ESTIMATION OF PROTEIN QUALITY

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Sources of Protein

Humans obtained protein from two main dietary sources

Animal Sources:

Proteins of animal origin are found in Milk, Meat , Fish , eggs and cheese. Egg proteins are considered to be the best among food proteins, known as "reference protein"

Vegetable Sources:

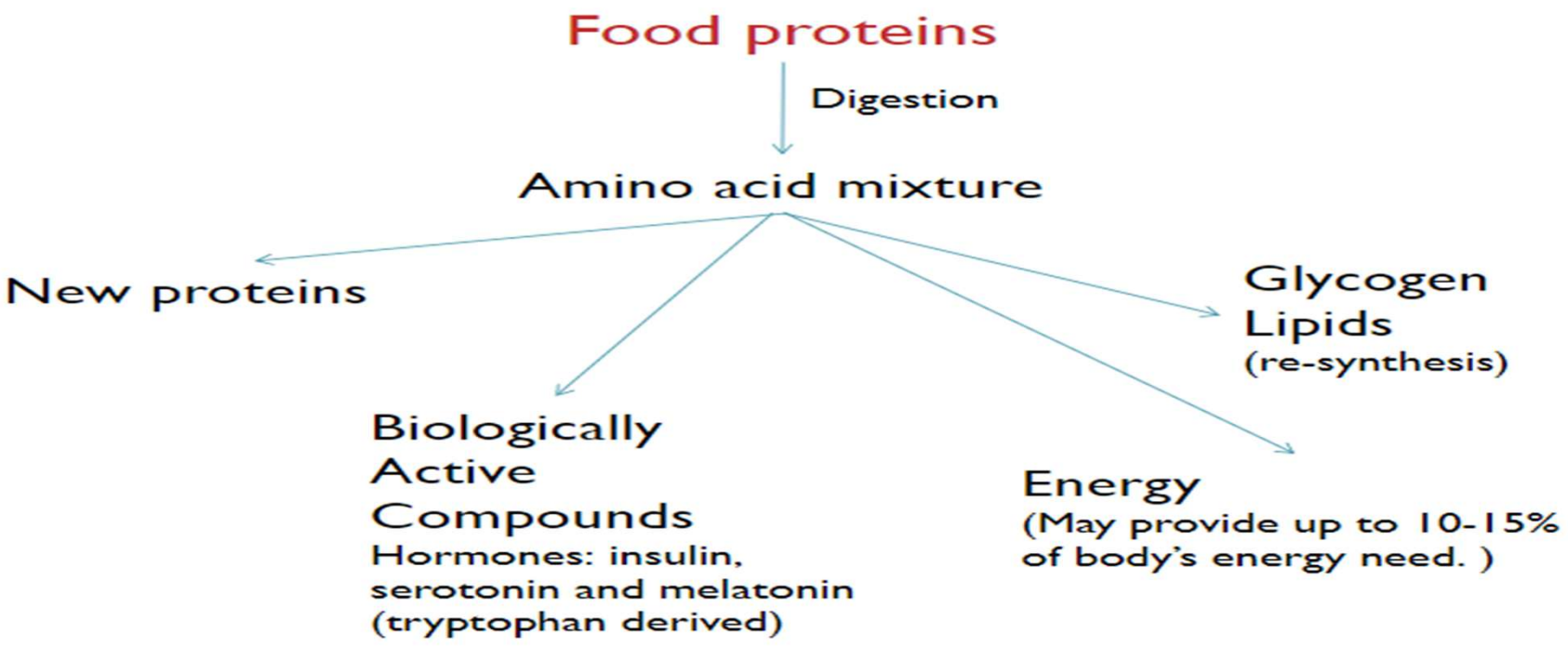
Vegetable proteins are found in pulses/legumes, cereals, beans, nuts, oil seed cakes ect.

Protein Requirements cont..

