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THE INFLUENCE OF SHEARING ON FOOD INTAKE AND THE DIGESTIBILITY OF DIETARY COMPONENTS AND THE MEASUREMENT OF FIBRE PRODUCTION IN ANGORA RABBITS

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ABSTRACT

Measurements were made of the food intake of 7 male and 4 female adult angora rabbits for 42 days before and 42 days after shearing. Intake (g/kg weight) was 39.5 and 40.9 before and 47.9 and 45.3 g after shearing for males and females respectively. There was considerable variation in intake over 3-d intervals and pattern of intake was different between males and females for the 42 d period.

Fibre weight and length measured every 3 weeks on 5 rabbits using a loin patch technique showed higher production and fibre length during the cool compared to the warm season. Similar observations were made on 18 rabbits shorn every 85 d over 4 shearings. Total fibre yield was 1.01 kg for bucks and 0.96 kg for does over 350 d.

Digestibility measurements on 2 pelleted diets based on alfalfa (1) or milled wheat straw (2) were made on rabbits before and after shearing. Only on diet 2 did food intake increase after shearing. Dry matter, fibre and energy digestibility were depressed, for rabbits fed the alfalfa-based diet, after shearing. However, crude protein digestibility increased. Other measures showed a decrease in water intake on both diets after shearing. Efficiency of dietary nitrogen (N) utilization was substantially reduced after compared to before shearing suggesting that dietary and perhaps tissue protein were being used as an energy substrate.

INTRODUCTION

Compared to meat rabbits, relatively little research has been undertaken on angora rabbits. These are kept for their fibre which has high insulative properties and some therapeutic value (Cheeke et al. 1987). Fibre production is some four times higher than that of sheep when compared on a kg body weight basis (Schlolaut 1985). Annual fibre yield is about 1 kg, with females normally producing about 20% more fibre than males. In Germany fibre production per rabbit has increased steadily over the past 30 years (Schlolaut 1987a).

Unlike sheep which are shorn annually, angora fibre is removed by clipping, plucking or shearing about every 90 days. The effects of fibre removal can be traumatic (Vermorel et al. 1988, Vernet et al. 1988), the changes in pattern of food intake, food utilisation and fibre production before and after shearing have not been well documented. The purpose of this study is to report on experiments aimed at answering some of these questions.

MATERIAL AND METHODS

Rabbits

Six angora rabbits of German breed were imported from New Zealand. These and their progeny were used in all experiments. Rabbits were shorn approximately every 90 d.

Diets

Throughout the period of experimentation the diet (diet 1, Table 1) offered was an alfalfa-based, pelleted, proprietary food (Fielders Stock Feeds, Tamworth, N.S.W.).

Table 1. Composition (%) of experimental diets fed to rabbits

Ingredient	diet 1 (%)	diet 2 (%)
Barley	10.0	10.0
Wheat bran	17.7	20.0
Wheat straw mix[1]	-	18.0
Alfalfa meal	36.0	-
Wheat	22.9	29.4
Meat meal	8.5	8.0
Soybean meal	4.0	9.1
Salt	0.25	0.25
Methionine	0.10	-
Dicalcium phosphate	-	0.25
Amprolmix	0.05	-
Molasses	-	3.0
Bentonite	-	1.5
Mineral & vitamin premix	0.50	0.50
Determined chemical composition		
Dry matter	93.5	89.4
Organic matter	95.7	93.4
Crude protein	18.4	18.3
Crude fat	2.7	2.1
Neutral detergent fibre	31.4	33.3
Acid detergent fibre	16.5	13.9
Gross energy (kJ/g)	16.3	15.6
Digestible energy (kJ/g)[2]	12.4	12.1
Metabolisable energy(kJ/g)[2]	11.8	11.3

[1] 75% milled wheat straw and 25% alfalfa meal. [2] determined using adult rabbits

For the digestibility experiments, a second diet was formulated as shown in Table 1 using the User Friendly Feed Formulation package (UFFF). Milled wheat straw was the main roughage source and the diet cold pelleted. Molasses was added to the diet to improve acceptability by the rabbits.

