# COMPARATIVE PHYSIOLOGY OF DIGESTION

The digestive tract is a muscular tube extending from the mouth to the anus. Its functions are grinding of food, digestion and absorption of food as well as elimination of solid wastes. Portions of the digestive system are the mouth, pharynx, oesophagus, stomach, small intestine, large intestine and the accessory glands which are the salivary glands, the liver and the pancreas.

The mouth is used primarily for grinding of food and mixing it with saliva. It also serve as a grasping (prehensile) mechanism and as a defensive and offensive weapon.

The soft and flexible lips of sheep and goats are used in picking up food while in cattle and pigs, the stiff and immobile lips functions in closing the mouth.

The cheeks aid the tongue in positioning food between the teeth for grinding.

Oesophagus is linked the mouth and the stomach. Bolus of food is forced into the stomach when the muscles of the oesophagus contracts in a caudally directed wave-like pattern or peristalsis.

## PHYSIOLOGY OF DIGESTION IN NON-RUMINANT (MONOGASTRIC)

The stomach of non-ruminants is shaped like a bent-pear. The stomach secretes gastric juice containing pepsin, rennin, gastric lipase and HCl. Proteins are converted by pepsin to proteoses and peptone in the stomach and the digestion of protein is completed in the intestine. Rennin is found in the gastric juice of calves, lambs, kids and possibly piglets. It is an enzyme that causes coagulation of milk in the presence of calcium ion. Gastric lipase helps in the emulsification of fats. HCl activates pepsin and rennin and aids pepsin in protein digestion by lowering the pH of the stomach contents.

The small intestine joins the stomach at the duodenum and large intestine at the Ileum. The pancreas secretes pancreatic juice into the duodenum. Pancreatic proteases (trypesin, chymotrypsin and carboxypeptidases) convert proteins to peptides. Pancreatic amylase converts starch to dextrins and maltose while pancreatic lipase converts fats into fatty acids and glycerol.

Bile (a greenish-yellow liquid) is secreted by the liver and passes directly into the duodenum through the bile ducts. Bile emulsifies fat and aid in the maintenance of an alkaline pH in the intestine.

Intestinal secretions are produced by the intestinal glands and duodenal glands. These includes

Maltase - hydrolyses maltose to glucose

Sucrase - hydrolyses sucrose to glucose and fructose

Lactase - hydrolyses lactose to glucose and galactose

Peptidase - hydrolyses peptides to amino acids

Nucleotidase - hydrolyses nucleotides into nucleosides and phosphoric acid

Nucleosidase - hydrolyses nucleosides.

Materials moved by peristalsis out of the large intestine or colon are faeces. These are periodically passed through the rectum and anus in the act of defaecation.

## PHYSIOLOGY OF DIGESTION IN RUMINANT

The ruminant stomach is complex and is divided into four chambers namely rumen, reticulum, omasum and abomasum.

The major feature of ruminant digestion is that microbial digestion or fermentation takes place on a large scale in the rumen and reticulum due to the presence of large numbers of bacteria and protozoa. Properties which allow microbial digestion of food in these regions include

- large capacity of the stomach
- near neutral pH (5.0 – 7.0) of the fluid environment
- slow passage of ingesta through the fermentation site
- continuous removal of the end-products of fermentation.

Soluble carbohydrates are rapidly fermented while structural components of plant tissues – cellulose, hemicellulose and lignin are more slowly fermented. The end produce of carbohydrate fermentation are simple volatile fatty acids (VFA), $CO_2$ and methane ($CH_4$).

Proteins are hydrolysed by rumen microorganisms to free amino acids which are later degraded by fermentative deamination to produce ammonia and short chain fatty acids. Some of the ammonia or amino acids are used to form new bacterial cells and these are eventually digested in the abomasum to provide the animal's requirements of amino acids.

Lipids are hydrolysed by rumen microbes to fatty acids and glycerol. Rumen microbes are able to synthesize the B vitamins required by the ruminant animals.

The omasum compresses the ingesta and withdraws fluid from it. It also reduces the food materials into finer particles. The abomasum is comparable to the simple stomach of the Monogastric animals and function as such.

The secretions of small and large intestines are similar to those of Monogastric animals. However, further fermentative digestion takes place in the colon and caecum to produce volatile fatty acids.

Absorption of Carbohydrate, Protein and Fat

In the Monogastric animals, simple sugars are absorbed across the wall of the duodenum and ileum. Absorption of amino acid is rapid in the duodenum and jejunum but slow in the ileum. Fat absorption is greatest in the upper parts of the small intestine, but appreciable amounts are also absorbed in the ileum.

In ruminants, the VFA produced in the rumen are absorbed through the rumen wall. Other substances absorbed through the rumen and reticulum walls include lactic acid, ammonia, chloride, sodium and potassium. The epithelia of the omasum and abomasums also permit the absorption of some VFA.

# PHYSIOLOGY OF DIGESTION IN FOWL

The digestive system of the fowl consists of the mouth, oesophagus, crop, proventiculus, gizzard, small intestine and large intestine.

The mouth begins at the cranial tip of the beak. There are no lips and teeth. The beak is used to break large food materials into smaller bits. The salivary glands secrete saliva which coats and lubricates the food material as it passes into the oesophagus. The oesophagus is relatively long because of the long neck in the fowl. At the base of the neck the oesophagus expands to form a thin-walled structure, the crop. The crop function as a reservoir of food materials especially whole grains for partial fermentation by salivary amylase. The food material passes into the stomach which is divided into two portions, the proventriculus and gizzard. Gastric juice is secreted in the proventriculus before the food moves into the gizzard. The gizzard breaks down grains into smaller bits with the aid of grits. This can then be more readily digested by the gastric enzymes.

The small intestine consists of 3 portions, duodenum, jejunum and ileum. Digestion of food materials continues and pancreatic juice is added at the duodenum. The enzymes in the pancreatic juice of the fowl are similar to those of the mammals except that lactase is absent. All non-digested food materials are passed into the large intestine which is divided into caecum, colon and rectum. Glucose and amino acids are absorbed in the small intestine; water and other digested materials are absorbed in the caecum. The faeces passes from the colon into the rectum and out through the cloaca.