UNIT 5: PROTEINS

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1.0 Introduction

You learned about carbohydrates and fats in units 3 and 4. theses are important nutrients in the foods that are used for energy and that perform some other important functions. The other nutrient that can also supply energy (4 kilocalories per gram) promotes growth and maintain the body tissue is Protein. This unit treats Protein, composition, sources, functions, dietary requirements and some other aspects of protein.

2.0 Objectives

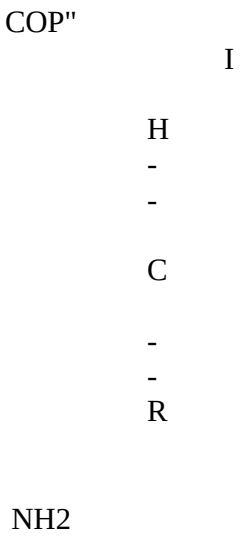
At the end of this unit, you should be able to:

- Explain the chemical composition of protein
- Differentiate between essential and nonessential amino acids
- List some sources of protein
- List some functions of protein
- Define some determinants of the quality of protein
- Explain the Denaturation of protein

3.0 Main Content

3.1 Chemical Composition

Proteins are complex organic substances that are made of amino acids. They are about twenty different naturally occurring amino acids that are used for the synthesis of proteins. The structural formula of an amino acid is given as



The are. a carboxyl group (COON), a hydrogen atom, an amino group (NH_2) and an amino acid radical (R) attached to a carbon atom. The difference in amino acids is brought about by the difference in the amino acid radical (R). The other components of a carboxyl group, a hydrogen atom and an amino group are the same with all amino acids.

The amino acid radical (R) varies from a single hydrogen (H) atom found in glycine, the simplex amino acid, to a longer carbon chains of 1 to 7 carbon atoms. The amino acid radicals are even in form of benzyl ring in some aromatic amino acids such as tyrosine and phenyalanine. Some amino acid radicals such as in cysteine and methionine also contain sulphur, some amino acids contain a second nitrogen atom and they are called dibasic amino

acids. Included in this arc tryplophan, lysine, histidine and arginine.

The nitrogen of the amino group is a very important characteristic factor n proteins since it is not found i[: other nutrients. It varies from 15% to 18% of the amino n=acid molecule. It is 159 in milk protein, 16% in wheat, 17% in cereals and 18% in nuts. In *e:* Hialing the content of protein in the body, nitrogen determination is done.

There is a need for you to leant the 11:10,':. of these naturally occurring amino acids. Some of the amino acids are (indispensable) while the others are non-essential (dispensable). t.r. ey*m.al amino acid cannot he synthesized by the body at a rate suffieie: •H. the needs for growth and maintenance. There must be the dietary r of those amino acids to meet the needs of the body. Nine of the t\\ • mmtrally occurring amino acids are essential. The non-essential amino (ein be synthesized in the body if there is adequate supply of nitrogen to the 1:ixly.

The naturally occurring amino acids are listed below.

a.Essential Amino Acids

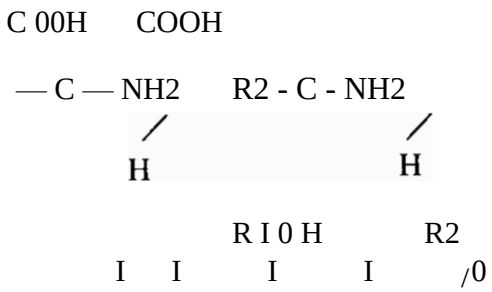
Leusine, isoleucine, lysine, methionine, phenyalanine, threoneine, tryptophan, valine and histidine.

b. The non-essential amino acids are glycine, alaninie, arginine, aspartic acid, asparagines, glutamine, glutamic acid, cystieine, praline, scrine, tyrosine.

c. There are some related compounds that are sometimes classified as
amino acids. They are:
Cystine, thyroxin, norleucine, hydroxyl-glutamic acid, hydroxylysine and hydroxyl-proline.

Glysine has been found to be essential for chicks and arginine to be essential for birds and rats.

In the synthesis of protein, the amino group of an amino acid reacts with the carboxyl group of another amino acid to form a peptide bond.



The properties of the protein are determined by the types of the amino acid it contains and the sequence of these amino acids. The types and the sequence of the amino acids in the protein also determines the three dimensional configuration of protein which determines both the enzymatic and catalytic activities of a protein.

