ENERGETIC FEED VALUE OF GRASSLAND PRODUCTS IN RUMINANTS

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ABSTRACT

A method for calculating the energetic feed value, based on the digestible nutrients and on the relations of the utilisation of the energy of the nutrients (carbohydrates = 100) for ATP syntheses is described.

This relative scale is a nominal feed value (NFV). It characterises the ATP potential of the feedstuffs and is therefore equivalent to the efficiency of utilisation of the feed energy in the catabolic metabolism (non-thermal maintenance, muscular work (movement)) and energy costs for syntheses as well as the productive performance as energy retention in animal products.

Therefore this scale secures a precise precognition of the animal performance and regulation of production for all kinds of ruminants and direction of production with the exception of the chemical heat regulation under special environmental and production conditions. The NFV can be transmitted for practical use in the other adopted and country-specific units. A general compatibility between the various feed evaluation systems could be achieved.

KEYWORDS

ruminants, energetic feed value, metabolizable energy, net energy, digestible nutrients, energy utilisation, ATP-potential/-syntheses, feed evaluation

INTRODUCTION

The **energetic feed value (EFV)** is up to now expressed in scales of digestible or metabolizable energy or kinds of net energy. The scales are independent from the different efficiency of the nutrients in the intermediate energy metabolism (digestible and metabolizable energy) or depend on the selected direction of production (net energy fat, lactation or growth) respectively. Therefore the figures of the EFV are very different, not compatible and comparable. They must be adapted and transferred to the special kinds of animals and/or directions of production. This situation is especially unsatisfactory for ruminants considering the necessity of a proper evaluation of grassland products varying in wide limits.

The aim of this work is to propose a method for expressing a universal energetic feed value for ruminants in connection with the economic demands, to create and implement a uniform system of energetic feed evaluation on a scientific basis for all animal species and directions of production.

FUNDAMENTALS

The substance and energy metabolism in ruminants is characterised by specialised energy transfer in the rumen (figure 1). The ATP-potential of the feed nutrients is transferred in the micro-organism and in the end products of fermentation. They are further fermented in the rumen and/or in the intestinal tract, resorbed and occur as products of decomposition in the intermediate metabolism. The ATP-bounded energy is gradually used up on the different levels of the metabolism in analogy to a cascade up to the surplus (excess) of ATP-potential stored materially as body substance (body fat or protein) and secretory products (milk). Therefore all these processes of energy utilisation are related to ATP-syntheses. The efficiency of energy utilisation is depending as well on synthesis of body substance from the part of direct incorporation of amino and fatty acids in body fat and body protein as on the volume of "turn-over reactions".

Above the "heat requirement" the energy metabolism can be subdivided in the reactions for covering the non-thermal maintenance requirement, for syntheses and "turn-over" of body nutrients and secretions and for muscular work. These metabolic processes need ATP-bounded energy and are equivalent to the ATP-potential of the feed (and/or metabolised body nutrients). The synthesised and in animal products (gain and secretion) accumulated nutrients are really not integrated in this actual energy metabolism.

The consequences for the **definition of the energetic feed value** are, that we need an additive scale, which characterises the energetic potential (net energy) and the energetic equivalence of feed nutrients in the **catabolic processes for energy use and <u>not</u> for energy retention**.

The scales, related one-sided on retention of animal products, e.g. "Net-Energy-Fat" or "Net-Energy-Lactation (NEL)", are from the physiological point of view an incorrect basis.

UNIFORM SCALE OF ENERGETIC FEED VALUE

It is **not possible to fix an absolute energy value**. Competent after that is not the absolute height of the utilisation, but only the relations between the utilisation of energy in single nutrients. Therefore **only relations of utilisation can be fixed uniformly as a scale for energetic feed value.** Only these relations determine the composition of balanced rations and the economic evidence. The absolute amount of the energetic feed value is in reality an insignificant figure, because it is compensated by the balance of the values of requirement and feed supply. The aim of the research is to find a universal relative energetic scale for all kinds of animals and directions of production.

As such a **uniform scale as basis of expressing the feed value** for all species of farm animals and direction of animal production is determined.

<u>the relations of utilisation of feed nutrients by the syntheses of ATP (table 1)</u>.

The ATP-related net energy is to term as **<u>"Universal Net-Energy (UNE)"</u>**
(analogue proposals of Scheele et al. (1976) for poultry and Martin-Rosset et al. (1992) for horses).

Energy standards have to realise the factors from the animal side as well as for keeping conditions. They are the variable element and must be adapted to the progress in breeding and procedures of production.

