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Dietary energy and its partition within the animal

An animal requires energy for both maintenance and production،energy associated with the synthesis of essential body constituents such as enzymes and hormones. In animal nutrition primary demand for energy is to meet this maintenance requirement and to prevent the catabolism of body tissues and maintain the body temperature at a higher level.
Energy supplied by food in excess of the maintenance requirement is used for production :
-In young growing animals, energy is stored in new tissues primarily as protein.
-In Mature animals, an increasing proportion is stored as fat.
-In pregnant and lactating animals, energy is stored in the products of conception (fetus and placenta) and in milk constituents, respectively.
-Also energy required for activity or exercise and the energy required for the synthesis of wool or eggs.

Calorie:it's the amount of heat required to raise the temperature of 1 gm of water by 1 ^{O}C

1kilocalorie (kcal) =1000 calories
1 Mega calorie (Mcal)= 1000kcal.
1 calorie = 4.184 joules (j)
1 kilocalorie = 4.184 kilojoules (kJ).
1 kilojoule= 0.239 kcal.

Main types of energy in animal feed and nutrition
1-Gross energy ————-> fecal energy
2-Digestible energy ————>loss in urine and methane
3-Metabolizable energy ————-> heat increment
4-Net energy ————-> maintenance and production

Gross energy (GE)
Gross energy is the amount of heat arising from the complete oxidation of a unit weight of feed

chemical components of feed ——> chemical energy —(oxidizing)——> heat by.

Proteins have a higher GE content than carbohydrates because they contain the additional oxidizable elements nitrogen and sulphur. Methane has a very high GE content because it consists entirely of carbon and hydrogen.

gross energy values of foods (MJ/kg DM):
Maize grain 18.5
Oat grain 19.6
Oat straw 18.5
Linseed-oil meal 21.4
Grass hay 18.9
Milk (400 g fat/kg) 24.9

Some of gross energy is lost from the animal as various solid, liquid or gaseous excretory products, and some is lost as heat.These sources of energy loss are illustrated in Fig. 1.

