Lecture title: Animal nutrition: Digestion of Nutrients

Lecturer Affiliation: *Professor, Dr.* ***Muntaha Ghazi Hasan***

Department of Public Health,College of Veterinary Medicine, University of Mosul, Mosul, Iraq
https://orcid.org/ 0000-0001-7250-0117

Summary:

In ruminants There are positive relationships among feed intake, the turnover rates of ruminal liquid, particles and bacteria, and microbial fermentation efficiency.
First: the number of ruminal microbes depends on their ability to reproduce at a rate equal to or greater than their losses from the rumen.
Second: the survival of ruminal microbes is enhanced by their attachment to feed particles.
Third: the efficiency of ruminal microbes to digest feedstuffs is increased when the transit of the feed particles through the rumen is prolonged.
Ruminal organic-matter digestion will be reduced when the total number of ruminal microbes is lowered. Microbial fermentation efficiency is very important for the ruminant because the host needs both short-chain fatty acids (SCFAs) and microbial protein for survival, growth, and reproduction. The digestion processes are important and may be grouped into:

Mechanical: The mechanical activities are mastication and the muscular contractions of the alimentary canal.
Chemical: The main chemical action is brought about by enzymes secreted by the animal in the various digestive juices.
Microbial: Microbial digestion of food, also enzymic, is brought about by the action of bacteria, protozoa and fungi, microorganisms that are of special significance in ruminant digestion

Microbial Digestion in Ruminants:

Ruminants have evolved a special system of digestion that involves microbial fermentation of food before its exposure to their own digestive enzymes. Herbivores other than ruminants, such as the horse, have adopted systems of microbial digestion that differ from those of ruminants. Ruminant teeth and Powerful muscles help in chewing actions of feeds and are adapted for the efficient comminution of fibrous foods. The food is diluted with copious amounts of saliva, first during eating and again during rumination: typical quantities of saliva produced per day are 150 l in cattle and 10 l in sheep. Rumen contents have 850–930 g water/kg on average, but they often exist in two phases: a lower liquid phase, in which the finer food particles are suspended, and a drier upper layer of coarser solid material

Saliva is about 99 % water, the remaining 1% consisting of:

- mucin
- inorganic salts
- enzymes -amylase
- complex lysozyme.

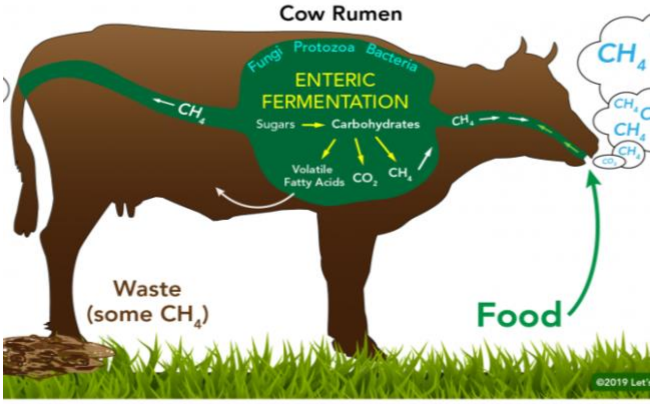
Some animals, such as the horse lack salivary amylase.

The main functions of saliva included:

1-Lubricating agents: water and mucin
2-Solvent action: dissolve food and stimulate taste buds
3-Buffering action: bicarbonate to prevent ulceration
4-Nutritive values: mucin, p and N
5-Anti frothing agents: prevent the formation of foams in rumen by block eructation

The contents of the rumen are continually mixed by the rhythmic contractions of its walls. Any liquid is rapidly swallowed again, but coarser material is thoroughly chewed before being returned to the rumen. The major factor inducing the animal to ruminate is the tactile stimulation of the epithelium of the anterior rumen; The time spent by the animal in rumination depends on the fibre content of the food. In grazing cattle, it is commonly about 8 hours per day, or equal to the time spent in grazing. Each bolus of food regurgitated is chewed 40–50 times.