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Metabolism cages

Cages measured 60cm x 30 cm x 38 cm. Floors were made of plastic covered wire to prevent occurrence of sore hocks. Collection trays were enamel painted galvanised metal. Faeces were separated from urine which was collected in a plastic bottle containing 3 ml 5N HC_L. Collections were made daily.

Chemical analysis

Food and bulked faecal samples were pre-weighed and dried to constant weight in a forced-draft oven at 70°C. The samples were milled through a 1 mm screen in a laboratory hammer mill. For the determination of urinary energy, pre-weighed volumes of urine were freeze-dried and subsamples used for energy determination. The micro-Kjeldahl method, using selenium as a catalyst (AOAC 1980) and the Ivan et al. (1974) distillation technique, were used to measure nitrogen (N). Crude protein (CP) was calculated as N x 6.25. Gross energy (GE) was determined in a bomb calorimeter. Neutral detergent fibre (NDF) of diets and faeces was determined as described by Van Soest and Wine (1967) and acid detergent fibre (ADF) according to the AOAC (1980). Crude fat was determined using a Soxhlet apparatus with petroleum ether as a solvent (AOAC 1980).

Voluntary food intake and wool growth experiments

Three male and two female angora rabbits were randomly selected and assigned to individual wire cages for a study of seasonal changes in the rate of wool growth. Each rabbit was patch-clipped on its right loin. Side patches measuring 5 cm x 5 cm were delineated with black dye. This was made by dissolving 0.8% (w/w) Durafur black in cold water and adding 0.8% (v/v) concentrated H_2O_2 as an oxidant (Williams and Chapman, 1966). The patches were clipped every 3 weeks and records kept of clip weight, fibre length of the clip and of the opposite unclipped loinside. This study was conducted from April 1989 to March 1990. Grade I fibre (> 6 cm) was separated from the remainder and weighed.

Voluntary food intake for both sexes of angora rabbits was recorded over 42 d (diet 1). Records were kept for seven male and four female rabbits before and after shearing.

Digestibility Experiments

Four adult angora rabbits, weighing between 2.7 kg and 3.2 kg were randomly allocated to the two diets (Table 1) in the pre-shearing and post-shearing periods. Room temperature was maintained at 15 ± 3°C. At the switching of dietary treatments the animals were allowed 7 d to adjust to the new diets before the collection of faeces and urine. Faeces and urine from all rabbits were collected using metabolism cages. Faeces and urine were collected and bulked over 5 d and frozen at -20°C for later analysis. Prior to analysis, samples were prepared as described previously. Water intake was also recorded.

Data were analysed using analysis of variance. Differences between means were examined using the least

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significant difference (LSD) test. Where appropriate a paired 't test' was used to examine 'before' and 'after' effects.

RESULTS

Voluntary food intake (g/d) of both sexes of angora rabbits in the pre- and post-shearing periods recorded over a temperature range of 14 to 18°C, is given in Table 2. The post shearing period was day 0-42 and the pre-hearing period was

Table 2. Voluntary daily feed intake (± SEM) of 7 male and 4 female angora rabbits

	Preshear		Postshear		
	male	female	male	female	SEM
Bodyweight (W,kg)	3.51[a1]	3.30[a]	3.48[a]	3.26[a]	0.093
Food intake (0-42d)					
(g/day)	138.5[c]	134.9[c]	166.5[a]	147.5[b]	3.94
(g/kg W)	39.5[b]	40.9[b]	47.9[a]	45.3[a]	1.18
Food intake (g/d)					
day 0-10	141.7[c]	145.2[c]	169.6[a]	155.0[b]	3.32
day 0-21	144.2[b]	139.3[b]	168.8[a]	147.7[b]	2.25
day 21-42	132.8[c]	130.4[bc]	164.3[a]	147.3[b]	1.18
day 33-42	121.0[c]	127.9[c]	167.4[a]	142.3[b]	1.53

[1] Values across rows with different superscripts are significantly different (P<0.05).

