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Determination of hair follicle characteristics, density and activity of Iranian cashmere goat breeds

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ABSTRACT

This experiment was conducted to identify some aspects of follicle characteristics and the extent of follicle inactivity of cashmere goat breeds kept in different provinces of Iran. A total of 212 male and female cashmere goats of different age from five breeds of cashmere goats were studied. To determine follicle characteristics and the percentage of follicle inactivity, samples of skin were taken from the left midside of animals. The overall averages for males and females were 11.4 and 10.5 for secondary to primary follicle (S/P) ratio; 2.9 and 2.7 for primary follicle density; 31.1 and 30.3 for secondary follicle density; 34.1 and 33.0 for total primary plus secondary follicle density; 21.7 and 22.4 for percentage of inactive secondary follicles. Significant differences were found in S/P ratio, follicle density and activity between the goats. Large variations existed between individual goats in the percentage of inactive secondary follicles ranging from 8% to 70%.

1. Introduction

The Iran goat population is 25 million heads of which 5 millions produce cashmere fibre. Most cashmere producing goats are Raeini, Nadoushan, Birjandi, Abadeh and Abasabadi.

The fleece of cashmere goats grows from specialized follicles in the skin. Primary follicles bear guard hair which are characteristically medulated and coarse (>30 μm) which provide a mechanical protection. Secondary follicles are more numerous than primary follicles and produce non-medulated fine cashmere fibre (<24 μm) which provide thermal protection (Ryder, 1966; Nixon et al., 1991)

The process of follicle shutdown in New Zealand cashmere goats was described by Nixon et al. (1991). Secondary follicles shed fibre in July and cashmere was absent from the fleece by November. Cashmere goat follicle cycle is composed of anagen (active), catagen (quiescent) and telogen (inactive) phases (Ryder, 1966). McDonald et al. (1987) indicated a circannual rhythm in S/P ratio and cashmere/hair ratio in Australian cashmere goats. Ryder (1966) investigated the extent of fibre shedding and follicle shutdown in Saanen, Toggenburg and Saanen × Angora goats. These workers emphasized the problems associated with harvesting fleece at the appropriate time of the year to achieve maximum production.

Since the value of cashmere is determined by weight and diameter of fibre (McDonald et al., 1987); the examination of the extent of follicle inactivity is required to obtain maximum cashmere yield. Presently, little information is available either nationally or internationally on Iranian

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Table 1
Least square means and standard errors of sex and age of cashmere goat breeds of Iran for secondary to primary (S/P) follicle ratio, primary (P) follicle density, secondary (S) follicle density, primary plus secondary (P+S) follicle density and percentage of secondary (S) inactive follicles.

Breed/province Sex/age	No.	Follicle characteristics				
		S/P ratio	P density	S density	P+S density	S inactive %
Mean		10.9 ± 0.2	2.8 ± 0.1	30.6 ± 0.4	33.4 ± 0.5	22.1 ± 0.9
Sex		*	*	NS	NS	NS
Male	72	11.4 ± 0.4[a]	2.9 ± 0.1[a]	31.1 ± 1.0	34.1 ± 1.0	21.7 ± 1.4
Female	140	10.5 ± 0.2[b]	2.7 ± 0.1[b]	30.3 ± 0.5	33.0 ± 0.5	22.4 ± 1.2
Age		NS	**	**	**	NS
1	63	11.0 ± 0.3	2.8 ± 0.1[a]	30.2 ± 0.9[a]	33.0 ± 0.9[a]	20.9 ± 1.7
2	43	11.2 ± 0.4	2.9 ± 0.1[b]	32.2 ± 0.7[ab]	35.1 ± 0.8[ab]	22.6 ± 2.3
3	106	10.5 ± 0.2	2.8 ± 0.2[ab]	30.1 ± 0.6[ab]	33.0 ± 0.7[ab]	22.7 ± 1.2
		*	*	*	*	**
Breed/province						
Abadeh/Fars	24	12.0 ± 0.4[b]	2.6 ± 0.1[c]	29.4 ± 1.1[bc]	32.0 ± 1.2[bc]	8.6 ± 2.6[b]
Nadoushan/Yazd	31	8.4 ± 0.3[d]	3.2 ± 0.1[a]	30.3 ± 1.0[b]	33.5 ± 0.9[b]	27.1 ± 2.4[a]
Abasabadi/North	49	10.8 ± 0.2[c]	2.6 ± 0.1[c]	28.6 ± 0.7[bc]	31.3 ± 0.8[bc]	22.3 ± 1.9[a]
Khorasan						
Birjandi/South	48	8.9 ± 0.2[d]	2.7 ± 0.1[c]	27.4 ± 0.6[c]	30.1 ± 0.7[c]	22.7 ± 1.2[a]
Khorasan						
Raeini/Kerman	60	13.0 ± 0.3[a]	2.9 ± 0.1[b]	35.3 ± 0.9[a]	38.3 ± 0.9[a]	24.4 ± 1.7[a]

NS: not significant.
* Significant at $P < 0.01$.
** Significant at $P < 0.05$.

cashmere goat follicle attributes. Accordingly, the present work was designed to identify follicle characteristics of Iranian cashmere goat breeds which is of primary importance in exploiting the production potential and quality of fibre for the future utility.

