The influence of lactation on the quantity and quality of cashmere production

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ABSTRACT

The aim of this study was to investigate the influence of lactation on cashmere production. Two groups of cashmere bearing goats, aged between 2 and 3 years, were used in this study. The control group included 12 non-lactating, non-pregnant subjects. The experimental group was made up of 12 goats that had given birth to twins or triplets and that had begun lactating in the second half of May. Lactation therefore had begun approximately 45 days prior to the beginning of the emergence of fibre on the body surface. Live weight was not affected by the physiological state under consideration. The decrease observed in January is too remote to have been an effect of lactation. One likely explanation is that after shearing the animals were obliged to use their body reserves for thermoregulation. Prolactin concentration was higher at the beginning of the study in both groups and it was not influenced by lactation. Albeit with a varied intensity, secondary follicles were found to be active during the entire trial period but activity never reached 100% in either group. Lactation significantly suppressed the percentage of secondary follicle activity and this was more evident from June to September. Fibre length and diameter did not differ between the two groups, so lactation did not affect fibre dimensions. The period of growth was shorter in lactating goats (184 vs 226 d). This did not make a difference in fibre length in so much as the lactating goats manifested a higher daily average growth rate (0.27 ± 0.03 vs 0.20 ± 0.03 mm/d; $P<0.05$) which compensated for the shorter period of growth. Lactation caused a decrease in productivity of an insignificant nature, therefore we hold that the negative effect of lactation on cashmere production does not depend upon the physiological status as such but, most probably, upon the level of productivity and the degree to which the lactation and fibre growth cycles overlap.

Key words: Goats, Lactation, Cashmere production, Prolactin.

RIASSUNTO

L'INFLUENZA DELLA LATTAZIONE SULLA PRODUZIONE QUANTI-QUALITATIVA DI CASHMERE

La prova che ha avuto lo scopo di valutare l'influenza della lattazione sulla produzione di cashmere ha utilizzato due gruppi di capre di origine scozzese di 2, 3 anni di età specializzate per tale attitudine ed allevate tradizionalmente al pascolo. Il gruppo testimone comprendeva 12 soggetti in asciutta e non gravidi, quello sperimentale era costituito da altrettanti soggetti che avevano partorito gemelli e/o triplette e che erano entrati in lattazione nella seconda metà di maggio e cioè in anticipo di circa 45 giorni rispetto all'emergenza dalla superficie corporea delle fibre cashmere.
Mensilmente, dopo il rilievo del peso vivo, veniva prelevato e pesato da ciascun soggetto, tramite rasatura, un campione di fibre ricadenti in 4 cm^2 di superficie di costato (patch). I campioni di fibra sono stati prelevati alternativamente dalla zona centrale del costato destro e sinistro. Le fibre secondarie sono state manualmente separate dalle primarie, misura-

te nella loro lunghezza, pesate e rapportate al peso del patch per la determinazione della resa. L'esame istologico di biopsie cutanee, prelevate dalla regione zoognostica del costato, ha consentito di valutare il numero di follicoli piliferi secondari attivi. La produzione di cashmere e il diametro dello stesso sono stati valutati sul patch che ha fornito la lunghezza massima delle fibre secondarie. La prolattina è stata, invece, determinata ogni due mesi sempre su sette soggetti di ogni gruppo presi a random.
Il peso vivo delle capre non ha subìto particolari influenze da parte dello stato fisiologico considerato. La diminuzione osservata in gennaio è troppo lontana per attribuirla alla lattazione. È più probabile, invece, che la causa sia stata l'asportazione della copertura pilifera che ha costretto l'organismo animale a mobilitare le proprie riserve corporee per produrre calore ai fini della termoregolazione. I valori della prolattina sono stati più elevati all'inizio della prova in ambo i gruppi e non hanno subìto influenze da parte della lattazione.
Sia pure con diversa intensità, l'attività dei follicoli secondari è stata sempre manifesta nel corso della prova anche se, in ambo i gruppi, la percentuale di attività non è stata mai del 100%. La lattazione, comunque, la deprime in maniera significativa e tale azione è più manifesta nei primi quattro mesi. La lunghezza e il diametro delle fibre cashmere non sono risultati diversi nei due gruppi per cui la lattazione, non ha influenzato le dimensioni della fibra.
Il periodo di accrescimento è stato più corto nelle capre in allattamento (184 vs 226 d). Ciò non ha generato differenze nella lunghezza delle fibre in quanto quelle delle capre in lattazione hanno manifestato un accrescimento medio giornaliero più elevato (0,27 ± 0,03 vs 0,20 ± 0,03 mm/d; $P<0,05$) che ha compensato il minore periodo di crescita. La lattazione ha fatto registrare un calo produttivo di trascurabile entità per cui si ritiene che un eventuale effetto negativo di quest'ultima sulla produzione di cashmere non dipende dallo stato fisiologico in quanto tale ma, più probabilmente, dal livello produttivo e dall'entità di sovrapposizione dei cicli della lattazione e dell'accrescimento delle fibre.