3.2 Sources of Protein

Proteins are from both the plant and animal sources. Animal proteins are superior to plant proteins in form of their amino acids composition and digestibility. The animal proteins have more essential amino acids than the plant proteins.

The animal sources are meat and meat products, milk and mild products, eggs, fish. Some plant sources are beans, peanuts, whole wheat bread, soyabeans and so on.

The toxic substances in soybean and peanuts do not allow eating of these foods raw. They must be detoxified before they can be

consumed. There is an antiryptic factor in soybean which must be destroyed at high temperature before the soybean and its protein can be useful in the body.

Student Assessment Exercise 5.1

Discus the chemical composition of protein tend distinguish between essential and non-essential amino acids.

3.3 Functions of Protein

Proteins are used for

a. Promoting growth and maintenance of the body tissues
b. Formation of essential compounds in the body
c. Maintenance of body neutrality
d. Stimulation of antibody formation
e. Transportation of nutrients

f. Protein prompts growth and maintains the body tissues. When some tissues are worn out, proteins are used to build new tissues.

g. The enzymes that are responsible for digestion are proteineous. The hormones, insulin, thyroxin and adrenaline are all proteins. These are used for regulations in the body.

Heomoglobin that carries oxygen to the cells for respiration

is also protein. In the dotting of blood, prothrombin and thromboplastin that are used are all proteins.

c. Since amino acids contain both basic and acid groups that is, they are amphoteric they help in maintaining body neutrality. Their presence in the body therefore helps to prevent accumulation of too much acid and base which could interfere with normal body functioning.

cl. the antibodies that are responsible in combating infection in the body are proteineous. Enzymes, proteineous in nature, are responsible for the detoxification of poisionous materials in the body. Protein depletion in the body affects the resistance of the body against infection and reduces the ability of the body to detoxify poisionous materials.

e. In the transportation of nutrients from intestine across the intestinal walls to the blood, from blood to the tissues and across the cell membrane into the cell, protein plays an essential role. Most of the carriers of nutrients are proteins. With depletion of proteins in the body, the absorption and transportation of some nutrients will be reduced.

3.4 Denaturation of Protein

Proteins, in their native forms, have three dimensional configurations. These determine the enzymatic and catalytic activities of the proteins. This configuration changes when protein is denatured thereby leading to the loss of the enzymatic and catalytic activities of protein.

The denaturing agents are:

a . H e a t
b. Vigorous agitation such as whipping or shaking

c. Organic solvents such as ethanol

d. Ey c.,ssive alkalinity or acidity

e. Salts of heavy metals

1. Alkaloidal agents such as tannic acid and picric acid.

Denaturation of proteins causes the destruction of enzymes. In some food processing the denaturing of enzymes is deliberate to prevent deterioration. Denaturation also leads to coagulation, get formation and curdling. In some processes, all these are desirable.

3•5 Dietary Requirements

There are two ways in which we can estimate the requirements. They are:

a. Minimum amount of protein require to promote growth in children and to maintain nitrogen balance in adults

b. Calculation of losses of nitrogen through urine and faeces on a protein-free diet, after allowances have been given for obligatory losses through skin, sweat and worn out cells. More amount of proteins per kilogram of body

weight is consumed by growing children, pregnant women and lactating mothers. There is no evidence of adverse effects of intake of protein above the minimum requirements. The protein required in the body must be able to meet the body *needs* for growth, maintenance of body tissues, compensate for losses through urine, faeces, worn out tissues and various body secretions and excretions.

3.6 Protein Quality

, The quality of proteins is determined by the types of amino acids, the number and the sequence of amino acids in the protein.

Proteins that contain all the essential amino acids in the required proportions, capable of promoting growth when they are consumed as the sole source of proteins are called complete proteins. These are good quality proteins of proteins of high biological value.

Proteins that contain all the essential amino acids in required proportions and in which at least of the amino acids is not in adequate proportion required to promote growth are called partially complete proteins. The amino acid in which the amount is relatively smaller than required is called the limiting amino acids. Arginine is the limiting amino acid in casein, and methoinme in fish and eggs.

The proteins that are lacking in at least one of the essential amino acids are incomplete proteins. They are of low biological values. Complete proteins contain about 33% essential amino acids and 66% nonessential amino acids.