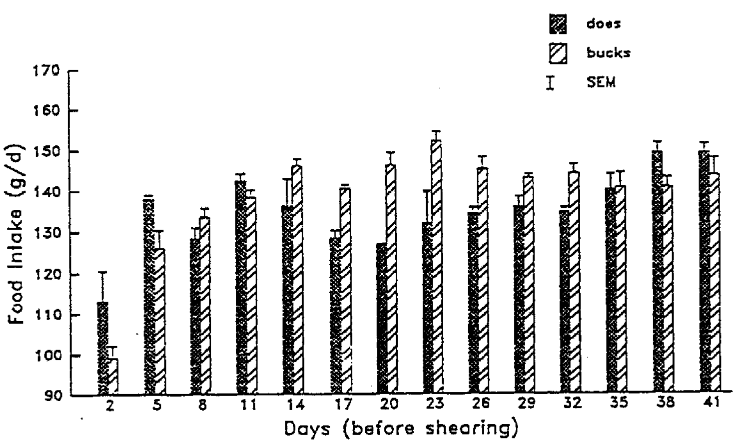
day 43-85 after shearing. Food intake (g/d) increased (P<0.05) from 138.5 and 134.9 before shearing to 166.5 and 147.5 after shearing for male and female rabbits respectively. Food intake in the pre-shearing period tended to decrease towards the end of the shearing interval. Food intake increased slowly after shearing though male rabbits tended to reach peak intake faster than females (Fig. 1). Intake was similar when adjusted for bodyweight differences (Table 2).

The pre and post-shearing periods when broken down into 3-day intervals show the effects of shearing on food intake were evident for both males and females in Fig. 1(a) and 1(b).

Annual fibre production was non-significantly (P>0.05) higher (6%) for males than females (Table 3) and was less for the third and fourth shearings compared to the first. When compared in a kg bodyweight basis, production was 289 and 290 g for females and males respectively. Yield and production indices were similar between sexes but bucks had a higher percentage of grade I fibre than does (74 vs. 71%).

Mean fibre production (g) and fibre length (mm) at 3-weekly intervals is shown in Fig. 2. Both were significantly (P<0.05) reduced in summer. This trend was also seen in data given Table 3.

(a)



(b)

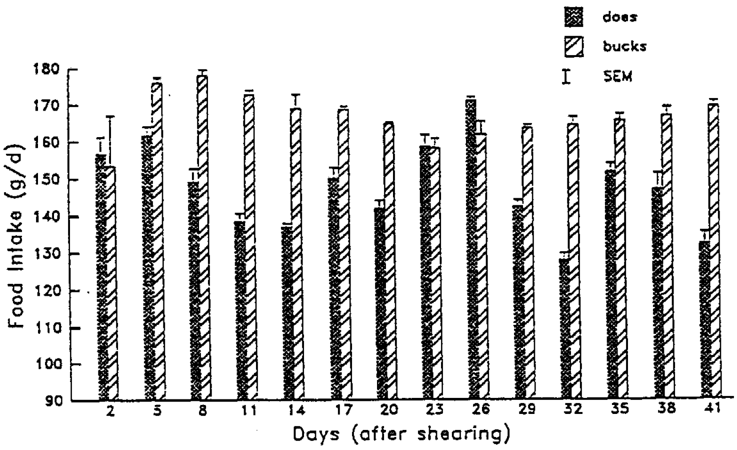


Fig. 1. The pattern of food intake of 7 bucks and 4 does for the 41 d period before (a) and after (b) shearing

The least squares estimate of the relationship between annual fibre production (AFP,g) and liveweight (W,kg) constrained through the origin for all 18 rabbits was

$$AFP = 394\ W^{0.75} \quad RSD = 0.94 \text{ and } AFP = 289\ W^{1.0} \quad RSD = 0.92$$

Apparent dry matter digestibility decreased ($P<0.05$) after shearing for rabbits fed diet 1 as did digestible energy, NDF and ADF (Table 4). Apparent CP digestibility increased ($P<0.05$) due to shearing only for rabbits fed diet 1.