ESTIMATION OF ENERGETIC FEED VALUE

The derivation and equation of calculation for the ATP-related energetic feed value is shown in table 1. Referring to the digestible nutrients as substantial coefficients the metabolizable energy of the single nutrients should be transmitted by means of the ATP utilisation relations (starch and sugar = 100) into an "**universal net energy**" as evaluation scale. Thereby the "universal net energy" is only a "Nominal Feed Value (NFV)" and not an absolute figure for the energetic feed value. The Nominal Feed Value can be transmitted within the frame work of practical use always in the other adopted and country-specific units. The factors for transmitting can be estimated from mean rations or several typical feedstuffs. In this simple way a remarkable progress in the shape of general compatibility between the various feed evaluation systems could be achieved without major changes and sacrifices.

Based on the wide application of "Net Energy Lactation (NEL)" in Europe it is proposed, to determine the nominal energetic feed value and standards for energy requirements for all species of animals and direction of production uniform to the dimension of Net Energy Lactation [MJ] (factor for transmitting of ATP-related nominal feed value (ruminants) = 0,67).

In table 2 the feed value and the relations of the energetic feed value (barley = 100) in various systems of feed evaluation are demonstrated. The relative values indicate clearly the overvaluation of the feedstuffs rich in protein (soybean meal 104 %) and in crude fibre (wheat straw 48 %) on the basis of metabolizable energy. In contrary to this the relation of feed value of the ATP-related evaluation with
Barley : soybean meal : dried grass : wheat straw = 100 : 90 : 66 : 39
shows real proportion between concentrates and roughages as well as between roughages of various quality. It agrees very well with the important net energy systems.

CONCLUSIONS

The above described ATP-related scale opened up new prospects (possibilities) for the objective evaluation of the energetic feed value,

especially grassland products in relation to the whole spectrum of feedstuffs in feeding systems for ruminants. It could be possible to achieve a remarkable progress in the shape of general compatibility between the feed evaluation systems.

In some special questions further research work is required. This concerns especially the precision of relations of utilisation by ATP-synthesis from the products of fermentation of fractions of crude fibre in ruminants.

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Table 1
Principe for ATP-related energetic Feed Value for Ruminants.

Term	Calculation				
Metabolizable Energy[1]					
ME [MJ] =	0,0173 dcp +	0,034 dcf +	0,0159 dst +	0,0151 dsu +	0,0154 dcnfe-r
multiply with	x	x	x	x	x
Relations for ATP-syntheses [2] (%)	78	92	100	100	75[3]
Nominal feed value (NFV)					
NFV [MJ]	**= 0,0135 dcp + 0,031 dcf + 0,0159 dst + 0,0151 dsu + 0,0115 dcnfe-r**				

Factor
related to the level of net-energy-lactation or other standards (specific for different countries)
↑ multiplication with constant factor for all kinds of ruminants
↑ Feed value (specific for and compatible to each country)

dcp = digestible crude protein (g/kg)
dcfa = digestible crude fat (g/kg)
dst = digestible starch (g/kg)
dsu = digestible sugar (g/kg)
dcnfe-r = digestible crude nitrogen free extract rest (fibre)(g/kg)
[1] Hoffmann et al., (1993); [2] Chudy und Schiemann (1969); [3] calculated

Table 2
Nominal Feed Value (NFV) and Relations of Energetic Feed Value (Barley = 100) in Different Systems of Feed Evaluation.

Feedstuff	Metabolizable Energy [MJ] actual	new	Net-Energy-Fat [MJ] actual	new	Net-Energy Lactation (NEL) [MJ]	Starch-Units STE	ATP-Evaluation NFW [MJ]	NEL-related
1. Feed Value (per kg dry matter)								
Barley	12,90	13,28	7,13	7,98	8,33	801	12,49	8.33
Soybean meal (Solvent extr. Oil)	14,12	13,85	6,64	6,24	7,94	796	11,21	7,48
Dried grass	10,04	10,14	5,60	5,44	5,67	559	8,20	5,47
Straw (Wheat)	6,21	6,35	3,54	2,40	3,14	270	4,86	3,24
2. Relations of Feed Value (Barley= 100)	1)/ 2)		2)					
Barley	**100**		100	100	100	100		**100**
Soybean meal (Solvent extr. Oil)	**104**		93/91	78	95	99		**90**
Dried grass	**76**		79/76	68	68	70		**66**
Straw (Wheat)	**48**		50/33	30	38	34		**39**

1) without/with correction for digestibility of energy
2) with correction for digestibility of energy
actual = in the Rostock System of Feed Evaluation

Figure 1
Energy Metabolism of Ruminants