THE ENERGETIC UTILIZATION OF FORAGES IN FRESH AND DRIED CONDITION BY RUMINANTS

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ABSTRACT

The influence of dehydration of forages on digestibility and energy utilization was measured by indirect calorimetry in respiration chambers with adult wether sheep as a model for ruminants. Comparisons were carried out between fresh and carefully dried forages (experiment 1) and between fresh and not only carefully but also severely dried forages (experiment 2). Careful drying caused no change, but severe drying decreased energy and especially crude protein digestibility. There were no differences in utilization of metabolizable energy between fresh and carefully or severely dried forages.

KEYWORDS

Forages, dehydration, digestibility, energy utilization, feed evaluation, respiration calorimetry, sheep

INTRODUCTION

Former systematic investigations (Burgstaller et al., 1974; Henk, 1967; Prym, 1970) demonstrated no relevant changes in crude nutrients composition of green fodder by careful drying with temperatures which stop the enzyme activities. The digestibility of crude nutrients can be reduced in dependence on drying temperature. Lower energy utilization of dried forage was found by Heinzl (1944) in one comparison of 18% and by Schoch (1965) of 10%. Graham (1964) measured on average of 4 comparisons about 2% lower and Ekern et al. (1965) in 8 comparisons about 4% higher utilization of metabolizable energy of dried compared with fresh forages. Because of the importance for feed evaluation (Barber, 1984) 2 experiments were carried out to study the effect of careful or severe drying on digestibility, metabolizability and utilization efficiency of metabolizable energy of forages.

METHODS

Adult wethers were used as a model for ruminants. The fresh and dried forages were harvested from the same sward. One half or one third was frozen (-20°C) and the other parts were dehydrated with hot air. In experiment 1 drying was carried out carefully and in experiment 2 both carefully and severely with the following temperatures:

blast-engine	careful drying	severe drying
above	120-160°C	200-210°C
central	90-140°C	130-180°C
below	70-100°C	90-140°C

The following forages were used in the 2 experiments:

Experiment 1

1. Leaves of sugar beet (*Beta vulgaris*) without crowns
2. Forage rye (*Secale cereale*), come into earing
3. Maize (*Zea mays*), Cobs little developed
4. Wheat (*Triticum*) and vetches (Vicia), form leaf-tube
5. Ryegrass (*Lolium perenne*), 1st cut, leaf-stage
6. Clover-grass (*Trifolium pratense, Lolium perenne*), 75:25, before flower
7. Peas-beans-mixture (*Pisum arvense, Vicia faba*), in flower
8. Lucerne (alfalfa) (*Medicago sativa*), 1st cut, coming in bud
9. Oats-peas-mixture (*Avena sativa, Pisum arvense*), oats in milk ripeness, peas at end of flower
10. Green oats (*Avena sativa*), before flower
11. Cocksfoot (*Dactylis glomerata*), 1st cut, before flower
12. Ryegrass (*Lolium perenne*), 2nd cut, before flower, little portion of clover
13. Lucerne (alfalfa) (*Medicago sativa*), 3rd cut, before flower
14. Lucerne (alfalfa) (*Medicago sativa*), 1st cut, before flower
15. Lucerne (alfalfa) (*Medicago sativa*), 3rd cut, coming in flower

Experiment 2

1. Forage rye (*Secale cereale*) coming into ear
2. Lucerne (alfalfa) (*Medicago sativa*), 2nd cut, coming in flower
3. Ryegrass (*Lolium perenne*) and Vetches (Vicia), grass before flower, vetches in flower
4. Clover-grass (*Trifolium pratense, Lolium perenne*) all in flower

Analytical methods for feedstuffs, faeces and urine and methods used in the respiration trial, were published by Schiemann et al. (1971). Determination of DM content and volatile fatty acids of fresh forages are described by Berg and Jentsch (1971). Factors for calculation of balance trials using indirect calorimetry in respiration chambers are given by Hoffmann and Schiemann (1980).

RESULTS AND DISCUSSION

Gross energy content and chemical composition of the selected forages as described and numbered above, are shown in Table 1. The crude fibre content varies within the wide range from 120 to 370g/kg DM and the crude protein content from 100 to 240g/kg DM.Although fresh and dried forages were from the same plot there were small differences in chemical composition. In agreement with Sundstøl and Ekern (1976) it becomes evident that it is not possible to get full accordant parts of forages for the different technical procedures. In all the chemical composition of fresh and dried forages was similar, no specific effect of severe drying was analyzed. The influence of drying on energy digestibility of the single forages is demonstrated in Figure 1. Careful drying compared with severe drying caused only in a few cases lower digestibility (e.g. forages No. 5 and 1), but severe drying had a negative effect. In these cases the effect is higher in crude protein digestibility (results are not demonstrated in detail). The effect of drying on metabolizability of energy is similar to energy digestibility, whereas metabolizable energy in % of digestible energy was unaffected by drying (not demonstrated in detail too). No systematical drying effects were measured in utilization efficiency of metabolizable energy as well in experiment 1 as in experiment 2 as shown in Figure 2.