Food and metabolizable energy (ME) intakes were similar on diet 1 before and after shearing but they increased by 16.5g and 142 kJ/day, respectively, on diet 2 after shearing (Table 5). Metabolisability of gross energy by the rabbits was lower ($P<0.05$) for diet 1 post-shearing and non- significantly so for diet 2. Water consumption by the rabbits declined ($P<0.05$) on both diets after shearing and by an identical amount proportion (40%) when expressed on a water:dry matter intake basis.

Table 3. Annual fibre production (±SEM) of 10 angora does and 8 bucks over 4 shearing intervals each of 85 d

						Index		
					Total (g)	Grade[1] fibre	Yield[2]	Productivity[3]
Bucks								
Month shorn	June	Aug.	Nov.	Feb.				
Fibre (g)	260^{ab}[1]	276^{a}	244^{bc}	234^{c}	1014	74	28.5	1.9
	(11.0)	(16.2)	(13.4)	(11.6)	(42.1)	(0.4)	(0.77)	(0.08)
Does								
Month shorn	June	Sept.	Dec.	Mar.				
Fibre (g)	260^{a}	248^{ab}	241^{b}	207^{c}	957	71	29.1	1.7
	(14.2)	(11.6)	(10.6)	(9.1)	(33.8)	(0.2)	(1.05)	(0.06)

[1] Values within a row with the same superscripts are not significantly different ($P<0.05$).
[2] Fibre yield index fibre yield (g) / body weight (g) x 100
[3] Productivity index fibre yield (g) / feed intake (g) x 100

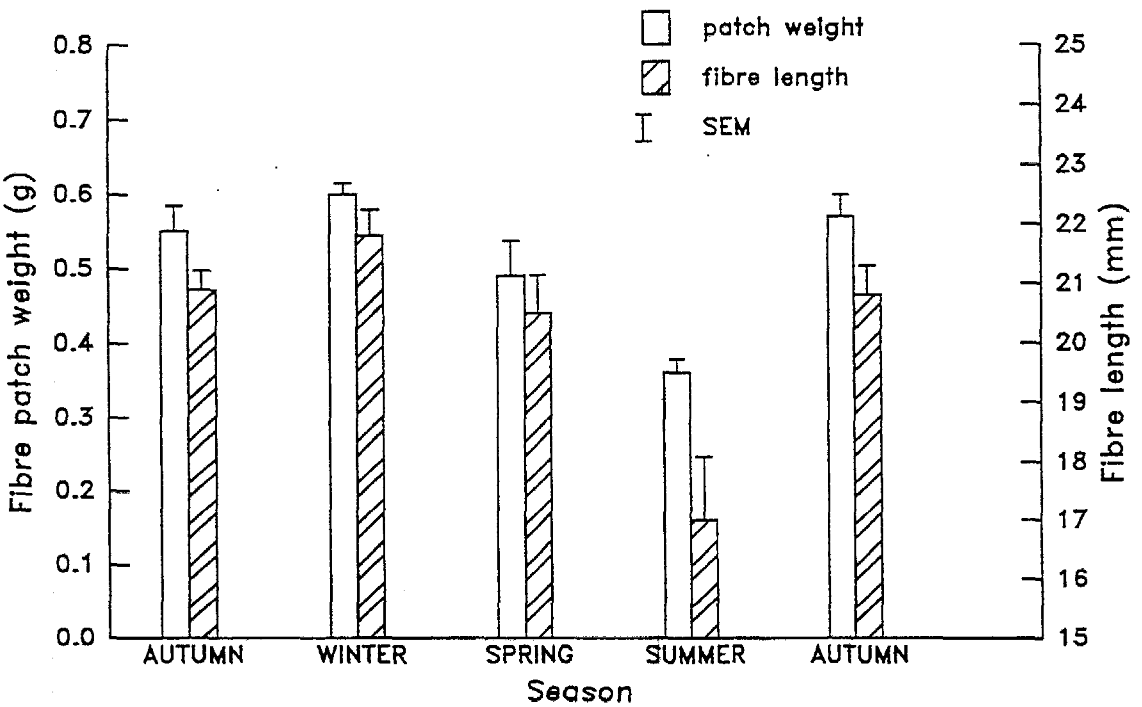


Fig. 2. Seasonal variation in fibre patch weight and fibre length of 5 angora rabbits.