Recommended Dietary Allowance for Proteins for Indians

Group	Category/Age	Protein -RDA
Infants	0-6 months	1.16 gm/kg/day
	6-12 months	1.69 gm/kg/day
Pre school child	1-5 years	0.94 gm/kg/day
School children	6-10 years	0.91 gm/kg/day
Adolescents	11-18 years-Boys	0.88 gm/kg/day
	11-18 years-Girls	0.86 gm/kg/day
Adult-Man	Sedentary, Moderate and heavy worker	1.00 gm/kg/day
Adult-Woman	Sedentary, Moderate and heavy worker	1.00 gm/kg/day
Pregnant woman		78 gm/day
Lactating mother	For first 6 months	74 gm/day
	For next six months	68 gm/day

Why do we need proteins?



The amount of protein needed depends on:

Individual physiological features:

- Sex
- Age
- Physical activity
- Health status

Protein quality:

- Amino acid composition/ratio
- Protein digestibility

Protein quality: Amino acid composition

20 common amino acids composing proteins.

Non-essential amino acids (NE): body can synthesize them.

Essential amino acids (E): body can not synthesize them. Must be supplied by diet.

Conditionally essential amino acids: nonessential amino acids that become essential under certain conditions. For example Tyr (NE) is synthesized by Phe (E). If diet is low in Phe then Tyr becomes conditionally essential.

The quality of a dietary protein is a measure of its ability to provide the essential amino acids required for tissue maintenance.

ESTIMATION OF PROTEIN QUALITY

CHEMICAL METHODS

- **Protein** Efficiency Ratio (PER)
- Net **Protein** Ration (NPR)
- Biological Value (BV)
- Net **Protein** Utilization (NPU)
- Amino Acid Score.
- Critique.
- Other **Methods** of Estimating **Protein Quality**.

BIOLOGICAL METHOS

- Microbial assays

Methods of evaluating protein quality

Protein efficiency ratio (PER) :-

- It is the simplest method.
- It measure the weight gain of a growing animal with reference to its protein intake.
- A high PER (>2.5) assigned to proteins that are efficient at promoting growth. Eg. Animals protein
- Major source of error in this method is the use of weight gain per se as sole criterion of protein value. It also dose not include protein required for maintenance.
- From 1919 until very recently, the PER had been a widely used method for evaluating the quality of protein in food.

$$PER = \frac{Gain\ in\ body\ mass(g)}{Protein\ intake(g)}$$

Methods of evaluating protein quality cont..

Net protein ratio (NPR) :-

This method was developed to overcome the drawbacks of PER method.

In this method another group of animals beside test animals included to whom protein free diet is given and the amount of protein required for maintenance was calculated.

It is calculated as difference in final body weight between test group fed the protein in diet, and a group receiving a protein free diet divided by the amount of protein taken by the test group

Methods of evaluating protein quality cont..

Digestibility Coefficient :-

It is the proportion of food protein which is absorbed.

It is computed from the measurement of the nitrogen content of the food ingested and the nitrogen excreted in faeces, taking into account the extent to which faecal nitrogen is "endogenous" which in turn is measured as faecal nitrogen lost on a protein-free diet.

$$\text{True protein digestible} = \frac{I - (F - Fe)}{I} * 100$$

Where I = Nitrogen intake

F = Faecal nitrogen lost on a test diet

Fe = Faecal nitrogen lost on a protein free diet

Methods of evaluating protein quality cont..

Biological Value (BV) :-

It is the percentage of absorbed nitrogen that is retained by the body for growth and maintenance.

It is expressed as nitrogen retained divided by nitrogen absorbed.

$$BV = \frac{I-(F-Fe)-(U-Ue)}{I-(F-Fe)} * 100$$

Where I = Nitrogen intake

F = Faecal nitrogen lost on a test diet

Fe = Faecal nitrogen lost on a protein free diet

U = Urinary nitrogen on test diet

Ue = Urinary nitrogen on protein free diet

Methods of evaluating protein quality cont..