Parole chiave: *Capre, Lattazione, Produzione di cashmere, Prolattina.*

Introduction

Within the goat species there exist over three hundred ethnic groups, which are characterised by a body surface covered with primary and secondary fibres (Rhind and McMillen, 1995). While the former, long and coarse, originate from the primary follicles and have a protective mechanical function, the latter are more numerous. They derive from the secondary follicles and protect the animal from the influence of external temperature. Secondary fibres that have a diameter no greater than 18.5 µm make up the class of high-quality fibres denominated cashmere (Pattie and Restall, 1990).

In the absence of extenuating factors, the production of cashmere is directly correlated to the number of active secondary follicles and their respective period and level of activity.

Unlike wool and mohair, cashmere has a growth period affected by photoperiod as it occurs between the summer and winter solstices. Fibre growth, whilst seeming to be insensitive to the influence of dietary factors (McGregor, 1988; Klören *et al.*, 1993; Jia *et al.*, 1995; Russel, 1995), varies amongst breeds (Rhind and McMillen, 1995) and according to the physiological state of the goat (Restall and Pattie, 1989). Klören *et al.,* (1993) sustain, however, that growth is conditioned by a typical endocrine milieu determined in turn by photoperiod. Dicks *et al.,* (1994) showed that the increasing secretion of prolactin found in cashmere-producing goats in spring is responsible not only for fibre shedding but also for the re-activation of primary and secondary follicles.

Changes in endocrine equilibrium due to pregnancies or lactation would have negative repercussions on hair follicle activity in so much as, according to Williams and Butt (1989), there would result a competition for nutrients between hair follicles, the uterus and mammary glands. Brown *et al.,* (1966) report that in sheep, as an effect of pregnancy and lactation, wool growth undergoes a decrease of 10%.

In goats, according to Pattie and Restall (1990), the negative influence of pregnancy and of lactation on cashmere production is much more drastic and it is even more so if during the period of fibre growth the subjects are lactating and pregnant contemporaneously.

The above points, of great scientific and technical interest, need further examination in order to verify if the intensity of the effects cited above changes in relation to the type of pregnancy, the level of milk production, the duration of the lactation period, the number of kids milked and the length of time between the beginning of the lactation period and the emergence of cashmere fibres.

This study intends to evaluate whether the quanti-qualitative production of cashmere and the factors that determine it are influenced by a lactation period that begins 45 days prior to the emergence of cashmere fibres on the body surface.

Material and methods

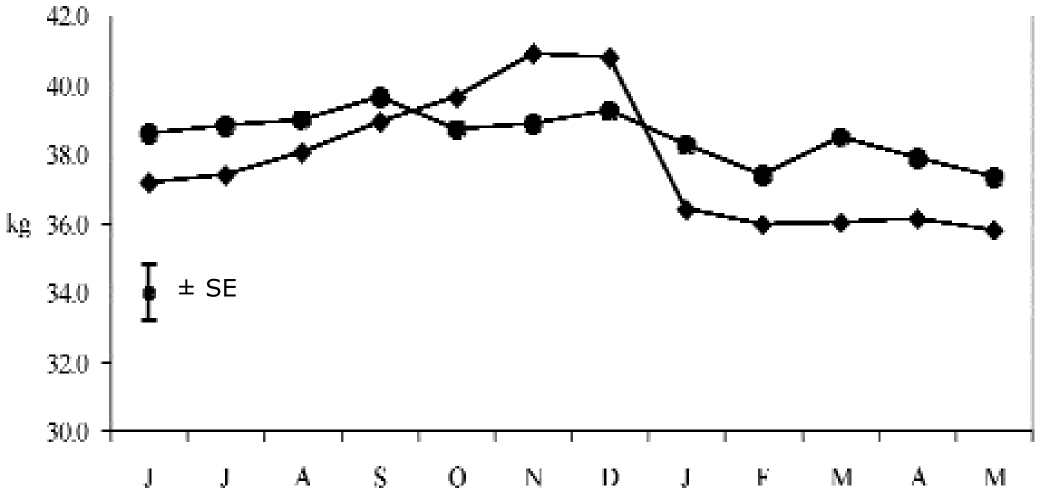
The study began in June 1998 and used 24 goats aged between 2 and 3 years from a breed-population of Scottish origin specialised in cashmere production. The experimental group included 12 goats that began their third lactation at the end of May and each milk-fed 2 or 3 kids for 45 days. The period of lactation lasted 150 days and 95 ± 9.5 kg of milk was produced, including that given to the kids. The other 12 goats were neither pregnant nor lactating and made up the control group.

