FOOD PROTEINS AND ENZYMES

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Summary

Proteins, as generally known, play a fundamental role in the function of living organisms. Although their role in biochemical processes of foods of animal and plant origin could not be neglected from side of food chemist, nevertheless in the framework of this chapter proteins will be treated particularly as main nutrients of man.

That's why in addition to chemical properties (amino acid composition, molecular structure, classification, hydrolysis, denaturation process) other topics, such as sources and production of food proteins, protein requirements of humans, interesting for food technologist and for nutritionist are also included in the chapter.

Primarily the most important food proteins (proteins of cereals, legumes, oilseeds, meat, fish and milk) will be discussed. Microbial proteins are also treated, although earlier expectations concerning their potential growing role in protein supply of animal husbandry and partly food industry were not realized. A short review of protein concentrates and isolates is also given.

The smaller second part of this chapter is devoted to enzymes of foods, particularly to enzymes playing considerable role in determination of quality of foods and/or in food processing (e.g. amylases and proteases).

1. Introduction

1.1. General

Proteins are very complex organic compounds present in all living organisms such as plants, animals and microorganisms. They play a fundamental role in the structure and function of living organisms. The name protein is of Greek origin (means most important) and first was used by the Dutch chemist Mulder in 1838.

Bearing in mind that overwhelming majority of food raw materials are of plant or animal origin, foods generally contain proteins. In animal body, proteins are the main constituents of muscles, important components of milk, of blood, skin etc., they occur in cereal seeds dry legumes, and in smaller amount in potato and fruits and vegetables.

Food proteins don not represent a separate group of proteins, because many of biologically active proteins are at the same time also important food proteins. Food proteins are simply those that are palatable, digestible, non toxic, and available economically for humans.

From chemical point of view, proteins contain, in addition to carbon atoms, hydrogen, oxygen and also nitrogen and usually sulfur. As minor components they may contain phosphorus, and metals (e.g. iron, copper, zinc). Numerous proteins have been isolated and purified. Their molecular mass varies from about 5000 to many million daltons. The hydrolysis (treatment with acid, alkaline compounds or protein degrading enzymes) of proteins results in the degradation of proteins to their building units to amino acids.

In spite to their complexity and immense diversity all proteins have been found to consist of 20 different building units named amino acids. The component amino acids are linked together by chemical bonds named peptide bond.

Proteins are the most important nutrients for humans. Different values for the average daily protein requirement can be found in the literature. Generally the optimal daily protein supply is calculated to be 0.8 g per body weight (in kg), roughly 56 g for a 70 kg man. Protein requirement is higher for growing children, is dependent on calorie intake. The lower of energy uptake, the higher must be the percentage of protein in diet.

Not only the quantity, but also the nutritional quality of protein should be kept in mind. Some of amino acids, the *essential amino acids*, cannot be synthesized in humans, thus these must be supplied in the diet. The nutritive value of a protein depends on its essential amino acid content.

A high quality food protein contains essential amino acids in ratios which correspond to the human requirements. Generally the animal proteins are of better nutritional quality in comparison to those of plant origin (except some legume- and oilseed proteins).

1.2. Sources of the Proteins

Cereal grains are the main source of food protein production (Table 1). Legumes and oilseeds are in the second place. Due to their higher protein content and better nutritive value in comparison to cereal proteins, their production, particularly that of soybean, increased significantly in last decades.

Product	**Total protein in 1000 t**
Animal origin3	
Total meat	30.017
Beef and veal	9.073
Pork	9.289
Poultry	7.290
Mutton and goat	1.597
Horse	98
Fish and sea animals	16.905
Total eggs	4.677

Hen's eggs	4.594
Total milk	17.547
Cow's milk	15.206
Buffalo's milk	1.402
Sheep's milk	449
Goat's milk	313
Total of animal origin	69.166
Plant origin	
Total grain	158.032
Wheat	50.630
Maize	24.773
Rice	28.244
Barley	14.198
Oilseeds	63.697
Roots and tubers	9.475
Legumes	9.155
Vegetables	5.242
Potatoes	4.111
Fruits and melons	2.222
Nuts	523
Total of plant origin	**252.417**
Total food protein	**321.583**

Table 1: Annual world production of food proteins (based on FAO statistics and average protein content of products)

The protein content of fruits and vegetables is low; these don't play a significant role in protein supply.

Concerning their quantity and quality, the proteins of meat (primarily beef-, pork-, and poultry meat) are the most important. Although lower in quantity, due to its high quality the eggs should be also mentioned as protein source.