2. Materials and methods

2.1. Selection of animals

Cashmere goats from Fars, Yazd, North Khorasan, South Khorasan and Kerman provinces kept under conditions of natural photoperiod and ambient temperatures were used in this study. A total of 212 goats (72 males and 140 females) of Abadeh, Nadoushan, Abasabadi, Birjandi and Raeini cashmere goat breeds were sampled. The goats grazed all year but their diet was supplemented during winter with limited amount of forages grains and were housed at night during severe weather conditions. The goats were grouped into 3 age groups: 1, 2 and 3-years old (Table 1).

2.2. Skin sampling and staining

Samples of skin were taken from the left midside of animals during fibre shedding season at the peak of secondary follicle inactivity in March. In order to facilitate skin sampling, goats were restrained in a lateral position, the left midside of the animals was clipped and anaesthetized with 1% lignocaine. A 1-cm diameter trephine was used to make an incision to the connective tissue beneath the skin.

The skin section was raised with forceps and a hand-held scalpel blade was used to cut parallel to the skin surface through the connective tissue, removing the skin section. Excess blood was wiped from the biopsies and skin samples were placed in plastic scintillation vials containing 10% formalin buffered with sodium phosphate. The samples were then placed in small mell individual baskets and dehydrated through a series of graded ethanols, cleared in histoclear using a Citadel tissue processor (Histokinette 200, Cambridge Instruments Company). Processed skin samples were embedded in paraffin using Leukhardt blocks. Embedded skin samples were sectioned in transverse plane to the follicle line at 8 μm using a base sledge microtome (Model Leica rm 213s, Nussloch, Germany). Approximately 60 sections were cut per sample, but only every fifth section was retained. Twelve sections were retained per sample and transferred to slides. Before staining all sections were deparaffinised and immersed in histoclear for 2 min and rehydrated in a graded series of ethanols to water. A special tetrachrome stain 'sacpic' (Auber, 1952) was used to demonstrate follicular tissue compounds.

2.3. Follicle density, secondary to primary follicle (S/P) ratio and follicle activity (morphology)

For each goat at least 25–30 follicle groups per skin sample were used to estimate follicle S/P ratio. Follicle density per 1 square millimeter of skin was counted (Clark, 1960). Primary and secondary follicles were identified through the associated gland structures. To determine the percentage of inactive secondary follicles of skin samples taken, approximately 300 follicles were counted per midside skin sample from randomly selected follicle groups as described by Nixon (1993). The basic criteria for distinguishing an active from an inactive follicle is the presence of fibre and inner root sheath cells. In an active follicle stained with SACPIC staining method a yellow stain fibre is surrounded by a red stained inner root sheath, while in an inactive follicle these structures are either absent or disrupted. In a tellogen follicle the outer root sheath cells are often columnar and radially or spirally arranged in contrast to the rounded shape of this cell type and their arrangement during anagen.

2.4. Statistical analysis

Analysis of variance was performed using a general linear model (GLM) of SAS package (SAS, 1996). Differences between means were tested using Duncan's new multiple range test. The statistical model used for cashmere goats of different age, sex and breed was:

$$Y_{ijk} = \mu + \alpha_i + S_j + B_k + (\alpha S)_{ij} + (\alpha B)_{ik} + (SB)_{jk} + \varepsilon_{ijk}$$

where Y_{ijk}, dependent variables; μ, the overall mean; α_i, the effect of age ($i = 1, 2, 3$); S_j, the effect of sex ($j = 1, 2$); B_k, the effect of breed ($k = 1, 2, 3, 4, 5$), ε_{ijk}, residual error; $(\alpha S)_{ij}$, interaction between age and sex groups; $(\alpha B)_{jk}$, interaction between age and breed groups; $(SB)_{jk}$, interaction between sex and breed groups.

All values were expressed as least square means ± SEM with $P < 0.05$ was considered to be statistically significant.

3. Results

3.1. Secondary to primary ratio

There was significant difference in the mean S/P ratio between male and female cashmere goats (Table 1). Mean S/P ratio of male and female cashmere goats was 11.4 ± 0.4 and 10.5 ± 0.2 respectively. Significant differ-