Evolution of Food : Digestibility

Digestibility: Digestible part of foods or nutrients is the proportion which is absorbed by the animal, which is not excreted in the faeces.

The chemical analysis is the first step for determining the nutritive value of feed, but the actual value of ingested nutrients depends on many factors. The first, and perhaps the most important consideration is .digestibility!.

Digestion studies generally consist of two periods:

1- Adjustment/adaptation period to free digestive tract of any prior undigested feed and accustom animal to test feed/ingredient and the facility.

2- Collection period - Actual collection of feces (& also feed samples).

Adjustment & collection periods of (3 - 5) days For pigs whereas these periods must be extended to (8 or 10) days for ruminant species.

In ruminants There are positive relationships among feed intake, the turnover rates of ruminal liquid, particles and microbes, 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: 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 requires 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

Measurement Of Digestibility

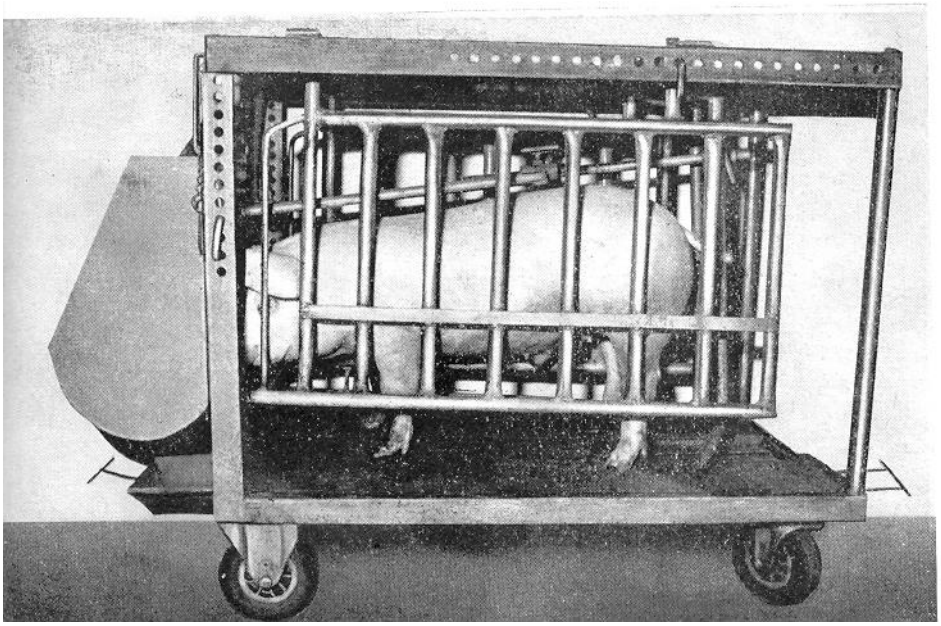
There are three methods to Measurement Of Digestibility:

Digestibility trials

In a digestibility trial, the food under investigation is given to the animal in known amounts and faecal output is measured. More than one animal (typically four) are used, because animals, even of the same species, age and sex, differ slightly in their digestive ability, and because replication allows more opportunity for the

detection of experimental error. In trials with mammals, male or castrated animals are preferred to females because it is then easier to separate the faeces from the urine. The animals should be docile and in good health. Small animals can be confined in metabolism cages, which facilitate the separation of faeces and urine by an arrangement of sieves. In larger animals such as cattle and sheep are fitted with harnesses and faeces-collection bags made of rubber or a similar impervious material. For females a bladder catheter can be used to separate the urine from the faeces. In poultry, the determination of digestibility is complicated by the fact that faeces and urine are voided from a single orifice, the cloaca. The compounds present in urine are mainly nitrogenous, and faeces and urine can be separated chemically if the nitrogenous compounds of urine can be separated from those of faeces. Typically a digestibility trial consists of three periods, each lasting for 7–10 days. During the adaptation period, animals are gradually adapted to the experimental diet. Finally, during the collection period, food intake and faecal output are recorded. A longer collection period generally provides more accurate results. The general formula for the calculation of digestibility coefficients is:

$$\frac{\text{nutrient consumed} - \text{nutrient in faeces}}{\text{nutrient consumed}}$$



Indicator methods

In some circumstances the lack of suitable equipment or the particular nature of the trial makes it impractical to measure either food intake or faecal output directly. For instance, when animals are fed as a group or in a grazing situation, it may be impossible to measure the intake of each individual. However, digestibility can still be measured if the food contains some indicator substance that is known to be completely indigestible. If the concentrations of this indicator substance in the food and in small samples of the faeces of each animal are then determined, the ratio between these concentrations can be used to calculate digestibility. For example, if the concentration of the indicator increased from 10 g/kg DM in the food to 20 g/kg DM

in the faeces, this would mean that half of the dry matter had been digested and absorbed. In equation form this is presented as:

$$\text{Dry matter digestibility} = \frac{\text{indicator in faeces (g>kg DM)} - \text{indicator in food (g>kg DM)}}{\text{Indicator in faeces (g>kg DM)}}$$

Internal or external indicators may be used. Internal indicators are natural constituents of the food such as lignin, acid-indigestible fibre or acid-insoluble ash (mainly silica). More recently, the long-chain hydrocarbons (*n*-alkanes, C25–C35) found in the waxy cuticle of leaves have been used as internal indicators, especially in grazing studies. External indicators are substances that are added to foods. Chromic oxide (Cr2O3) is perhaps the most common external indicator as it is very insoluble and hence indigestible; moreover, chromium (Cr) is not present as a natural constituent of most foods. In non-ruminant nutrition, titanium oxide (Ti2O3) is often used as an external indicator.

External indicators such as chromic oxide may also be used to estimate faecal output rather than digestibility. In this application, the indicator is normally given for 10– 15 days in fixed amounts (e.g. administered in a gelatin capsule) and once its excretion is assumed to have stabilized its concentration in faecal samples is determined. Faecal dry matter output (kg/day)

Laboratory methods

Since digestibility trials are laborious and expensive to carry out, numerous attempts have been made to determine the digestibility of foods by reproducing in the laboratory the reactions that take place in the alimentary tract of the animal. Digestion in non-ruminants is not easily simulated in its entirety, but the digestibility of food protein may be determined from its susceptibility to attack in vitro by pepsin and hydrochloric acid. It is also possible to collect digestive tract secretions via cannulae and to use them to digest foods in vitro.

The digestibility of foods for ruminants can be measured quite accurately in the laboratory by treating them first with rumen liquor and then with pepsin. During the first stage of this so-called two-stage in vitro method, a finely ground sample of the food is incubated for 48 hours with buffered rumen liquor in a tube under anaerobic conditions. In the second stage, the bacteria are killed by acidifying with hydrochloric acid