The goats were reared traditionally at pasture and received a dietary supplement *ad libitum* of vetch and oats hay. The lactating goats also received 200 g of a commercial concentrate per head each day. The chemical composition of the feed administered is set out in Table 1.

Live weight was measured every month, and immediately after a 4 cm^2 fibre patch was clipped from the midside. The primary and secondary fibres in the patch were manually separated and the length of the latter was measured. The patch that gave the maximum cashmere length was then tested for yield, fibre diameter and production level. The yield being the weight of cashmere fibres compared to that of the entire patch. The diameter was determined using the Optical Fibre Diameter Analyser (O.F.D.A.). Production level was calculated by extrapolating the weight of the cashmere fibres in the patch to the whole body surface using the formula reported by Couchman and McGregor (1983). At the end of December the goats were shorn in order to collect the cashmere. The area shorn included the entire body surface except two areas of 200 cm^2 on the right and left midsides, which were used to continue patch sampling and skin biopsies. The fibre growth period was calculated by counting the days between the emergence of the fibres and achievement of maximum length. Every two months blood samples were taken from seven subjects selected randomly from each group in order to determine the prolactin concentration. The samples were taken from the selected subjects every two hours over one day. Plasma concentration of prolactin was measured by RIA, with the method described by Galeati *et al.,* (1983).

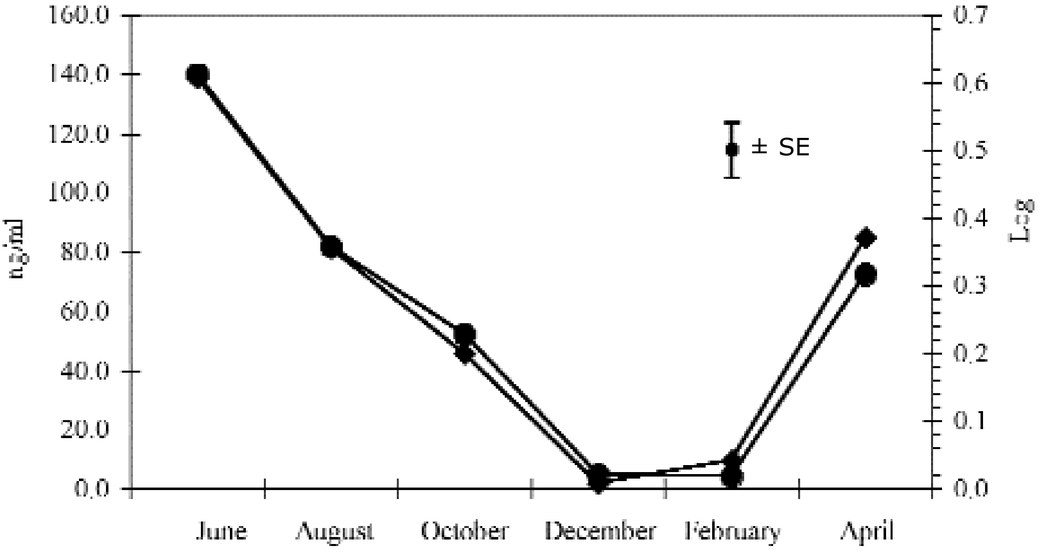
The number of active secondary follicles was

Figure 1.



Live weight pattern in dry (◆) and lactating (●) goats.

Figure 2.



Plasma prolactin concentration in dry (◆) and lactating (●) goats.

calculated monthly via a histological exam of skin biopsies taken from the same point as the fibre patches (SACPIC method as modified by Nixon, 1993).

The statistical analysis of fibre length, of the percentage of active secondary follicles, of blood prolactin concentration and of live weight was carried out using the ANOVA procedure for repeated measures by SYSTAT statistical package (1992) with a bi-factorial model (physiological state and sampling month).

As regards fibre length and active secondary follicle percentage, the interaction between physiological status and sampling month was not reported because it was not significant. The degrees of freedom of the interaction were included in those of the error.

The statistical analysis in relation to cashmere yield, diameter and fibre production used a monofactorial model (physiological state). The statistical analysis of the percentage of active secondary follicles and the concentration of prolactin in the blood was preceded by a transformation in Arcsine ($x^{1/2}$) and Logarithm, respectively. The differences between the means were tested using the LSD. The Pearson correlation coefficients were calculated between some of the elements of the study.