Food and water enter the rumen and the food is partially fermented to yield principally volatile fatty acids, microbial cells and the gases methane and carbon dioxide. The gases are lost by eructation (belching) and the volatile fatty acids are mainly absorbed through the rumen wall. The microbial cells, together with undegraded food components, pass to the abomasum and small intestine; there they are digested by enzymes secreted by the animal, and the products of digestion are absorbed. In the large intestine there is a second phase of microbial digestion. The volatile fatty acids produced in the large intestine are absorbed, but microbial cells are excreted with undigested food components in the faeces. The acids produced by fermentation are theoretically capable of reducing the pH of rumen liquor to 2.5–3.0, but under normal conditions the pH is maintained at 5.5–6.5. Phosphate and bicarbonate contained in the saliva act as buffers; in addition, the rapid



absorption of the acids and ammonia helps to stabilize the pH. The main organ for the absorption of dietary nutrients by the monogastric mammal is the small intestine. This part is specially adapted for absorption because its inner surface area is increased by folding and the presence of villi. Although the duodenum has villi, this is primarily a mixing and neutralizing site, and the jejunum is the major absorptive site. Absorption of a nutrient from the lumen of the intestine can take place by passive transport, involving simple diffusion, provided there is a high concentration of nutrient outside the cell and a low concentration inside. Another method of absorption is by pinocytosis 'cell drinking,' in which cells have the ability to engulf large molecules in solution or suspension. Such a process is particularly important in newborn suckled mammals in which immunoglobulins present in colostrum are absorbed intact.

Carbohydrates digestion:

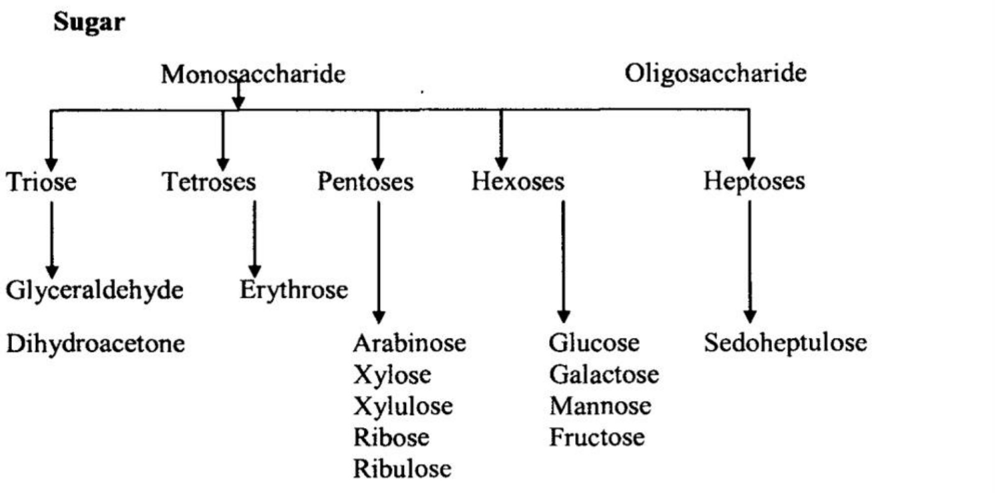
It is a major part of plant tissues include about 70% of dry matter in forages, in cereals grains carbohydrates concentrations reach to about 85%. The carbohydrates are a major source of energy in animal life, and they have many functions:

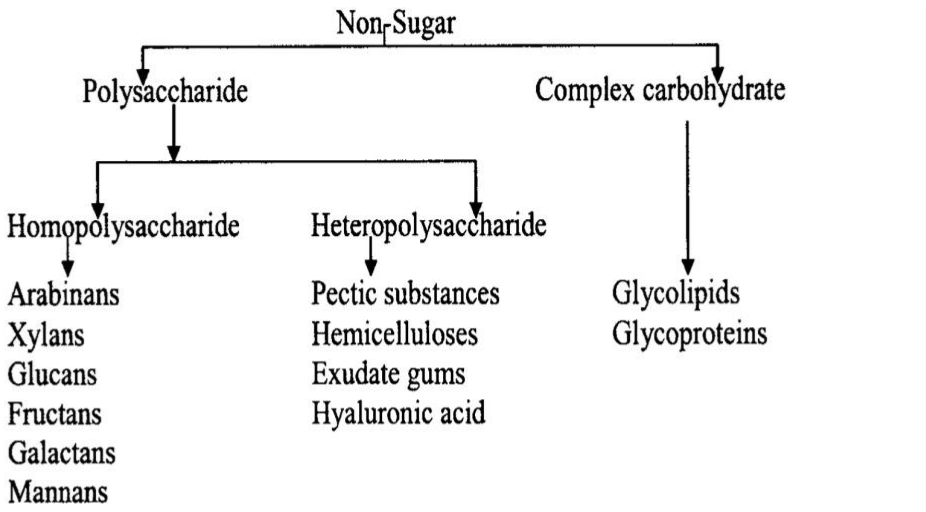
1.Carbohydrates serve as a major source of energy in animal body.
2. They are essential components of production, temperature control
3. They are essential components of milk as lactose.
4. They are stored as glycogen, excess of carbohydrates in the diet is converted into fat and stored in the fat depot. These are reserve energy materials of the body in liver. and muscles of animals and starch in plants.
5. They are helpful in absorption of calcium and phosphorus in younger animals.
6. They help the secretion of digestive juices in gastrointestinal tract.
7. They provide suitable environment for the growth of rumen bacteria and protozoa.
8. They maintain the glucose level of plasma.
9. They are also component of several important biochemical compounds such as nucleic acids, coenzymes, and blood group substance.
10. They play a key role in the metabolism of amino acids and fatty acids

Classification of carbohydrates:

carbohydrates are classified into five groups:

1. Monosaccharides (simple sugars)
2. Disaccharides (having 2 monosaccharide units)
3. Oligosaccharides (having 3–10 monosaccharide units)
4. Polysaccharides (having more than 10 monosaccharide units) subdivided into homopolysaccharides (having only one type of monosaccharide) and heteropolysaccharides (having more than one type of monosaccharide)
5. Conjugated carbohydrates. (bound to lipids or proteins to form glycolipids or glycoproteins, respectively).





Lignin, which is not a carbohydrate but is closely associated with this group of compounds, confers chemical and biological resistance to the cell wall, and mechanical strength to the plant. Lignin is of particular interest in animal nutrition because of its high resistance to chemical degradation. Physical incrustation of plant fibers by lignin makes them inaccessible to enzymes that would normally digest them. There is evidence that strong chemical bonds exist between lignin and many plant polysaccharides and cell wall proteins that render these compounds unavailable during digestion.The diet of the ruminant contains considerable quantities of cellulose, hemicelluloses, starch and water-soluble carbohydrates that are mainly in the form of fructans.in young pasture herbage, which is frequently the sole food of the ruminant, each kilogram of dry matter may contain about 400 g cellulose and hemicelluloses, and 200 g of water-soluble carbohydrates. In mature herbage, and in hay and straw, the proportion of cellulose and hemicelluloses is much higher, and that of water-soluble carbohydrates is much lower.the rumen microorganisms; the principal bacterial species involved are Fibrobacter succinogenes and the Ruminococci. Lignin hinders the breakdown of the cellulose with which it is associated. Thus, in young pasture grass containing only 50 g lignin/kg DM, 80 % of the cellulose may be digested, but in older herbage with 100 g lignin/kg, the proportion of cellulose digested may be less than 60 %. diets based on cereals may contain as much as 500 g/kg of starch (and sugars), of which over 90 % may be fermented in the rumen and the rest digested in the small intestine. This fermentation is rapid, and the resulting fall in the pH of rumen liquor inhibits cellulose-fermenting organisms and thus depresses the breakdown of cellulose.