Factors affecting the metabolisable energy values of foods

The table shows the ME values of a number of foods. It is clear that, of the energy losses so far considered, faecal losses are by far the most important. Even for highly digestibility foods such as barley, twice as much energy is lost in the faeces as in the urine and methane.

Animal	Food	Gross energy	Energy lost in Faeces	Urine	Methane	ME
Fowl	Maize	18.4	2.2		–	16.2
	Wheat	18.1	2.8		–	15.3
	Barley	18.2	4.9		–	13.3
Pig	Maize	18.9	1.6	0.4	–	16.9
	Oats	19.4	5.5	0.6	–	13.3
	Barley	17.5	2.8	0.5	–	14.2
	Coconut cake meal	19.0	6.4	2.6	–	10.0
Sheep	Barley	18.5	3.0	0.6	2.0	12.9
	Dried ryegrass (young)	19.5	3.4	1.5	1.6	13.0
	Dried ryegrass (mature)	19.0	7.1	0.6	1.4	9.9
	Grass hay (young)	18.0	5.4	0.9	1.5	10.2
	Grass hay (mature)	17.9	7.6	0.5	1.4	8.4
	Grass silage	19.0	5.0	0.9	1.5	11.6
Cattle	Maize	18.9	2.8	0.8	1.3	14.0
	Barley	18.3	4.1	0.8	1.1	12.3
	Wheat bran	19.0	6.0	1.0	1.4	10.6
	Lucerne hay	18.3	8.2	1.0	1.3	7.8

The main factors affecting the ME value of a food are:

1. **digestibility**.
2. **species of animal** . The effect of animal species is that differences between cattle and sheep in urine and methane losses of energy are small and of no significance.
3. **intervention of microorganisms**: Fermentative digestion, in the rumen or further along the gut, incurs losses of energy as methane. A lesser effect of the intervention of microorganisms in digestion is an increase in the losses of energy in either urine (as the breakdown products of the nucleic acids of bacteria that have been digested and absorbed) or faeces (as microorganisms grown in the hind gut and not digested).

In general, losses of energy in methane and in urine are greater for ruminants than for nonruminants, and so foods such as concentrates, which are digested to the same extent in ruminants and non-ruminants, will have a higher ME value for non-ruminants. However, fibrous foods given to non-ruminants will also incur losses due to fermentative digestion in the hind gut. In ruminants, foods such as silages that have been fermented before consumption by the animal will incur smaller energy losses in digestion but will already have incurred losses in the silo. Thus, silages are said to contain less fermentable metabolisable energy (FME) than comparable foods such as hays; this difference, however, is of greater importance to the protein nutrition of ruminants than to energy nutrition.

4. **whether the amino acids supplied are retained by the animal for protein synthesis:** The ME value of a food will vary depending on whether the amino acids supplied are retained by the animal for protein synthesis or deaminated and their nitrogen excreted in the urine as urea.
5. **level of feeding and the manner**: In ruminants, increases in the level of feeding and the manner in which food is processed may in some cases affect its ME value. As

discussed earlier, increases in the level of feeding, or the grinding and pelleting of forages, result in higher rates of passage and increased faecal energy loss. However, this may be partly offset by reductions in methane production. Nevertheless, for finely ground roughages and for mixed roughage and concentrate diets, ME values are reduced by increases in level of feeding. For poultry, the grinding of cereals has no consistent effect on ME values.

In theory it should be possible to prevent the production of methane in the rumen and thereby avoid losing 8–12 per cent of gross energy intake in this form.

6. **adding antimicrobial drugs:** In practice it is possible to suppress methane production by adding antimicrobial drugs to the diet (one effective chemical is chloroform), but the consequences are not consistently favourable. Energy may be diverted to another gaseous by-product, hydrogen ; furthermore, the rumen microorganisms may adapt to the presence of the drug and revert to the synthesis of methane.

7- Associative effects : The digestibility of a food is influenced not only by its own composition but also by the composition of other foods consumed with it. Associative effects of this kind have also been observed in relation to the efficiency of ME utilization. In one experiment, ME derived from maize meal was used for gain with an apparent efficiency varying between 0.58 and 0.74, depending on the nature of the basal diet to which it was added. In ruminants, such differences are likely to arise through variations in the way in which the whole diet is digested, and hence in the form in which energy substrates are absorbed. The implications are that values for the efficiency of ME utilization for individual foods are of limited significance.

8- Balance of nutrients : The effects of the relative proportions of nutrients in a diet have been partly covered above. However, a fattening animal will tend to use metabolisable energy more efficiently if it is provided as carbohydrate rather than protein. Similarly, if a growing animal is provided with insufficient protein, or with insufficient amounts of a particular amino acid, then protein synthesis will be reduced and it will tend to store energy as fat rather than protein. In this situation, the efficiency of ME utilization will probably be altered.

Mineral and vitamin deficiencies can also interfere with the efficiency of ME utilization. A deficiency of phosphorus has been shown to reduce the efficiency of ME utilization in cattle by about 10 per cent. This effect is hardly surprising given the vital role of phosphorus in the energy-yielding reactions associated with intermediary metabolism.

Net energy (NE) and energy retention

Subtraction of the heat increment of a food from its ME value gives the net energy (NE) value of a food. The NE value of a food is the energy that is available to the animal for useful purposes . for body maintenance and for various form of production.

Net energy used for maintenance is mainly used to perform work within the body and will leave the animal as heat. That used for growth and fattening and for milk, egg or wool production either is stored in the body or leaves it as chemical energy, and the quantity so used is referred to as the animal's energy retention.