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Effect of level of nutrition and season on fibre growth in alpacas

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ABSTRACT

The effect of nutrition on fibre production varies with species and response to nutrition may also be influenced by season. This study examined the effect of feed allowance and season on fibre growth in alpacas. 14 one-year-old alpacas were pen-fed a pelleted lucerne diet at a maintenance or ad lib intake level for 11 weeks in summer (January - February) and winter (July - September). Intake, liveweight gain and fibre growth rate were measured.

Voluntary feed intake was 45 % higher in summer than in winter, 68 vs 47 ± 2 g DM/kg$^{0.75}$/day. Estimated maintenance requirements from this trial were 31.11 g DM/kg$^{0.75}$/day or 0.276 MJ ME/kg$^{0.75}$/day.

There was a positive relationship between feed intake, liveweight gain and fibre growth rate. Increased feed allowance resulted in higher liveweight gain and increased fibre growth rate. Differences in fibre length growth between maintenance and ad lib feeding levels, 0.36 and 0.33 ± 0.02 mm/day respectively, were not significant (P=0.07). Feeding level had no effect on fibre diameter. Fibre growth rate was greater (0.77 vs 0.62 ± 0.04 mg/cm^2/day) and fibre diameter coarser (33.7 vs 31.3 ± 0.9 μ) in summer than winter. The rate of response of fibre growth to increased feed allowance was the same in summer and winter.

Keywords: Alpacas; fibre; length; diameter; nutrition; season.

INTRODUCTION

The marked seasonal fibre growth pattern exhibited by sheep and fibre producing goats has been widely demonstrated. In sheep and Angora goats, fibre growth rate is greater in summer than winter, with amplitude varying between breeds (Sumner and Bigham, 1993). Long wooled sheep breeds in New Zealand, such as the Romney, grow wool up to four times faster in summer than in winter (Hawker and Crosbie, 1985). Seasonal changes in fibre growth rates in alpacas have been demonstrated (Wuliji, 1993).

There is a positive relationship between fibre growth and feed intake in sheep (Allden, 1979) and Angora goats (McGregor, 1984), however, cashmere production in goats appears relatively insensitive to nutrition under grazing conditions (Sumner and Bigham, 1993). Changes in wool growth rate due to feeding level changes are associated with equivalent changes in fibre length and mean fibre diameter (Sumner and Wickham, 1969). There is also a pronounced interaction between season and the responsiveness of wool growth to feed intake, with the response rate to increased allowance lower in winter than in other seasons (Sumner and Bigham, 1993).

The effects of nutrition on the quality and quantity of fibre growth have not been critically evaluated for the camelids (Adam, 1990). The objective of this study was to investigate the effect of level of nutrition on fibre production in alpacas (*Lama pacos*) and to examine the response of fibre growth to level of nutrition in summer and winter.

MATERIALS AND METHODS

Fourteen one-year-old alpacas, 7 male and 7 female, were individually penned indoors at Flock House Agricultural Centre, Bulls (latitude 40°14'S, longitude 175°16'E). Trial alpacas were New Zealand born progeny of dams imported from Chile. The alpacas were previously shorn in November 1991.

The alpacas were introduced to the diet feed prior to the start of the trial and placed in pens indoors for 3 weeks to allow adaption to experimental conditions and to overcome any lag phase effects on fleece growth (Nagorcka, 1977). When taken indoors animals were drenched to eliminate internal parasites and injected with selenium. Alpacas were ranked on liveweight within each sex and randomly assigned to dietary treatments. Trial periods were in summer, from 1 January to 26 February 1992, and in winter from 14 July to 30 September 1992. Average minimum and maximum daily temperatures were 15° and 22° C in summer and 9° and 13° C in winter.