Results and discussion

Live weight

Restall and Pattie (1989) found that the live weight of Australian goats specialised in cashmere production varies significantly with the physiological state. In our study, live weight increased almost till December in the control group and remained almost constant in the lactating group (Figure 1). The expected negative effect of lactation on live weight did not occur and this may be explained, firstly, by the good climatic conditions that favoured the maintenance of satisfactory quanti-qualitative characteristics of the pasture

Table. 1. Chemical composition of feeds supplied.

		Hay	Concentrate
Dry matter	%	87.5	90.8
Crude protein	% DM	8.5	12.6
Crude fibre	"	34.6	7.4
Ether extract	"	1.8	2.9
N-free extract	"	44.7	69.4
Ash	"	10.4	7.7

and, secondly, by the not elevated level of milk production that characterises the breed-population used in the study (Di Trana and Sepe, 2000).

The decrease in weight observed in January, in both groups, is probably linked to the shearing of the animals for fibre collection. This exposed the animals to a more intense and lasting thermal stress and therefore induced them to mobilise their body reserves to produce heat for thermoregulation. Littherland *et al.*, (1992) found that in shorn goats transferred from an environment at 30°C to one at 10°C heat production increased by 50%. The reduction, if not the annulment, of a fall in live weight due to winter shearing is an objective not to be overlooked. It is important not only because the losses can amount to 15% (Merchant and Riach, 1995) but also because, according to Mitchell *et al.*, (1989), shearing makes the goat susceptible to cold stress for at least three months.

Prolactin

Figure 2 shows that the concentration of prolactin in the blood varies notably during the year. According to Gebbie *et al.*, (1999) the highest levels are reached in summer in so much as longer days and an increased external temperature favour this. Our results, in agreement with those of the authors cited, were at a maximum at the beginning of the study but contrary to what we expected, they were not affected by lactation. During lactation, the lack of a significant change in the prolactin levels of the experimental group suggests that the effect of lactation is, probably, mitigated by the stronger seasonal one.

Percentage of active secondary follicles

Table 2 shows that the percentage of active secondary follicles is affected by both the physiological state (P<0.01) and the timing of the biopsy (P<0.001). Lactation caused a lower percentage of activity (13%) but the average differences were higher during the first 120 days. However on the whole, the lowest percentages were reached outside the period of intensive fibre growth and, in accordance with Rhind and McMillen (1995), the inactivity was never total. We are able to definitely confirm the results of Celi *et al.,* (2001), that is, that the follicular activity is quite extended over time, it manifests a strong seasonal variability and it never involves all of the secondary follicles. Lactation also delays the achievement of the maximum level of follicular activity, which was reached in November (77%) when the fibres are concluding their growth period.

Klören *et al.,* (1993) reported that elevated prolactin concentrations determine a fall in the number of active secondary follicles in goats that received dietary rations of a higher nutritional level than that needed for body maintenance. Our results are in agreement with those cited above even though the subjects had a traditional diet without the added nutrients. During the spring months when prolactin concentration in the blood tends to increase, the percentage of active secondary follicles was not very high.

Table 2. Least square means of percentage of active secondary follicles.

Sampling month	Physiological status		All
	Dry	Lactation	
June	29.7	11.2	20.5^{AEb}
July	46.5	24.5	35.5^{A}
August	79.2	41.7	60.4^{DF}
September	78.8	57.7	68.2^{BD}
October	78.7	71.7	75.2^{BD}
November	74.4	76.6	75.5^{BD}
December	68.3	72.0	70.1^{BD}
January	51.2	33.7	42.5^{AFa}
February	37.1	29.5	33.3^{ACa}
March	29.2	26.7	27.9^{AC}
April	28.6	8.9	18.7^{AEb}
May	15.3	6.4	10.9^{CEb}
July - May	51.4^{A}	38.4^{B}	

SE of physiological status is 1.99 and SE of sampling month is 4.88.
Levels of significance of physiological status (P<0.01) and sampling month (P<0.001).
In the same row or column means followed by different capital letters differ at P<0.001 and small letters differ at P<0.05.

Length and growth

Restall and Pattie (1989) showed that lactation reduces the length of cashmere fibres by 48%. Our results, set out in Table 3, do not confirm such a drastic effect seeing as the maximum length of cashmere fibres observed was the same for the lactating goats and those in the control group (4.9 cm). We believe that this is a consequence of the poor aptitude for milking of the breed-population in question and of the incomplete synchronisation of milk secretion and cashmere fibre growth. Both of these processes mitigated eventual disparities in the partitioning of nutritional substances between hair follicles and mammary glands.