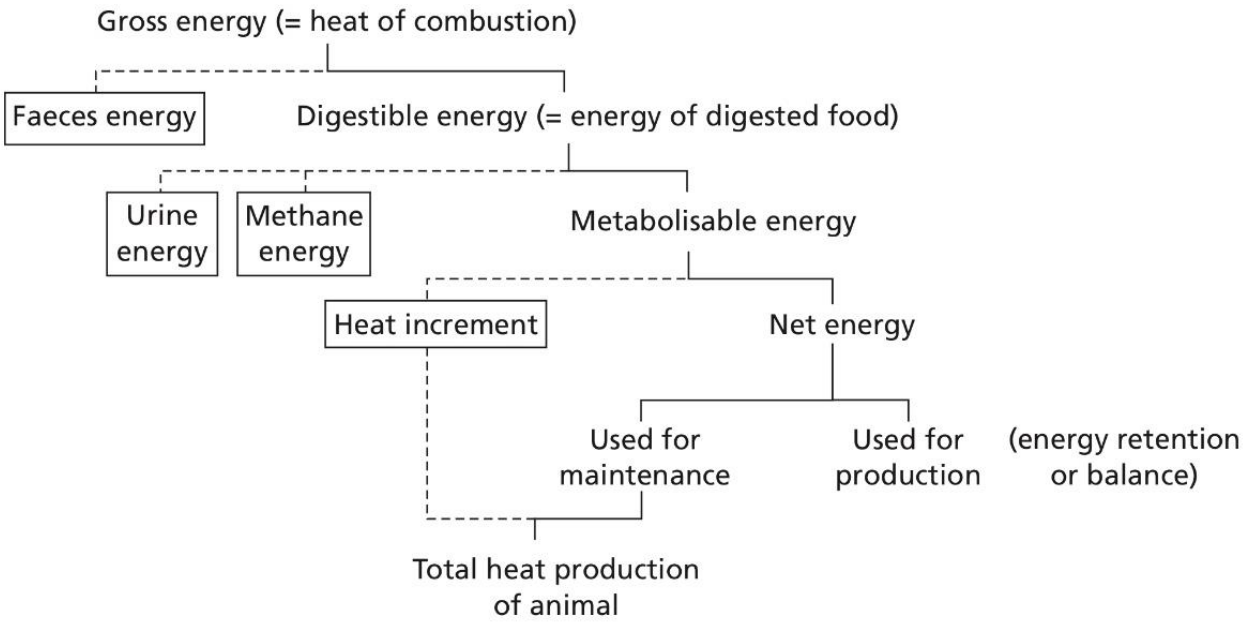

Figure 1. The partition of food energy in animals

Digestible energy (DE)
Digestible energy represents energy absorbed by the animal.Apparent digestible energy is calculated as the GE provided by a unit of food minus the GE content of the faeces resulting from the consumption of that unit of food. DE is a far better measure of the energy available to support animal production than GE.

Example:

Sheep consumed 1.63 kg hay and excreted 0.76 kg faecal DM. If we assume that the GE content of the hay and the faeces, determined by bomb calorimetry, were 18.0 MJ/kg DM and 18.7 MJ/kg DM, respectively, then the total GE intake would be 29.3 MJ/day and the total GE output would be 14.2 MJ/day. The apparent GE digestibility and digestible energy content of the hay would be calculated as follows:

$$\text{GE digestibility} = \frac{29.3 - 14.2}{29.3} = 0.515$$

DE = 18.0 * 0.515 = 9.3MJ/kgDM

Metabolizable energy (ME)
Metabolizable energy represents energy that is available for use by the animal and is calculated as DE minus energy lost in urine and combustible gases .The energy lost in urine is present as :
-nitrogen-containing compounds such as **urea**, **hippuric acid**, **creatinine** and **allantoin**
- non-nitrogenous compounds such as **glucuronates** and **citric acid**.

ME=energy in the food–energy lost in faeces + energy lost in combustible gases + energy lost in urine.

Normally about 8% of gross energy intake is lost through the methane production, losses of energy in methane and in urine are greater for ruminants than for non- ruminants.

Factors affecting the metabolizable energy values of foods

1. Species of the animal
2. Composition of feed
3. Type of digestion
4. Level of feeding

Basal metabolism : it's a condition in which a minimal amount of energy is sustain the body.
Factors affect of basal metabolism are:

1. Age
2. Species
3. Breed
4. Neuroendocrine

Heat increment of foods:
Animals are continuously producing heat and losing it to their surroundings, either :
-directly by radiation, conduction and convection
-indirectly by the evaporation of water.

If a fasting animal is given food, then within a few hours its heat production will increase above the level represented by basal metabolism. This increase is known as the heat increment of the food**;** The heat increment may be expressed in absolute terms (MJ/kg DM). The causes of the heat increment are to be found in the processes associated with digestion of foods and metabolism of the nutrients derived from them. Protein metabolism is estimated to account for about 10 % of the animal's heat production.

heat increment of foods varies considerably, depending on :
-the nature of the food
-the type of animal consuming it
- the various processes for which nutrients are used.

Net energy (NE) :
Net energy used for maintenance is mainly used to perform work within the body and will leave the animal as heat. It is a portion of ME which may be used as needed by the animals for work , growth, fattening, fetal development, milk , egg or wool production. the quantity so used is referred to as the animal's energy retention. Subtraction of the heat increment of a food from its ME value gives the net energy (NE) value of a food.

expressing the energy value of feeds and requirements of animal is various system are followed in different countries are as follows:

1. Total digestible nutrients (TDN)
2. Starch equivalent (SE)
3. Gross energy (GE)
4. Digestible energy (DE)
5. Metabolizable energy (ME)
6. Net energy (NE)
7. Scandinavian food unit
8. Mollgaard,s values.