The diet consisted of lucerne pellets, which averaged 88 % dry matter. The diet contained, per kg dry matter (DM), an estimated 19.1 kJ gross energy, 14.7 - 15.4 % crude protein, 68.8 % organic matter digestibility, and 41.6 % neutral detergent fibre (NDF). The animals were offered maintenance or ad lib feed intake levels, where maintenance was calculated at 61 kcal digestible energy per kg$^{0.75}$ liveweight (Schneider *et al.*,1974 in Fowler, 1989). Alpacas on the ad lib feeding level were offered twice calculated maintenance requirements to ensure refusals were a minimum of 20 % of feed offered. Quantities offered were calculated on individual liveweight to increments of 0.1 kg at the start of each trial period and were kept constant over the trial. Feed was given once daily at 09.00 hours in summer and at 12.00 hours in winter. Refusals were collected prior to next feeding and feed intake recorded daily. Liveweight was recorded fortnightly.

A patch, approximately 10 cm x 10 cm, was clipped with Oster small animal clippers on the right midside of each alpaca at the start of the trial (day 0) and at 28 day intervals (days 28 and 56) to measure fibre growth rate (Newman and Paterson, unpubl.). The fibre was alcohol washed and reconditioned to 16 % regain to determine yield of greasy and clean fibre. Fibre diameter was measured by projection microscope with 400 fibres randomly selected from each sample. Kemp and medullation percentages were calculated, defining fibres as normal fibre, partially or fully medullated fibre or kemp (Wildman, 1954 in Villarroel, 1959; ASTM, 1975). Fibre length growth rates were calculated by measuring staple length on 10 staples from the midside patch.

Apparent dry matter digestibility of the pellets was determined at the end of the summer trial period. Six male alpaca were placed in metabolism crates and feed intake and faeces output measured over a 10 day period. Dry matter levels were determined daily for a sample of the feed offered and for faeces from individual animals.

The data were analyzed by analysis of variance and regression, using the SAS statistical package (SAS Institute Inc., USA). Effects of sex, season, level of nutrition and the interactions on intake, liveweight and wool production were tested. Liveweight gain and fibre growth rate were also adjusted for the effects of metabolic liveweight ($kg^{0.75}$). The response of liveweight gain and wool growth rate to feed intake were examined by regression analyses.

RESULTS

Initial liveweights for each trial period were 35.5 ± 1.3 kg (14.8 $kg^{0.75}$) in summer and 45.1 ± 1.6 kg (17.4 $kg^{0.75}$) in winter. The effects of season and level of nutrition on dry matter intake, liveweight and wool growth are presented in Tables 1 and 2.

Feed intake and liveweight gain

Alpaca voluntary intakes were determined from the ad lib feeding treatment groups. Absolute voluntary dry matter intakes were the same in summer and winter (Table 1), however on a metabolic liveweight basis winter intake was significantly lower (P<0.001) than summer intake (47 vs 68 g DM/$kg^{0.75}$/day). Voluntary dry matter intake was 44.7 % higher in summer than winter. On a liveweight basis, average voluntary dry matter intake represented 3.0 % of liveweight in summer and 2.2 % in winter.

TABLE 1: Dry matter intake and liveweight gain of alpacas on maintenance and ad lib feeding levels in summer and winter.

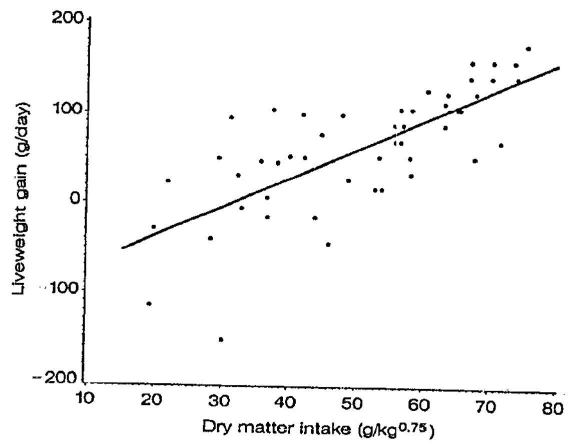
	Summer		Winter	
	Maintenace	Ad lib	Maintenance	Ad lib
Intake (g/day)	876 ± 55a	970 ± 43a	527 ± 46b	891 ± 55a
Intake/$kg^{0.75}$	55.9 ± 2.0a	67.5 ± 1.6b	31.2 ± 1.6c	47.1 ± 2.0d
Liveweight gain (g/day)	62 ± 17a	122 ± 13b	7 ± 14c	56 ± 17a
Liveweight gain/$kg^{0.75}$	3.9 ± 1.0a	8.6 ± 0.8b	0.1 ± 0.9c	2.9 ± 1.0a

where $kg^{0.75}$ refers to metabolic liveweight
and a,b,c,d indicate significant differences between means P<0.05.