Table 4. Dry matter (DM), crude protein (CP) neutral detergent fibre (NDF), acid detergent fibre (ADF) and energy and apparent digestible energy (ADE), metabolizable energy (ME) and nitrogen (N) utilization by angora rabbits (n=4) fed a alfalfa-based (1) and a wheat straw-based (2).

	Diet 1		Diet 2			Effects		
	Pre	Post	Pre	Post	SEM	Diet (D)	Shearing (S)	DxS
DM	64.5^{a}	59.8^{b}	65.8^{a}	63.4^{ab}	3.63	-[2]	*	NS
CP	74.0^{b}	77.8^{a}	72.1^{b}	73.0^{b}	2.01	**	*	NS
NDF (%)	35.4^{a}	22.9^{b}	35.2^{a}	31.4^{ab}	2.71	NS	*	NS
ADF (%)	24.4^{a}	12.2^{b}	16.9^{ab}	16.3^{ab}	2.13	NS	-	NS
ADE (%)	64.7^{b}	66.2^{ab}	66.4^{ab}	68.2^{a}	1.98			
ADE (kJ/g)	12.9^{a}	12.1^{b}	12.0^{b}	12.3^{ab}	0.38	-	NS	*
ME (kJ/g)	12.1^{a}	11.2^{b}	11.4^{ab}	11.6^{ab}	0.33	NS	-	*

[1] values with the same superscript are not significantly different (P>0.05)
[2] NS = not significant; - =0.1>P>0.05; * = P<0.05; ** = P<0.01

Retention of N (g/d) and efficiency of retention (%) were reduced significantly (P<0.05) after shearing on both diets. Although N intake was similar for diet 1 pre- and post-shearing, efficiency of N retention was reduced from 17.7 to 9.9 (Table 6). A similar reduction (24.7 vs. 16.9%) was observed for diet 2 but here there was an increase in dietary N intake after shearing compared to before.

Table 5. Results of nitrogen and energy digestibility and water intake of angora rabbits(n=4) on two diets fed in the preshearing (70 d after shearing) and postshearing (6 d after shearing) periods

	Diet 1		Diet 2		
	Preshear	Postshear	Preshear	Postshear	SEM
Mean body weight(kg)[1]	2.97^{a2}	2.73^{b}	3.08^{b}	2.89^{ab}	0.082
DM intake (g/day)	90.2^{b}	93.0^{b}	88.3^{b}	104.9^{a}	3.05
Water Intake(g/day)	302.3^{a}	221.4^{b}	301.1^{a}	255.0^{b}	12.80
Water/DM ratio	3.35^{a}	2.38^{b}	3.41^{a}	2.43^{b}	0.20
DE Intake (kJ/day)	1164^{a}	1125^{a}	1060^{a}	1290^{a}	85.4
(kJ/W/day)	392^{a}	412^{ab}	394^{b}	446^{a}	29.6
ME Intake(kJ/d)	1091^{b}	1042^{c}	1008^{b}	1217^{a}	38.2
(kJ/W/d)	367^{abc}	383^{ab}	327^{b}	422^{a}	26.4
Metabolisability(%)	69.2^{a}	65.5^{ba}	65.3^{a}	66.7^{ab}	2.03
N intake (g/day)	2.65^{a}	2.74^{a}	2.59^{a}	2.08^{a}	0.232
(g/W/day)	0.89^{a}	1.00^{a}	0.84^{a}	1.07^{a}	0.083
N retention (g/day)	0.47^{ab}	0.27^{c}	0.64^{a}	0.52^{ab}	0.115
(g/W/day)	0.16^{ab}	0.10^{b}	0.21^{a}	0.18^{ab}	0.035
N efficiency(%)	17.7^{ab}	9.9^{b}	24.7^{a}	16.9^{ab}	2.98

[1] preshearing body weights (W) have been corrected for shorn fibre. [2] Values within a row with different superscripts are significantly different (P<0.05).