Summarizing mean results shown in Table 2 indicate that drying of forages has no effect or negative effects on digestibility depending on drying temperature, with less effect on energy than on crude protein digestibility. Careful drying as well as severe drying did not influence utilization efficiency of metabolizable energy. Results from these trials have been included in the research work for improving feed evaluation (Hoffmann et al., 1993).

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Table 1
Energy content and chemical composition of fresh forages.

Forages No.	Gross energy MJ/kg DM	Organic matter g/kg DM	Crude protein g/kg DM	Crude fibre g/kgDMg	N free extract g/kgDM
Experiment 1					
1	16.57	886	178	122	576
2	18.10	908	160	294	426
3	18.05	932	116	259	539
4	18.26	900	183	243	452
5	18.85	893	214	244	395
6	18.49	896	200	225	436
7	18.07	872	236	236	380
8	18.65	884	209	257	396
9	18.73	944	122	294	499
10	18.69	941	99	332	483
11	18.37	915	114	348	424
12	18.49	896	201	278	395
13	18.69	905	196	312	377
14	17.66	868	162	348	345
15	18.68	918	165	365	370
Experiment 2					
1	17.71	890	161	262	432
2	18.17	886	205	274	385
3	18.55	920	154	306	435
4	18.55	934	120	311	483

Table 2
Mean results of all experiments with fresh (a) and dried (b carefully, c severely) forages.

	Experiment 1		Experiment 2		
	a	b	a	b	c
Gross energy (GE), MJ/kg DM	18.29	18.20	18.24	18.14	18.04
Crude protein, g/kg DM	170	164	160	160	155
Crude fibre, g/kg DM	277	284	288	276	289
Energy digestibility, %	65.2	64.5	66.5	66.2	63.0
Crude protein digestibility, %	73.3	69.6	72.1	70.2	64.7
ME in % of GE	53.7	52.7	55.4	54.8	51.6
Utilization of ME, %	51.7	53.2	55.1	55.3	54.9
Mean differences in % (fresh = 100)					
Gross energy (GE)		-0.4±0.6		-0.6±0.2	-1.1±0.8
Energy digestibility		-0.7±4.0		-0.3±3.0	-3.5±3.0
ME in % of GE		-1.0±3.8		-0.6±2.9	-3.8±2.5
Utilization of ME		+1.5±2.9		+0.2±3.9	-0.2±1.8
Crude protein digestibility		-3.8±5.6		-2.0±5.7	-7.4±1.0

ME = Metabolizable energy

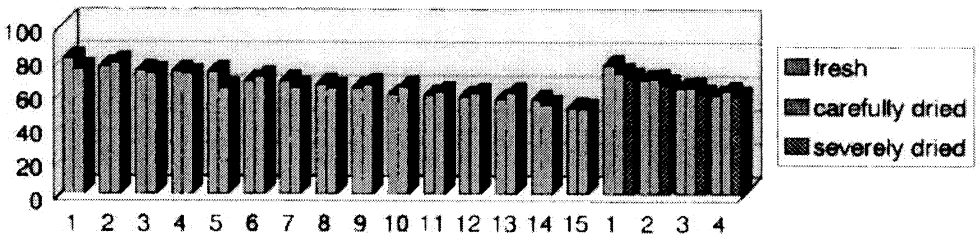

Figure 1
Energy digestibility of fresh and dried forages.

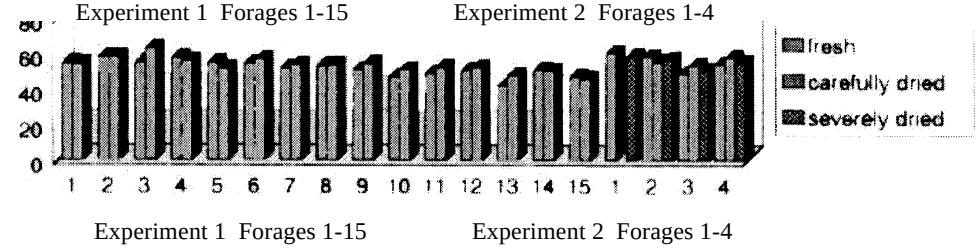

Figure 2
Utilization efficiency of metabolizable energy of fresh and dried forages.