However, the maximum length of cashmere fibres was obtained in different periods. In the lactating goats, cashmere fibres stopped growing in December and therefore before the control group. This suggests that the shearing of animals that have confronted and overcome a period of lactation must be anticipated, within reason and in compatibility with the environmental conditions and the availability of shelters and feed.

Table 3. Least square means of cashmere length (cm).

Sampling month	Physiological status		All
	Dry	Lactation	
June	0.0	0.0	0.0
July	0.3	0.2	0.3^{D}
August	1.2	0.7	0.9^{DFG}
September	1.9	1.4	1.6^{BGa}
October	3.0	2.6	2.8^{BGHb}
November	3.8	3.7	3.8^{AEHb}
December	4.7	4.9	4.8^{A}
January	4.9	4.6	4.7^{A}
February	4.9	4.6	4.7^{A}
March	4.1	3.5	3.8^{ACb}
April	2.4	2.6	2.5^{BCEa}
May	1.9	1.6	1.7^{BF}

SE of sampling month is 0.25.
Levels of significance of physiological status (NS) and sampling month (P<0.001).
In the column means followed by different capital letters differ at P<0.001 and small letters differ at P<0.05.

The emergence of secondary fibres from the body surface varies according to photoperiod, the breed and the environmental conditions (Kuanhu *et al.*, 1996; Merchant and Riach, 1995; Rhind and McMillen, 1995 and 1996). Previous studies have confirmed this variability having verified growth both in July (Celi *et al.*, 2001) and in August (Celi *et al.*, 2000). In this study, fibre emergence was observed in July, independent of lactation.

Klören and Norton (1993) showed that there exists an inhibitory effect of lactation on cashmere fibre growth that occurs as lactation begins and lasts a month. Our results only confirm in part the above, in as much as the minor fibre length observed in the experimental group in the first month of growth, and then in the successive months, was not significant.

The duration of cashmere fibre growth, albeit shorter in the lactating goats (184 vs 226 days), did not influence the maximum length of the fibres because the increased average daily growth of the same (0.27 ± 0.03 vs 0.20 ± 0.03 mm/day; P<0.05) compensated for the shorter growth period. The growth levels observed are on average inferior to those observed by Celi *et al.,* (2001) in subjects of the same breed-population. The cause of this could be the difference in timing of the two studies.

It is interesting to note that in the June - December period the cashmere fibre length and prolactin values describe opposite trends that allow the identification of a negative correlation between the two parameters (r = -0.45; P<0.01).

Production, yield and diameter

Cashmere production depends on the number of secondary fibres and their size. In fact, it is highly correlated with secondary fibre length (r = 0.7; P<0.01) and with the weight and yield of these in the patch (r = 0.9; P<0.001).

The average production level (Table 4) lay in the interval between the values identified by Celi *et al.,* (2000). However, contrary to that which Restall and Pattie (1989) reported, lactation caused a minor and insignificant fall in production. It is likely, then, that the negative effect of lactation on cashmere production does not depend

Table 4. Quantitative and qualitative parameters of cashmere fibre (means ± SE): yield (%), production (g) and diameter (μm).

Physiological status	Yield	Production	Diameter
Dry	37.0 ± 2.37	175.2 ± 18.31	16.8 ± 0.25
	NS	NS	NS
Lactation	35.5 ± 2.37	168.0 ± 18.31	16.2 ± 0.25

on the physiological state itself but the level of milk productivity. Sahlu *et al.,* (1992) stated that mohair production in Angora goats decreases significantly with the increase in milk production.

Cashmere yield (Table 4) falls within the range of variability indicated by Pattie and Restall (1992), being between 15 and 50%. The yield given by the lactating goats was lower than that of the control group because of a smaller percentage of active follicles, but not significantly so.

The fibre diameter values set out in Table 4 highlight the good quality fibre produced. The diameter of the fibre from the experimental group was slightly smaller than in the control group but not significantly different, confirming that lactation does not effect cashmere fibre diameter as previously observed by Restall and Pattie (1989).

Conclusions

Lactation affected the percentage of active secondary follicles. The percentage in the lactating goats, in fact, was significantly lower and furthermore did not reach its maximum until November. Fibre length was identical in both groups. However, the length varied significantly over time and maximum length was achieved in November by the lactating goats and December by the control group. The lack of a significant difference in the quanti-qualitative production of cashmere between the two groups can be attributed to the low milk production of the subjects and the lack of synchronisation between the lactation peak and the most intense period of fibre growth, which usually begins with the emergence of the fibres on the body surface.

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