Amino acid score (AAS) :-

It is a measure of the concentration of each essential amino acid in the test protein expressed as a percentage of that amino acid in the reference protein such as Egg or Milk or a provisional amino acid pattern.

The AAS do not take the digestibility of the protein and absorption of amino acid into account, and thus, actual utilization from a given food might differ.

The score is calculated from the following equation:-

$$\text{Amino acid score} = \frac{\text{mg of amino acid in 1 gm of test protein}}{\text{mg of amino acid in 1 gm of reference protein}} * 100$$

Methods of evaluating protein quality cont..

Net Protein utilization (NPU) :-

It is the proportion of food nitrogen that is retained in the body under standard conditions.

It is the product of digestibility coefficient and biological value divided by 100.

The NPU gives a more complete expression of protein quality then AAS.

When food proteins are completely digested, the NPU and BV would be the same

Methods of evaluating protein quality cont..

Net dietary protein calories percent (PE ratio) :-

It relates protein quality to energy intake.

Dietary protein is expressed as percentage of total calories rather than as that of total weight and is calculated as

$$\text{N D p Cal \%} = \frac{\text{Protein calories}}{\text{Total calorie intake}} * 100 * \text{NPU}$$

A diet providing less than 5% or 8% of the calories from proteins dose not meet the protein requirement of an adult or child, respectively.

Methods of evaluating protein quality cont..

Protein digestibility corrected amino acid score (PDCAAS) :-

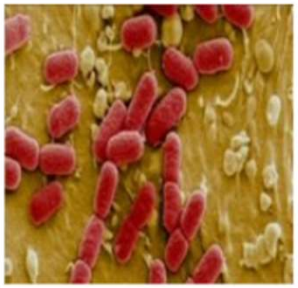
- It is the amino acid score corrected for the digestibility of the protein
- **It** is a method of evaluating the protein quality based on both the amino acid requirements of humans and their ability to digest it.
- The PDCAAS rating was adopted by the US Food and Drug Administration (FDA) and the Food and Agricultural Organization of the United Nations/World health Organization (FAO/WHO) in 1993 as "the preferred 'best'" method to determine protein quality.

- The formula for calculating the PDCAAS percentage is: (mg of limiting amino acid in 1 g of test protein / mg of same amino acid in 1 g of reference protein) x faecal true digestibility percentage.

Biological methods: Microbial assays

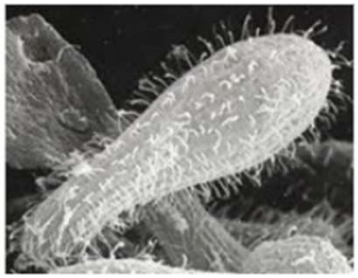
For determination of:

- Total amino acids (after chemical hydrolysis)
- Bioavailable amino acids

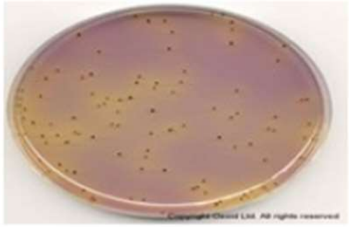


Microorganisms used:

- *Escherichia coli*



- *Tetrahymena pyriformis*



- *Streptococcus zymogenes*

Streptococcus zymogenes:

- It does not require lysine and therefore, this amino acid (neither total nor bioavailable) can not be determined.
- Can hydrolyze protein with own enzymes but slowly. Protein could be pre-treated with enzymes.

