

# Nutritive value of proteins

# Introduction

- The diet contains a variety of different animal and plant proteins.
- The nutritional quality or biological value of a given protein depends upon two factors: (i) its content of essential amino acids and (ii) its digestibility.
- On the basis of their nutritional quality the proteins has been classified into (1) complete protein (2) partially complete and (3) incomplete protein.

## **1. Complete proteins:**

- Complete proteins maintain life and provide for normal growth of the young when used as the only protein in the diet of experimental animals.
- Proteins of meat, poultry, fish, eggs and milk are complete proteins and are of high biological value because they contain all essential amino acids.
- Some proteins in legumes, cereals and nuts are also complete proteins e.g. glycinin of soybean, glutenin of wheat and glutelin of corn.

**2. Partially complete:** Partially complete proteins maintain life but fail to support normal growth. e.g. gliadin of wheat, hordein of barley.

**3. Incomplete proteins:** Incomplete proteins neither maintain life nor support growth. Most vegetable proteins are incomplete and are of low biological value (e.g. rice, wheat, corn, beans).

# Essential amino acids

- **Essential amino acids:** The 10 essential amino acids are **methionine, tryptophan, threonine, valine, isoleucine, leucine, phenylalanine, lysine, arginine and histidine** and are essential for growth in children.
- The remaining amino acids are called non-essential or dispensable as they can be synthesized in animals from other compounds. They are **glycine, cysteine, alanine, serine, proline, tyrosine, aspartic acid, asparagine, glutamic acid** and **glutamine**.
- Cereals contain lower value of lysine while pulses contain lower value of methionine. Combining plant proteins from different sources ensures a more complete complement of essential amino acids.

# Digestibility

- Digestibility is defined as the proportion of food nitrogen that is absorbed after ingestion.
- The nutritive value of proteins depends upon its digestibility.
- Animal proteins are the most available for digestion and absorption and the proteins of legumes are the least available because of their incomplete digestibility.
- Digestibility depends upon the fibre content present in the food item and also in the remainder portion of diet.

- Plant proteins, particularly those of wheat and other grains, are not completely hydrolyzed during digestion because the protein-rich portions of the grains are surrounded by protective husks of cellulose and other polysaccharides that are not hydrolyzed by intestinal enzymes.
- Since only free amino acids can be absorbed from the intestine, not all the amino acids of most plant foods are biologically available.

# Food sources for the supply of proteins and amino acids

- Proteins are widely distributed in nature but only a few foods provide sufficiently higher quantity of proteins.
- Eggs, fish, meats, nuts and poultry have protein ranging from 12-29%.
- Cereal contributes 1-2% of proteins.
- Fruits and vegetables are low sources of protein foods. Syrups, oils and fat contain no protein.
- Animal foods have high protein values and also have good quality. Soya bean and some nuts contain protein of high quality.



# The supplementary value of protein

- Foods differ in the nutritive value of the protein they contain. Each food, with the exception of gelatin, contains more than one kind of protein, each with a characteristic number and concentration of amino acids.
- The proteins of some foods contain limited amount of certain essential amino acids, generous amounts of others. Therefore a combination of foods in which the amino acid contained in the proteins supplement each other is of higher nutritive quality than either alone.
- There are possibilities of combining foods so that amino acids may supplement each other. For e.g. **Lysine** is a **critical or limiting amino acid** of **cereals**. Similarly **methionine** is limited in **pulses** and is the **critical or limiting amino acid** of their protein. They need to be supplemented by animal proteins.

# Deficiency of Protein

- Protein- energy malnutrition results from inadequate intake of protein and/or calories. Two forms of child malnutrition, often occurring together, are Marasmus and Kwashiorkor.
- **a. Marasmus:** Marasmus (from Greek, “to waste”) is the term applied to chronic deficiency of calories in children. Marasmus is caused by a diet deficient in both protein and calories. (Total calorie deprivation).
- Marasmus is characterized by arrested growth, extreme muscle wasting, weakness and anemia. It is usually complicated by multiple deficiencies of vitamins and minerals. Calorie deficiency in early childhood, even if ultimately alleviated with an ample diet, leaves a permanent deficit in body growth.

**b. Kwashiorkor:** Chronic protein deficiency in children is called “Kwashiorkor”, an African word that means ‘weaning disease’.

- Kwashiorkor is caused by a diet inadequate in protein in the presence of an adequate calorie intake consisting primarily of carbohydrates.
- Since the protein content of plant foods is generally low and proteins are also low in quality, a serious shortage of “good” protein often occurs in areas where population growth is especially great.

# Methods for the determination of nutritional quality of proteins

- The nutritional quality of proteins can be determined in the following methods

**1. Protein Efficiency Ratio [PER]:** It is a measure of weight gain/unit protein fed

$$\text{PER} = \frac{\text{weight gain (g)}}{\text{Protein fed on dry on dry wt. basis(g)}}$$

# Biological value

➤ It has been defined as the "percentage of absorbed nitrogen retained in the body" and a complete evaluation of the dietary protein includes measurement of the Biological Value and the Digestibility.

➤ 
$$\text{Biological value} = \frac{I - (F - F_0) - (U - U_0)}{I - (F - F_0)} \times 100$$

where

I = Nitrogen intake of test protein

F = Faecal nitrogen

F<sub>0</sub> = Faecal nitrogen on nitrogen-free diet (Metabolic N)

U = Urinary nitrogen

U<sub>0</sub> = Urinary nitrogen on nitrogen-free diet (Endogenous N)

## **Net Protein Utilization (NPU) or BV x Digestibility**

- It is measure of the protein gain during an experimental period/ unit protein absorbed by the fish

$$\text{NPU} = (\text{Final body protein} - \text{Initial body protein}) / \text{Total protein fed} \times 100$$

## Chemical Score (CS)

- The quality of protein in a protein source is decided by the quantity of essential amino acid content present.
- The essential amino acid content of source is compared with that of a standard protein
- The usual standard protein used by the Nutritionists is hen's egg white.

Chemical score =  $\frac{\text{Limiting amino acid in test protein (g)}}{\text{Limiting amino acid in whole egg protein (g)}} \times 100$

## **Digestibility Coefficient**

- Nutrients present in the food are not completely available to the human body.
- Large portions of the nutrients are excreted in the faeces because of being not digested in the alimentary tract.
- Hence, the digestibility of the food is defined as the portion of a food or nutrient which is not recovered in faeces, the portion which has been absorbed by the animal.



$$\text{Digestibility Coefficient (DC)} = \frac{\text{Nutrients eaten (g)} - \text{Nutrient in feces}}{\text{Nutrient eaten (g)}} \times 100$$

## **Pepsin digestibility**

Pepsin digestibility assesses the *in vitro* digestibility of the protein in fluids containing the proteolytic enzyme pepsin and the release of amino acids are measured. In one method, test proteins are first digested with pepsin and then with pancreatin. In another method proteins are digested with three enzymes namely pancreatic trypsin, chymotrypsin and porcine intestinal peptidase under standard assay conditions.