

Diss. Nr. 4797

**Untersuchungen an ausgewachsenen Schafen über
das Wiederkauverhalten, die Bildung flüchtiger Fettsäuren
im Pansen und die Energieverwertung bei Verfütterung
von Rationen unterschiedlicher Struktur**

ABHANDLUNG

zur Erlangung
der Würde eines Doktors der technischen Wissenschaften
der

EIDGENÖSSISCHEN TECHNISCHEN HOCHSCHULE
ZÜRICH

vorgelegt von

MARTIN FELIX WIESER
dipl. Ing.-Agr. ETH
geboren am 6. Februar 1936
von Neunkirch (Kt. Schaffhausen)

Angenommen auf Antrag von
Prof. Dr. A. Schürch, Referent
Prof. Dr. H. Heusser, Korreferent

Juris Druck + Verlag Zürich
1972

ZUSAMMENFASSUNG

Unsere Untersuchungen hatten zum Ziel, einige Auswirkungen von unterschiedlichen Rauhfutteranteilen und einer unterschiedlichen physikalischen Struktur von Rationen an ausgewachsenen Schafen zu prüfen. Im ersten Teil der Arbeit wurde das Wiederkauverhalten von Schafen untersucht (Versuch 1, 2 und 3). Die verabreichten Rationen unterschieden sich bezüglich der Anteile an Heu und an Kraftfutter sowie bezüglich des Zerkleinerungsgrades. Heuanteil und Zerkleinerungsgrad der einzelnen Rationen sowie deren Kurzbezeichnung sind in Tabelle 10 wiedergegeben.

Tabelle 10: Zerkleinerungsgrad und Heuanteil der verwendeten Rationen

Heuanteil der Ration %	Zerkleinerungsgrad		
	Ungemahlen	Grob gemahlen	Feingemahlen
100	G ₃₀	-	-
40	G ₁₅	F ₁₅	FF ₁₅
0	G ₅	F ₅	-

Im zweiten Teil der Arbeit wurden die Auswirkungen unterschiedlicher Struktur des Futters und unterschiedlich hoher Futtergaben auf die Bildung flüchtiger Fettsäuren im Pansen und den Energiewechsel von Schafen untersucht. Diese Versuche wurden nur mit zwei Rationen durchgeführt, die zwar diesselbe Zusammensetzung (40 % Heu, 60 % Kraftfutter) hatten, sich jedoch in Bezug auf ihre physikali-

sche Struktur unterschieden (ungemahlen, bzw. gemahlen). Diese Rationen waren identisch mit den schon in Versuch 2 und 3 verwendeten Rationen G_{15} und F_{15} . Beide Rationen wurden sowohl in Mengen von 1000 g als auch in solchen von 1500 g (Versuch 4) bzw. 1400 g (Versuch 5) verabreicht. Die Schätzung der Bildungsrate flüchtiger Fettsäuren im Pansen erfolgte mit Hilfe einer Isotopenverdünnungsmethode. Diese Versuche wurden ergänzt durch Gesamtstoffwechselversuche.

E r g e b n i s s e

Das Wiederkauverhalten der Versuchstiere

1. Bei ausschliesslicher Verabreichung von Häckselheu (Ration G_{30}) betrug die durchschnittliche tägliche Wiederkauzeit 8 Stunden 54 Minuten. Das Wiederkaumuster war durchwegs regelmässig; die rejektierten Bissen wurden durchschnittlich 1 Minute gekaut. (Tabelle 2, Seite 22; Figur 1, Abb 1. S. 24).

2. Durch die Substitution von 60 % Häckselheu durch Kraftfutter (Ration G_{15}) wurde die tägliche Wiederkauzeit im Vergleich zur ausschliesslichen Heuration G_{30} um rund 45 % auf 4 Stunden 52 Minuten reduziert. Das Wiederkaumuster hingegen wurde nicht wesentlich verändert. Bei der Verfütterung der Kraftfuttermischung G_5 lag die tägliche Wiederkauzeit um rund 72 % tiefer als bei der Ration G_{30} . Das Wiederkaumuster war teilweise gestört; die einzelnen Boli wurden in unregelmässigen Abständen regurgitiert und im Durchschnitt nur während ca. 44 Sekunden gekaut. (Tabelle 3, S. 26; Figur 1, Abb. 2 - 5, S. 24).

du méthane - énergie thermique de la fermentation) constituée par les acides gras volatils formés dans la panse se trouvait réduite par le broyage du fourrage et aussi, nettement, lors de l'augmentation des quantités affourragées ($G_{15}(1000):74,6 \%$, $G_{15}(1400): 67,2 \%$, $F_{15}(1000): 62,1 \%$, $F_{15}(1400): 58,12 \%$) (tableau 8, p. 52).

SUMMARY

The aim of this study was to investigate the effects of rations differing in their roughage to concentrate rations as well as in physical structure. The rumination behaviour of sheep was investigated in the first part of this work (experiments 1, 2 and 3). The rations used differed in regard to their content of hay and concentrates as well as in regard to their physical structure. Roughage content and physical structure of the various rations are given in table 10.