Milk production represents the largest production reserves for nutritionally and physiologically valuable animal protein. Fishes and sea animals are the third protein source in human nutrition, however according to opinion of majority of experts; the biological potential of oceans to produce high quality food protein is limited.

Expectations, published in seventies and eighties of last century, concerning the growing production and use in human food of new, unconventional sources of protein were not realized.

The production of *single-cell- proteins* (*SCP*) based on oil and gas is too expensive and in addition may be connected with some allergy problems. The same is the situation with leaf protein concentrates and protein preparations from algae.

The growing production of new protein rich food products, the enrichment of foods with protein, the improvement of physical or /and nutritive quality of some foods resulted in industrial production of protein concentrates (protein content 60-70%) and isolates (protein content over 90%).

Soy protein preparations, vital gluten from wheat, legume protein concentrates are most widely used among proteins of plant origin. Fish protein concentrates, blood protein preparations are mainly used in feeding animals.

From point of view of food safety it should be mentioned the several plants contain *antinutritive factors*, which may be present as contaminants in protein concentrates and isolates. Natural enzyme inhibitors, enzymes, phytic acid, and lectines are the most important.

For a complex view it should finally also mentioned that some protein is used for non-food purposes e.g. production of packaging materials, adhesives etc.

2. Chemistry of Food Proteins

2.1. Protein-forming Amino Acids

In spite of their complexity and immense diversity, all proteins have been found to consist of only about 20 structural units, the so called *amino acids*.

In proteins the various amino acids are linked by *peptide bonds* i.e. the carboxyl group of one amino acid is linked with the amino group of the second amino acid with elimination of H_2O.

When hydrolyzed by strong mineral acids, or with the aid of certain enzymes, proteins can be completely decomposed into their component amino acids. The name, structural formula, three-letter symbol and one-letter symbol of protein forming amino acids are shown in Figures 1-3.

Their structures, except for glycine, have a center of asymmetry and consequently may occur in two forms, called *L*- or *D*- configuration (for details of chemical structure the reader is referred to literature given at the end of this chapter). All amino acids forming natural proteins are of L-configuration.