The incomplete proteins contain about 25% essential amino acids. All animal proteins except gelatin, is limited in both tryptophan and lysine, are complete proteins since they lack in one or more essential amino acids.

There are some biological and chemical methods of evaluating the quality of proteins. Some indexes are also used to define the quality of proteins. There area:

a. Biological value

b. Net protein utilization

c. Protein efficiency ratio

d. Chemical scores or amino acid score

a. Biological Value

Biological value measures the amount of protein retained to the amount of protein absorbed. There is the assumption that more proteins will be retained when the essential amino acids are supplied in the quantities that will meet the need for growth. You have learned that nitrogen is lost through urine and . through faeces from unabsorbed nitrogen.

Biological value (By) is given as:

$$\frac{\text{Nitrogen Retained}}{\text{Nitrogen Absorbed}} \times 100$$

When a protein is consumed as the only dietary source of protein (Nitrogen) and in the amounts that are capable of meeting the needs of body for

nitrogen, the percentage- nitrogen used for protein synthesis is the biological value of that protein.

The biological value of protein is evaluated by determining the amount of nitrogen in the food intake, in the urinary and faecal excretions of both the

test protein and on a protein free diet.

$$BV = \frac{\text{Dietar N- Urinal N - U x Faecal}}{\text{Dietary N - (Faecal N — F0)}} \times 100$$

N means Nitrogen

U_o --,- Urinary loss of nitrogen in a protein free diet

F_o = Faecal loss of nitrogen in a protein free diet Diet with biological value of *70%* and above are considered good enough of supporting growth. This index may apply to single proteins, single foods and combination of proteins in foods.

A table of biological values of some proteins is listed below:

Food	Biological Value
Egg	93
Milk	86
Rice	86
Fish	75
Beef	75
Casein	75
Corn	72
Cotton Seed Flour	60
Peanut Flour	56
Wheat Gluten	44

Source: Guthrie 11. A. (1979) Introductory Nutrition 4th ed., the C V. Mosby

b. Net Protein Utilization

The biological value does not take into account the differences in the digestibility of the proteins. It is only based on the amount of nitrogen absorbed. The net protein utilization however takes into consideration both the nitrogen absorbed and the digestibility of the protein.

Net protein utilization (NPU) is expressed as Biological Value multiplied by Coefficient of digestibility

NPU = 1W x coefficient of digestibility..

c. Protein Efficiency Ratio

Protein efficiency ratio is the simplest method of determg the quality of protein. It requires no chemical analysis. The protein *efficiency* ratio is the weight gain of a growing animal in relation to its protein intake when calories are supplied well and the protein source is fed at an adequate level for a long Period of time (four weeks) to assess the protein in comparison to casein with known protein efficiency ratio (PER) of 2.5 (Gultrie, 1979)

d. Chemical Score (Amino Acid Score)

There are some chemicals scores of determining the quality of protein. The Amino Acid score is *given* as

= ma of amino acid in / m of test otein x 100 mg of amino acid in reference protein

Chemical scores do not take into consideration the imbalances in the amino acids content of a protein and the differences in the absorption of the amino acids.

Student Assessment Exercise 5.2

Winn is the Denaturation of protein? What are the denaturing agents?

4.0 Conclusion

This unit teaches protein, its composition, sources, funclions dietary requirements, Denaturation and determinants of the quality of proteins.

5.0 Summary

In this unit you learned that amino acids combine in polypeptide linkages to form protein. Properties of protein are dependent on the types of amino acids in the protein, also determined are the three dimensional configuration of protein that determines both the enzymatic and catalytic activities of the protein. Heat. vigourous agitations, presence of salts of heavy metals, excessive alkanity and acidity, presence of alkaloidal agents and alcohol could lead to the changes in this three dimensional configuration of protein, thereby causing Denaturation of protein. Animal proteins have been found to have higher quality in terms of digestibility and amino acids contents than vegetable proteins. The quality of protein and the completeness of other wise of protein is determined by the number and amount of the essential amino acids in the proteins. Other measures of the quality of protein are given as Biological Value, Net Protein Utilization, Protein Efficiency Ratio and Amino Acid Score.

6.0 Tutor Marked Assignment

Discuss the various determinations of the quality of proteins.

Answers to Student Assessment Exercise

5.1 See answers in Section 3.1 of this unit

5.2 See the answers in section 3.5 of this unit.

7.0 References and Other Sources

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