Table 10: Physical structure and hay content of the rations used

Hay in the ration %	Physical structure		
	unground	coarsely ground	finely ground
100	G_{30}	-	-
40	G_{15}	F_{15}	FF_{15}
0	G_5	F_5	-

In the second part of this study the effects of variations in the physical structure of the feed and of various levels of intake on the formation of volatile fatty acids in the rumen and on the energy metabolism of sheep were investigated. These experiments were carried out with two rations of the same composition (40 % hay, 60 % concentrates) which differed however in regard to their physical structure (unground, ground). These rations were identical with the rations G_{15} and F_{15} used in the experiments 2 and 3. Both rations were fed in amounts of 1000 gr as well as in amounts of 1500 gr (experiment 4) or 1400 gr (experiment 5). The production rates of the fatty acids in the rumen were estimated with an isotope dilution method. In addition, metabolism trials were carried out with the same two rations.

R e s u l t s

The rumination behaviour of the experimental animals

1. On the ration of chaffed hay (ration G_{30}) the animals ruminated on average for 8 hours 54 minutes daily. The rumination pattern was always regular; on average the regurgitated boli were chewed for one minute (table 2, page 22, figure 1, tracing 1, page 24).
2. If 60 % of the hay in the ration were substituted by concentrates (ration G_{15}) the daily rumination time was reduced by 45 % to 4 hours 52 minutes in comparison to the hay ration G_{30} . The rumination pattern, however, was not significantly altered. On the concentrate ration G_5 the daily rumination time was about 72 % shorter than on the ration G_{30} . The rumination pattern was partially disturbed; the boli were regurgitated at irregular intervals and chewed for only 44 seconds (table 3, p. 26, figure 1, tracings 2 - 5 p. 24).

3. The comparison between three rations with identical composition (40 % hay, 60 % concentrates) but differing in their physical structure, i.e. unground (ration G₁₅), coarsely ground (ration F₁₅) and finely ground (ration FF₁₅) showed a decrease of the daily rumination time with increasing fineness of the feed. The average daily rumination times for the rations G₁₅, F₁₅, and FF₁₅ were 4 hours 52 minutes, 2 hours 10 minutes and 1 hour 35 minutes respectively. The rumination pattern was barely altered on the only once ground ration (ration F₁₅). If the ration, however, was ground a second time through a finer mesh (ration FF₁₅) a strongly abnormal behaviour with short and irregular chewing of the boli was observed (table 3, p. 26; figure 1, tracing 4-7, p. 24/25).

4. The grinding of the all concentrate ration (ration F₅) brought about an almost complete suppression of the rumination activity (average daily rumination time:40 minutes). The rumination behaviour was very erratical. Passages with somewhat regular rumination were followed by periods of pseudo-rumination, i.e. the animal regurgiated, but the bolus was swallowed immediately thereafter.(table 3, p. 26, figure 1, tracing 8-10, p. 25).

The formation of volatile fatty acids in the rumen

1. The production rate of the volatile fatty acids in the rumen reached its maximum in the first hour after feeding. After two hours, the production rate was already greatly reduced and decreased slowly but continuously thereafter until the next feeding time. (figure 4, p. 44).

2. On the ground ration F₁₅, the production of volatile fatty acids was significantly reduced compared to the

unground ration G_{15} . An increase in the level of feed intake led to an increase of the production of volatile fatty acids. This increase was, however, less than proportional to the increase in the feed intake. The amounts of fatty acids produced in 12 hours were 3.68 moles for the ration G_{15} (1000 gr), 4.05 moles for the ration G_{15} (1400 gr), 2.90 moles for the ration F_{15} (1000 gr) and 3.28 moles for the ration F_{15} (1400 gr). (table 5, p. 46).

3. The production rates of the volatily fatty acids were only partially related to their concentrations in the rumen liquid (table 5, p. 46).

4. Neither the physical structure nor the level of intake had any significant effect on the molar proportions of the fatty acids in the rumen (table 6, p. 48).

The energy metabolism of the experimental animals

1. The increase of the feed intake from 1000 gr to 1500 gr led on the unground ration G_{15} as well as on the ground ration F_{15} to higher energy losses in the faeces and therefore to a reduction of the digestibility. (table 7, p. 49).

2. The losses as methane and urine on the other hand were lower at high feed intakes and on the ground ration than at low feed intakes and on the unground ration. (table 7, p. 49).

3. The increase of the feed intake led on both rations to a considerable increase in heat production and accordingly to a relatively small increase of the energy retention. On the low level of feed intake, the grinding had no

significant effect on heat production. On the high level of feed intake, however, it resulted in significantly reduced heat losses (table 7, p. 49; table 9, p. 53).

The contribution of the volatile fatty acids produced in the rumen to the energy supply to the animals

The relative energy contribution of the volatile fatty acids produced in the rumen expressed as a percentage of the "absorbed energy" ("absorbed energy" = gross energy - energy of faeces - energy of methane - heat of fermentation) was lower on the ground rations than on the unground rations and decreased with increasing feed intake (G_{15} (1000 gr): 74.6 % G_{15} (1400 gr): 67.2 %, F_{15} (1000 gr): 62,1 % F_{15} (1400 gr): 58,1 %). (table 8, p. 52).