Dept. of Public Health
Animal Nutrition \ Theoretical Assist. Lect. Chalang Madad
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Digestion of proteins

Digestion of protein in non-ruminants

There is no digestion of protein in the mouth because saliva has no proteolytic enzyme. But saliva softens the food particles, which is helpful for ingestion of protein.

Digestion of proteins in the stomach

The digestion of protein starts in the stomach by the action of peptic enzymes. Pepsin and gastricin are the most important peptic enzymes of the stomach. Both enzymes are most active at about pH **2** to **3**, and completely inactive at pH above **5.** Gastric glands secrete hydrochloric acid at a pH of about 0.8, but by the time it's mixed 68 The Protem in Animal Nutrition with the stomach contents, the pH ranges around **2-3,** a high favourable for peptic enzyme activity. These enzymes are capable of digesting protein, collagen and nucleo proteins into proteoses, peptones and polypeptides.

Digestion of proteins in the intestine

1. Digestion of proteins by pancreatic secretions: When the proteins leave the stomach they ordinarily are in the forms of proteoses, peptones, large polypeptides and amino acids. Immediately upon entering the duodenum the partial breakdown products are attacked by the pancreatic enzymes trypsin, chymotrypsin and carboxpolypeptidases. These enzymes are capable of hydrolyzing all the partial breakdown products of proteins to polypeptides and amino acids.

2. Digestion of polypeptides by the epithelial enzymes of the small intestine: The epithelial cells of the intestine contain several different enzymes for hydrolyzing the final peptide linkages of the different dipeptides into amino acids. So the end product of protein digestion is various amino acids.

Digestion of protein in Ruminants

The digestion and metabolism of proteins in ruminants are different than non-ruminants. The biological success of the ruminant in utilizing crude proteins and non-protein nitrogenous (NPN) substances seems to be dependent upon the physiological regulation rumen environment as microbial habitat. As the microbes multiply, they synthesize protein to construct their own bodies by utilizing dietary protein and NPN substances. This microbial protein is available to the host for subsequent digestion in the lower part of the gut.

Digestion and metabolism of protein and NPN compound

Proteolysis: The proteins available to the ruminants are digested by the process of proteolysis in the rumen and are converted to peptides and amino acids. These are further fermented, by deamination to carbon dioxide, ammonia and short chain fatty acids.

Ammonia production

The ammonia in rumen liquor is the key intermediate in the microbial degradation and synthesis of protein. Parts of the ammonia produced in the rumen liquor is utilized by the rumen bacteria along with carbon moiety to synthesize the microbial proteins, and excess of ammonia is absorbed into the blood, carried to the liver and converted to urea.

Urea recycling

It is now well established that blood urea enters back into the rumen directly by transfusion through rumen wall and also indirectly through saliva. The process would be of great value to animals on low nitrogen intake.

Urea toxicity symptoms

Nervousness, muscle tremors, difficulty in respiration, excessive salivation, bloat, tetany, convulisons and death within 2 to 3 hours are the symptoms of urea toxicity. The severity of symptoms depends upon the dose of urea intake.

Protein metabolism

Dietary proteins are digested through the action of proteolytic enzymes to amino acids. These amino acids are absorbed through the small intestine into the portal blood. Major site of absorption of amino acids is proximal2.j3rd of small intestine. Absorption is an active type in which transport of sodium is involved. Tripeptides are absorbed more rapidly than dipeptides, which are in turn faster than free amino acids. There is a competition for absorption within groups of free amino acids, viz, acidic, basic, neutral and amino acids but no competition between groups which suggests that slightly different mechanisms of transport exist for different chemical configurations. They are transported to the liver and then to the systemic blood circulation. Amino acid of the blood pool serves as a major source for tissue protein synthesis. Excess of amino acids, which are not required for synthesis of tissue protein, hormones, enzymes etc. are catabolized in the liver tissues. The catabolism of amino acid involves deamination whereby ammonia and a-keto-acid are formed. The released ammonia is converted into urea or may be utilized by a-keto acid to form amino acid. Amino acid degradation take place mainly in the liver although, the kidney shows considerable activity, unlike muscular tissues which is relatively inactive.

Urea formation

One of the consequences of amino acids metabolism is the production of ammonia, which is highly toxic. Some of this may be used in the amination of amino acids synthesis in the body. Most is excreted from body, as urea in mammals and uric acid in birds.

Utilisation of amino acids

The absorbed amino acids in the body are utilised for various functions.

1. For the protein synthesis.

2. For the synthesis of essential amino acids.

3. As a source of energy and ammonia.

4. For a special function - various important compounds are formed from amino acids which are very helpful in living system.

Histidine — Histamine

Glycine — Purine

Aspartic acid — Purine & pyrimidine

Protein synthesis

Proteins are synthesized from amino acids, which become available as the end products of digestion or as the result of synthetic processes within the body. Direct amination may take place as in the case of a- ketoglutarate, which yields glutamate_ The glutamate may undergo further amination to give gluatmine and undergo transamination reactions with various keto acids to give amino acids. Amino acids other than glutamate may undergo such transaminations to produce new amino acids. Thus both alanine and glycine react with phosphohydroxypyruvate to give &erine.

The process of protein synthesis may be divided into four stages:

1. Activation of individual amino acids.

2. Initiation of peptide chain formation.

3. Chain elongation.

4. Chain termination.

Factor affecting protein utilization in ruminants:

Various factors affect the protein utilization in ruminants, which are described below.

1. Dietary level of protein: Protein utilization if improved by increasing the level of protein in the diet up to the level of requirements however, more protein supplement above the requirement is not properly utilized.

2. True protein nitrogen (TPN) vs. Non-protein nitrogen (NPN) ratio: True protein is the best source of nitrogen which is followed by mixture of TPN + NPN and then NPN.

3. Degradability of protein: Protein utilization is decreased as the degradability of protein in rumen is increased.

4. Indigestible nitrogen content in diet: Indigestible nitrogen present in feed is due to damage of protein.

Protein deficiency Symptoms

It includes reduced feed intake and utilization, reduced growth rate, infertility, reduced serum protein concentration, accumulation of fat in the liver and carcass, reduced synthesis of certain enzymes and hormones resulting depression of most metabolic activities which may lead even to early death.

Amino acid deficiency

It is a condition in which the dietary supply of one or more of the essential amino acids is less than that required for the efficient utilization of other amino acids and other nutrients. Diets are in general unlikely to be completely devoid of anyone or more amino acids but may be deficient in respect of required quantity.