Liveweight gain was significantly higher (P<0.001) on the ad lib than maintenance feeding level, and significantly higher (P<0.001) in summer than winter. The relationship between liveweight gain and dry matter intake is shown in Figure 1 and described by the equation :

gain (g/day) = 3.263 x intake (g DM/$kg^{0.75}$/day) - 101.482 (r^2 = 0.56)

FIGURE 1: The relationship between liveweight gain and dry matter intake in alpacas.



Maintenance requirement of dry matter for alpaca estimated from this equation is 31.11 g DM/$kg^{0.75}$/day. Season had no effect on the relationship between intake and liveweight gain.

Average apparent dry matter digestibility was 59.2±0.6 %. Differences in dry matter digestibility between the maintenance and ad lib feeding levels, 60.4 and 58.1 % respectively, were not significant (P<0.05). The maintenance requirement of digestible dry matter (DDM) was 18.42 g DDM/$kg^{0.75}$/day.

Fibre growth

Fibre growth rates were 21 % higher (P<0.05) on the ad lib than on the maintenance feeding level, 0.76 ± 0.04 and 0.63±0.04 mg/cm²/day respectively. Fibre growth rates were 25 % higher (P<0.05) in summer than in winter, 0.77 ± 0.04 and 0.62 ± 0.04 mg/cm²/day respectively. Differences were similar on a metabolic liveweight basis.

The relationship between fibre growth rate and dry matter intake is shown in Figure 2 and described by the equation :

fibre growth (mg/cm²/day) = 0.308 + 0.0077 x intake (g DM/$kg^{0.75}$/day) (r^2 = 0.40)

Season had no effect on the relationship between intake and fibre growth rate.

There were no significant differences between season or feed intake level in yield. The average yield over the trial was 86.3 ± 0.5 %.

Although length growth rate was greater on the ad lib than maintenance feed level (0.36 vs 0.33 mm/day), these differences did not attain significance (P=0.07). There was no difference in length growth rate between the seasons.

There was a significant difference (P<0.05) in fibre diameter between summer and winter, 33.7 ± 0.9 and 31.3 ± 0.9 μm respectively, but no difference in fibre diameter between the feed intake levels.

DISCUSSION

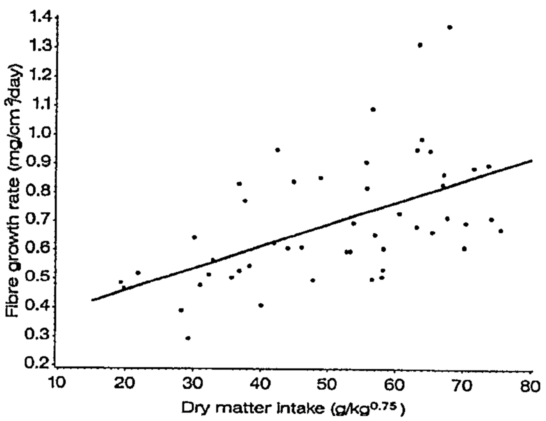
Feed intake is an important aspect of formulating rations and grazing animal management strategies. In 16 studies

TABLE 2: Fibre growth and characteristics of alpacas on maintenance and ad lib feeding levels in summer and winter.