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DISCUSSION

The changes in food intake that occurred during the shearing cycle (Table 2 and Fig. 1) appeared to reflect the effects of low temperature and perhaps the rabbits compulsive need to grow fibre. Fibre growth was stimulated during the cooler times of the year in both amount (Table 3) and length (Fig. 2). Comparisons of intake on days before and after shearing (Fig. 1) showed a very large initial increase in intake. For males a maximum value was achieved at about 5 - 11 d post shearing declining gradually to day 23 and slowly increasing thereafter. For females the pattern was different and more erratic (Fig. 1). Pre-shearing values for females gave maximum intake at about 26 d after shearing and declining sharply to just before the next shearing. For females, intake showed short-term cyclical effects in relation to shearing time. It should be remembered that there were only 4 does compared to 7 bucks used in this experiment. Schlolaut (1987a) reported a rapid rise in food intake shortly after shearing of both does and bucks. Season also modified intake. To some extent Schlolaut (1987a) attributed this to difficulties of angora rabbits regulating their body temperature particularly when fibre is long. In this regard, it is interesting that a reduction in water intake was observed after compared to before shearing (Table 5) perhaps reflecting differences in needs for temperature regulation.

Schlolaut (1985) reported greater fibre density and fibre length of rabbits in the winter than in summer. This is related to temperature (Schlolaut 1987b) and perhaps photoperiod. Schlolaut (1987a) presented results indicating a 6% increase in fibre production of rabbits at 5°C compared to that at 18°C and a decrease of 14% at 30°C. Our results gave a maximum seasonal increase in total fibre yield of 17% for bucks and 26% for does (Table 3). Based on differences in clipweight of a loin patch, the maximum value was 67% for 3 males and 2 females.

Changes in the apparent digestibility of dietary components, before and after shearing, have to our knowledge not been reported previously. Interestingly, significant changes occurred only in rabbits fed diet 1 which contained 36% alfalfa meal as the main dietary fibre source. Food intake was lower than observed during the previous long-term intake studies. In part this may reflect the confined space of the small metabolism cages compared to the holding cage of larger size allowing greater activity.

Diet 2 contained a mixture of 75% milled wheat straw and 25% alfalfa meal. Both diets contained similar amounts of ADF and NDF. Only rabbits fed diet 2 showed an increase in intake after shearing. Although many of the observed differences in the digestibility of dietary components before and after shearing stemmed from a decline in the apparent dry matter digestibility of diet 1, it is noteworthy that there was an increase in crude protein digestibility of diet 1 (Table 4). No attempt was made here to prevent recycling of soft faeces (caecotrophy) which is known to occur in rabbits (Hornicke 1977). Raharjo et al. (1990) showed that prevention of caecotrophy in New Zealand White rabbits reduced significantly the apparent digestibility of all major components of alfalfa.

Clearly fibre fermentation in the hindgut was likely reduced in rabbits fed diet 1 after shearing but not on diet 2. The nature of the dietary fibre components in wheat straw and alfalfa are likely to be different, particularly in the higher lignin content of wheat straw. Rate of passage of the feed was not measured here. Transit time may have differed both between diets and before and after shearing. In ruminant animals rate of passage of feed will influence the apparent dry matter digestibility particularly of a low-quality, high roughage diet (Blaxter 1967).

The order of magnitude of the digestibility values given in Table 4 are in general agreement with those reported by Butcher et al. (1981) who included diets with a similar range of dietary fibre values to those used here.

The water to feed ratio of 3.4 found before shearing (Table 5) is substantially higher than reported previously for New Zealand White rabbits even at 30°C (2.2 - 2.4) and at 20°C (1.6 - 1.7) by Jin et al. (1990). The water:feed ratio found after shearing (2.4) is high and suggests that the angora rabbit may have a higher water requirement than meat rabbits.

Efficiency of dietary nitrogen declined after compared to before shearing on both diets and by approximately the same amount. This appeared to be due mainly to a greater urinary N excretion and suggests that dietary and perhaps tissue protein were being used an an energy substrate, particularly after shearing.

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