Tetrahymena pyriformis

- It requires all essential amino acids for growth
- Own extracellular enzymes to hydrolyze proteins
- Assay takes 2-3 days

Escherichia coli

- Auxotrophs for specific amino acids are used
- Use own extracellular enzymes to digest food ingredients
- Assay can be completed in 6 to 8 hours

Advantages of microbial assays

Compared to animal assays:

- Simple
- Fast
- Cheaper
- Do not require elaborate equipment
- Do not require vast working space
- Overall cost effective

Assessment of protein nutrition status

A battery of tests have been suggested to assess the state of protein nutrition. These include:-

1. Arm muscle circumference
   It should be more than 13.5 cm
2. The urinary creatinine-height index
   CHI=24 hr urine creatinine of patient/24 hr urine creatinine (normal child of same height). Level below 1 indicate severe malnutrition
3. Serum albumin levels
   Level below 2.5 gm/dl indicate severe malnutrition
4. Serum transferrin levels
   Level below 0.45 mg/ml indicate severe malnutrition
5. Total body nitrogen
   The ratio of Non essential and Essential AA increases

Disorders related with Protein

(a) Disorders due to deficiency of Protein

PROTEIN-ENERGY MALNUTRITION

Especially common in children in underdeveloped nations.

Major health and nutritional problem of our country

Manifest primarily by inadequate dietary intake of protein and energy

Insufficiency of food- the so called "FOOD GAP" appears to be the chief cause

It is estimated to be an underlying cause in 30 % of deaths among children under age 5.

Is also affect people who have suffered severe physical trauma that increases protein needs (for example, extensive skin burns)

Disorders related with Protein cont…

There are 2 types of protein-energy malnutrition:

1. Marasmus

- A state of semi-starvation that can occur in people of all ages who have limited access to food, but is most common in non-breastfed children given diluted infant formula.
- Weight loss, severe muscle wasting, severe loss of visible fa stores, weakness, fatigue and frequent infections are the symptoms.

Disorders related with Protein cont…

2. Kwashiorkor

- A Ghanaian word for "the evil spirit that infects the child".
- Was first described in 1933 and typically occurs in children younger than 4 years old, fed diets high in carbohydrates with little or no protein.
- Muscle wasting, edema (fluid retention), low wt. for height, diffuse pigmentation, sparse hair and an enlarged and fatty liver, with the preservation of visible fat stores are its symptoms.

Disorders related with Protein cont…

Some other effects of protein deficiencies are:

- Edema
- Weak immune system.
- Weight loss
- Thinning or brittle hair and hair loss
- Ridges or deep lines in finger and toe nails
- Skin becomes very light, burns easily in the sun

Disorders related with Protein cont…

- Reduced pigmentation in the hair on scalp and body
- Skin rashes, dryness, flakiness
- General weakness and lethargy
- Muscle soreness, weakness and cramps
- Slowness in healing wounds, cuts, scrapes, and bruises
- Bedsores and other skin ulcers

Management of PEM

There is no simple solution to the problem of PEM, many types of action are necessary

The following method is adopted from the 8th Food and Agriculture Organization of United Nations and WHO expert committee on nutrition for the prevention of PEM in the community

- **Health promotion**
  - Measure directed to pregnant and lactating women
  - Promotion of breast feeding
  - Development of low cost weaning food
  - Nutrition education
  - Family planning and spacing of birth

Management of PEM cont…

- **Specific protection**

  The child diet must contain protein and energy rich foods, milk, eggs, fresh fruits should be given if possible

  Immunization

  Food fortification

- **Early diagnosis and treatment**

  Periodic surveillance

  Early diagnosis and treatment of infections and diarrhoea

  Deworming of heavily infested children

  Development of supplementary feeding programmes during epidemics.

  Family planning and spacing of birth

- **Rehabilitation**

  Nutritional rehabilitation services

  Hospitalization

  Follow up care

Disorders related with Protein cont…

(b)Disorders due to excessive intake of Protein

- The effect of excessive dietary intake of protein have not been studied extensively and the findings are uncertain or equivocal.
- It increases obligatory fluid loss, may lead to dehydration.
- High protein intake especially casein, in infants can result in acidosis and aminoacidemia.
- In adult it is associated with Heart diseases, obesity and colon cancer.
- Bone-demineralization, which will lead to osteoporosis and kidney stone formation.