	Summer		Winter	
	Maintenace	Ad lib	Maintenance	Ad lib
Fibre growth (mg/cm^2/day)	0.69 ± 0.06a	0.85 ± 0.05b	0.57 ± 0.05a	0.67 ± 0.06a
Fibre growth/kg$^{0.75}$	0.045 ± 0.004a	0.059 ± 0.003b	0.033 ± 0.003c	0.035 ± 0.004c
Length growth (mm/day)	0.32 ± 0.02	0.36 ± 0.01	0.35 ± 0.02	0.37 ± 0.02
Fibre diameter (µm)	34.7 ± 1.4a	32.7 ± 1.1a	29.9 ± 1.4b	32.7 ± 1.4a

where kg$^{0.75}$ refers to metabolic liveweight
and a,b,c indicate significant differences between means P<0.05.

FIGURE 2: The relationship between wool growth rate and dry matter intake in alpacas.



reviewed by San Martin and Bryant (1989) the average daily dry matter intake as percentage of body weight in alpacas under penned conditions was 1.83 ± 0.46 %. Dry matter intake under grazing conditions for llamas and alpacas ranged from 38 to 67 g/kg$^{0.75}$ depending on type of pasture and season of use (San Martin, 1987 in San Martin and Bryant, 1989). Winter feed intake in this trial was at the top of the range, 1.25 to 2.40 %, reviewed by San Martin and Bryant (1989), summer intake exceeded this.

Voluntary feed intake in the alpacas was higher in summer (44.7 %) than in winter, as has been found in other species. Domingue *et al.* (1991) found deer showed marked increases during summer in voluntary dry matter intake (35 %) and goats showed evidence of a summer increase in intake (17 %) which did not attain significance.

Maintenance feed requirements will vary depending on the energy value of the feed offered. By using Moir's (1961) regression to convert digestible dry matter to digestible energy (DE) and assuming metabolisable energy (ME) = 0.82 DE (ARC, 1980), then the energy requirement for maintenance can be calculated to be 0.276 MJ ME per kg$^{0.75}$ per day (65.8 kcal ME/kg$^{0.75}$/day). This is similar to Engelhardt and Schneider (1977) who estimated the maintenance requirement of metabolisable energy to be 61.2 kcal/kg$^{0.75}$ for llamas. In some comparative digestibility trials, camelids have shown a greater ability to digest dry matter, particularly fibre, than sheep or cattle (Hintz *et al.*, 1973). However in other trials, no such differences were observed (San Martin and Bryant, 1989; Warmington *et al.*, 1989). San Martin and Bryant (1989) suggested that discrepancies in digestibility between species might be attributed to quality of feed used, as greater digestion coefficients were reported for llamas than sheep on low and medium quality diets, but digestion coefficients were similar on high quality diets.

Possible nutritional and seasonal effects on alpaca fibre growth have been observed in other reports but no scientific studies separating these effects had been undertaken. Marshall *et al.* (1981) found significant increases in liveweight and fibre production of alpacas grazed on lucerne compared to native pasture. Differences in fibre production were greater fibre length, coarser fibre diameter and heavier fleece weights. Wuliji (1993) found growth rate was highest in summer and declined in order of autumn, winter and spring (0.45, 0.42, 0.41 and 0.35 mg/cm^2/day respectively).

Villarroel (1959) and von Bergen (1963) noted that the considerable variation in fineness along the length of alpaca fibre in the highlands of Peru might be a direct implication of seasonal conditions. Pumayalla and Leyva (1988) noted that diameter exhibits a high degree of variation depending on age, sex, genetic improvement and nutritional level. As was found in this study, fibre diameter changes have been shown to follow same seasonal pattern as fibre growth, being greatest in summer and finest in late winter / early spring (Wuliji, 1993).

CONCLUSIONS

In sheep fibre growth rate changes are associated with equivalent changes in fibre length growth rate and mean diameter (Sumner and Bigham, 1993). In this study although fibre growth rates varied with season and feeding level, no significant differences were found in length growth rate, although differences in length growth rate between feeding levels approached significance. Fibre diameter was coarser in summer than winter but no differences were found between feeding levels.

Unlike in sheep, where the association between fibre growth and feed allowance differs between seasons in sheep breeds with a pronounced seasonal wool growth cycle, the response in fibre growth rate to increased nutrition was the same in summer and winter in alpacas.

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