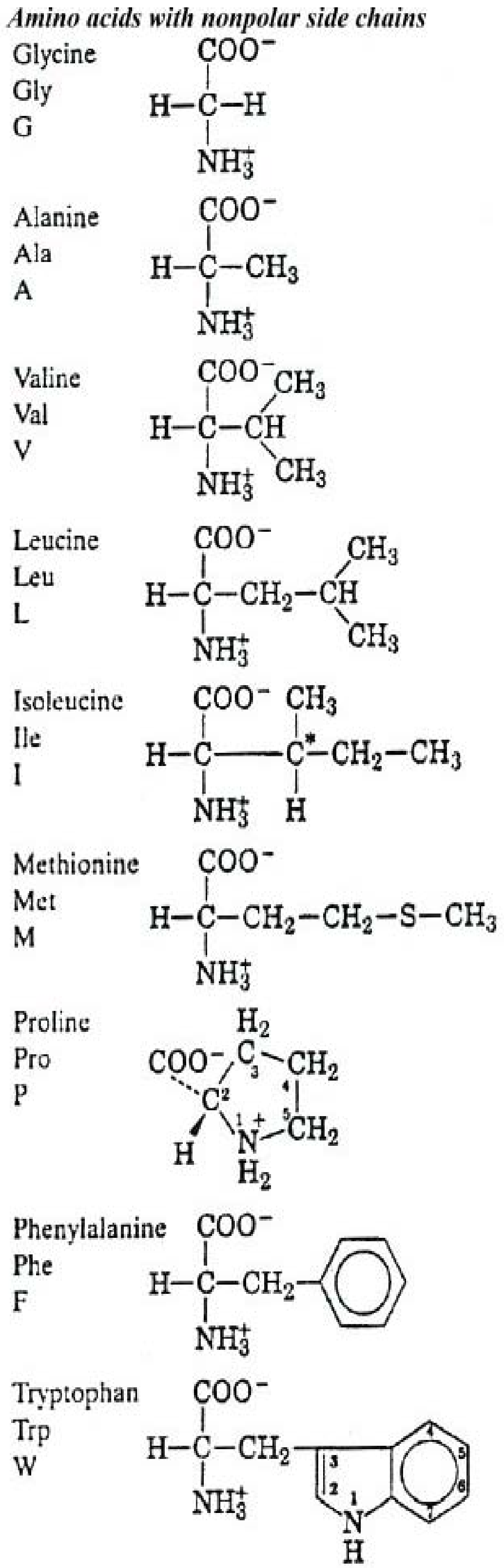

Figure 1: Amino acids with non-polar side chains

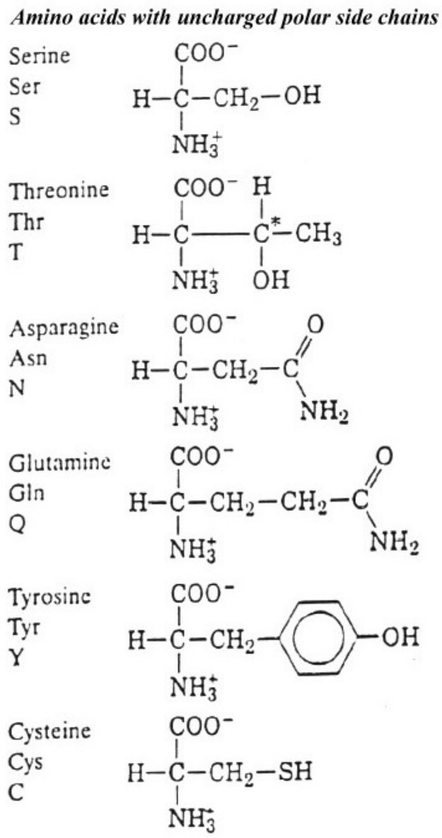

Figure 2: Amino acids with uncharged polar side chains

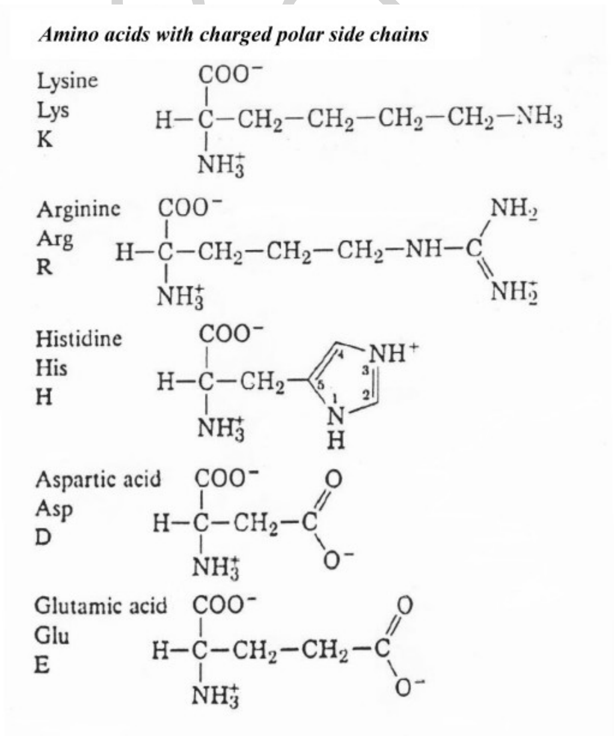

Figure 3: Amino acids with charged polar side chains

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Biographical Sketch

Radomir Lasztity D.Sc., Professor of the Department of Biochemistry and Food Technology at Budapest University of Technology and Economics, was born in 1929 in Deszk, Hungary. Dr Lasztity received his M.Sc. degree in Chemical Engineering in 1951 and his D.Sc. degree in Chemical Science in 1968. He is honorary president of International Association for Cereal Science and Technology (ICC) and deputy technical director. He was acting chairman of the Codex Committee on Methods of Analysis and Sampling of the FAO/WHO Food Standard Program in the period 1975 – 1988. Dr Lasztity is a member of the Food Chemistry Division of the Federation of European Chemical Societies and a member of the editorial boards of several international scientific journals. Among other awards he has received the Bailey and Schweitzer Medal of the ICC, the State Prize of the Hungarian Republic, and the Golden Medal of Czech Academy of Sciences. Dr Lasztity's main research activities are chemistry and biochemistry of food proteins, food analysis and food quality control. He has published more than 800 articles in Hungarian and overseas journals. He is the author/editor of more than twenty books and textbooks [*Chemistry of cereal proteins*(*1984, second ed. 1996*), *Amino Acid Composition and Biological Value of Cereal Proteins* (*1985*), *Cereal Chemistry* (*1999*), *Use of Yeast Biomass in Food Production* (*1991*), *Gluten Proteins* (*1987*)].