foods. These properties of egg white can be attributed to complex interactions among its protein constituents, namely ovalbumin, conalbumin, lysozyme, ovomucin, globulins and other minor proteins. Whole egg or egg white powders are commercially manufactured and used in many food products and also non-food applications. Among specific egg proteins, lysozyme can easily be separated from egg white using crystallization or ionexchange resins. Purified lysozyme has shown promise as a food preservative, e.g. in prevention of late fermentation of hard cheese and in reduction of pathogenic bacteria on meat surfaces. Egg immunoglobulins

(IgY) can be enriched and isolated in a highly purified form using a serial filtration system or ultracentrifugation combined with a chromatographic purification process. IgYs have already found use in immunoassay techniques and may, in the future, be used as ingredients of functional foods and feeds aimed at preventing or curing gastrointestinal infections.

1.1.2.4 *Plant proteins*

Recently, plant proteins are finding commercial application in a number of formulated foods as an alternative to proteins from animal sources. Many studies have shown the interest of plant protein hydrolysates as functional foods and flavour enhancers. However, it is only in recent years that the commercial applications of plant protein hydrolysates in supplementation of liquid foods or high energy beverages, production of hypoallergenic foods and development of medical diets for the treatment of specific illness have been remarkably increased. According to criteria of nutritional quality and cost, many plant sources have been investigated for the production of protein hydrolysates in medical foods. Among plants, soybean is the source most widely used in special nutritional formulations. Other legumes such as peas and chickpeas are becoming increasingly important as a source of edible proteins with interesting functional and nutritional properties. Additional sources, including under-utilised by-products of the oil industry extraction, such as sunflower and rapeseed have been recently reported.

Plant proteins need to be processed prior to enzymatic hydrolysis. The excellent properties of plant protein concentrates and isolates as substrates for proteolytic enzymes are well known. A high protein content and low levels of polyphenols, sugars and protease inhibitors facilitate the control of the hydrolytic process, increasing the effectiveness of proteolytic enzymes and the yield of the process. The main drawback of plant protein hydrolysates with respect to casein or whey hydrolysates is the low level of some essential amino acids (e.g. sulphur-containing amino acids in hydrolysates derived from legumes). They must be added to the formulation to reach the necessary standard amino acid profile.

1.1.2.5 *Proteolytic enzymes*

The use of enzymes allows good control of the hydrolysis and thereby the properties of the resulting products. Proteolytic enzymes hydrolyse the peptide linkage between amino acids, yielding a mixture of peptides of different molecular size and free amino acids. The ability of enzymes to hydrolyse a protein substrate is highly variable. Therefore, the selection of suitable enzymes to produce compounds with defined physicochemical and nutritional characteristics is essential. Proteolytic enzymes are classified by their hydrolyzing mechanism into endopeptidases or exoproteases. Endopeptidases hydrolyse the peptide bonds within protein molecules at random to produce relatively large peptides. Exoproteases systematically remove amino acids from either the N terminus or the C terminus by hydrolysing the terminal peptide bonds. Protein hydrolysates used in special formulations are composed of free amino acids, short peptides and normally do not contain any peptide longer than 12 amino acid residues (molecular mass ≈ 1 500). To obtain such hydrolysates, a sequential reaction of endopeptidases and exoproteases is preferred. The initial use of endopeptidases facilitates the action of exoproteases in a second step to achieve a more complete degradation.

1.1.3 Main uses of protein hydrolysates in clinical nutrition

At present, there are more than 100 formulas used in clinical nutrition. Some of them contain protein hydrolysates as the major protein component and are commonly used in the dietary management of phenylketonuria, food allergy and chronic liver disease.

1.1.3.1 *Phenylketonuria* (*PKU*)

Phenylketonuria, or hyperphenyl-alaninemia, is one of the most well known disorders of amino acid metabolism. It is caused by the autosomal recessive deficiency (less than 2% of normal activity) or absence of the hepatic enzyme phenylalanine hydroxylase, which converts phenylalanine to tyrosine. Lack of this enzyme leads to phenylpyruvic acid accumulation in the blood. In the absence of treatment or when treatment is late (after 3 weeks of age), intellectual and neurological damage is inevitable. However, when dietary treatment with phenylalanine restriction is started early, the child can achieve close to normal development. Current data suggest that dietary restriction should be life long.

Dietary treatment of PKU was introduced in the early 1950s. Initial treatments indicated that young infants had a greater need for phenylalanine than had been previously recommended, recognising that the requirement were near normal. At present, it is known that the majority of infants require a low-phenylalanine controlled diet to reduce phenylalanine intake to 50 ~ 70 mg/kg body weight per day and reduced levels to the interval 10 ~ 40 mg/kg body weight per day from 7 years through adulthood. However, although general patterns are established, PKU patients show a broad spectrum of clinical and biochemical phenotypes which correlate with the phenylalanine hydroxylase genotype. The importance of individualised diagnosis of PKU patients to provide objective and effective criteria for the dietary treatment of each particular case has been recently recognised.

The dietary management of PKU patients includes two different kinds of protein substitutes: (i) a mixture of free amino acids fortified with carbohydrates, vitamins and minerals, or (ii) infant formula which has a similar nutritional composition to normal infant formula milks using phenylalanine-free protein hydrolysates as the main protein component. The use of such substitutes permits the addition of normal foods with low levels of phenylalanine to the daily diet, such as fruits, vegetables and certain cereals.

Phenylalanine-free protein hydrolysates or protein hydrolysates with low levels of this amino acid have been used for treatment of phenylketonuric infants, with satisfactory physical growth and mental development. They supply the majority of the protein requirements to PKU patients. Since PKU patients have the inability to convert phenylalanine to tyrosine, protein hydrolysates need to be supplemented to provide 100 ~ 120 mg/kg tyrosine body weight daily. Rectification of such hydrolysates is possible according to European Community Regulation 231/91 which states that amino acids may be added to improve the nutritional value of infant formula, but their addition is allowed only in a proportion that is considered useful for this purpose.

The development of protein hydrolysates for patients with PKU includes post-hydrolysis procedures to remove phenylalanine such as the treatment by activated carbon or the use of ionic exchange resins. Cogan et al. developed a sequential enzymatic procedure (papain and pepsin) followed by activated carbon treatment to obtain protein hydrolysates with a substantial reduction of bitterness accompanied by a selective loss of phenylalanine (36%). Arai et al. tested a series of enzymes on whey protein and achieved excellent results for phenylalanine removal using a pepsin-pronase system, followed by separation on G-25 Sephadex. These hydrolysates were passed through an activated carbon column to remove 92% of the total phenylalanine. The degradation of phenylalanine through its deamidation with phenylalanine ammonia lyase (PAL) has also been reported.

Several infant formulas containing protein hydrolysates with null or low amounts of phenylalanine are commercially available. Lofenalac is widely used as a protein substitute for cow's milk proteins in infants with PKU. As the protein ingredient this formula has an enzymatic protein hydrolysate of casein with levels of phenylalanine between 0.06% and 0.1% (approximately 75 mg/100 g of product). Acosta et al investigated growth and nutrient intake in 88 treated infants with phenylketonuria using