A quantitative evaluation of different regions of skin in adult Iranian native sheep

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ABSTRACT: The present investigation aimed to evaluate the histomorphometric features of the skin of the Iranian native sheep (Bakhtiari breed). A total of 24 apparently healthy Iranian Bakhtiari sheep, aged 1–2 years were analysed and categorised on the basis of sex (12 females and 12 males). Samples were taken as small pieces from different regions of the skin, fixed and stained with H&E. The quantitative evaluations of different regions of skin were carried out using lattice line graticule (5 × 5) and light microscopy. The Student *t*-test and one-way ANOVA were used to analyse the data and detect significant differences. Results showed that the volume densities of different histological structures varied between sexes and among the different regions. No significant difference was observed in volume densities of sebaceous glands, arrector pili muscles and blood vessels, but the other parameters studied differed significantly among the regions. Except for the arrector pili muscle and connective tissue, the volume densities of other tissue structures were significantly affected by sex.

Keywords: Bakhtiari sheep; evaluation; region; various dermal structures

Sheep are kept for meat, wool, milk and pelt. The sheep population in Iran is 50 million, belonging to 26 ecotypes. (FAO 1998; Kiyanzad et al. 2003). More than 96% of Iranian sheep are fat-tailed (Kiyanzad et al. 2003). One of the main Iranian fat-tailed and native breeds is Bakhtiari which is encountered in the western and southwestern regions of the country especially in Charmahal and Bakhtiari province (Mobini 2012a,b,c).

Skin that covers the body makes up 7–12% of the live weight. Besides its biological and immunological importance, it has an economic value as a raw material in industry (Ozfiliz et al. 2002). The skin consists of two layers, epidermis and dermis, with different development and features (Dellmann 1993). Epidermis consists mainly of a multilayer of keratinocytes (Junqueira and Camerio 2003). Dermis, which is a connective tissue that supports epidermis, can be divided into a superficial papillary layer and a deep reticular layer (Dellmann 1993; Kurtdede 2002; Mobini 2012a).

The skin glands which derive from interactions of the epidermis and dermis within the skin (Widelitz et al. 1997) are located close to hair follicles in the papillary layer (Kurtdede 2002; Ozfiliz et al. 2002). The hair is an appendage of the skin that grows out of the hair follicle (Dellmann 1993). Hair can be divided into two groups: primary and secondary hair (Kurtdede 2002; Ozfiliz et al. 2002; Mobini 2012a,b,c).

The measurements of dermal structures in sheep may offer a number of potential benefits for sheep producers in terms of wool growth and monitoring body condition. Also, there is clear evidence of a strong relationship between the skin structures and wool yellowing in Merino and Romney sheep (Sumner and Craven 2005).

The value of hair and wool produced by sheep is mainly determined by morphometry of hairs and follicles (McDonald et al. 1987). One of the main morphometric studies of skin is the quantitative evaluation of various structures of the skin. In the available literature, there is a lack of data characterising the histomorphometric properties of the skin in Bakhtiari sheep. The purpose of this study was therefore to describe these properties for various regions of skin in this breed.

MATERIAL AND METHODS

A total of 24 clinically healthy Iranian Bakhtiari sheep (12 females and 12 males), aged from one to two years were used to determine the volume densities of various structures of skin. Sheep were selected according to their phenotypic features in the abattoir of Shahrekord. Immediately after slaughtering, samples of skin, 3 cm^2 each, were taken from eight regions, namely the belly, neck, leg, rump, flank, forearm, shoulder and hip. The samples were immediately fixed in 10% neutral buffered formalin solution for 24–48 hours and then submitted to a dehydration process with alcohol and embedded in Paraplast. Transverse sections (6 μ thick) were cut parallel to the surface of the skin at midsebaceous gland level and stained with H&E (Kiernan 2008). Using a lattice line graticule (5 × 5), the volume densities of the following six parameters were measured per one mm^2: total hair follicles (F), arrector pili muscles (Ar), sebaceous glands (Se), blood vessels (Bv), sweat glands (Sw) and connective tissues (Ct). Data were analysed using the Student *t*-test and one-way ANOVA, using the SPSS/PC (version 18) statistic software. All values were expressed as mean ± standard deviation (SD). $P < 0.05$ was considered as significant (Duncan's Multiple Range test).

RESULTS

The volume densities of different histological structures studied in the various regions of skin in 1–2 year-old sheep are shown in Table 1.

There was evidence for sex-related differences in four parameters: total follicles, sweat glands, sebaceous glands and blood vessels.

The total follicle and sebaceous gland values were higher in male sheep, whereas the females had a higher value of blood vessels. No significant differences were detected between the other parameters in male and female sheep ($P > 0.05$).

The total follicle density per mm^2 in leg and rump regions were higher in male sheep than in females ($P < 0.05$). The volume densities of different histological structures in four regions of skin, namely, the leg, rump, forearm and hip were clearly affected by sex ($P > 0.05$).

Table 1. The volume densities of total follicles (F), sweat glands (Sw), sebaceous glands (Se), Arrector pili muscles (Ar), blood vessels (Bv) and connective tissue (Ct) per one mm^2 of skin in different regions of male (M) and female (F) Bakhtiari sheep; mean ± SD

Region	Sex	Structures					
		F	Sw	Se	Ar	Bv	Ct
Belly	M	4.16 ± 2.40	5.55 ± 2.40	0.93 ± 0.80	0.93 ± 0.80	0.93 ± 0.80	20.83 ± 1.39
	F	8.79 ± 3.50	1.85 ± 0.80	1.39 ± 0.0	0.0 ± 0.0	0.93 ± 0.80	20.37 ± 3.20
Neck	M	9.72 ± 1.39	3.24 ± 1.60	0.46 ± 0.80	0.46 ± 0.80	0.93 ± 1.60	18.52 ± 2.89
	F	7.87 ± 2.12	1.39 ± 0.0	0.93 ± 0.80	0.93 ± 1.60	0.46 ± 0.80	21.76 ± 0.80
Leg	M	11.11 ± 1.39*	3.24 ± 3.20	2.32 ± 0.80	1.85 ± 0.80	0.46 ± 0.80	14.35 ± 2.12
	F	4.63 ± 1.60	4.63 ± 2.12	1.85 ± 0.80	0.93 ± 0.80	0.46 ± 0.80	20.83 ± 3.67
Rump	M	9.72 ± 2.41*	0.93 ± 0.80*	1.85 ± 1.60	0.93 ± 0.80	3.70 ± 5.26	16.20 ± 3.20
	F	4.17 ± 2.40	3.24 ± 0.80	1.39 ± 0.0	0.93 ± 0.80	1.85 ± 2.12	21.76 ± 2.12
Flank	M	6.94 ± 1.39	1.85 ± 1.60	1.85 ± 0.80	0.46 ± 0.80	1.39 ± 0.0	20.83 ± 2.41
	F	8.46 ± 2.30	2.78 ± 2.40	1.39 ± 1.39	0.93 ± 0.80	1.39 ± 0.0	18.05 ± 2.77
Forearm	M	12.04 ± 2.89	2.32 ± 0.80	2.32 ± 0.80*	0.0 ± 0.0	0.46 ± 0.80*	16.20 ± 2.12
	F	6.02 ± 2.89	3.71 ± 0.80	0.46 ± 0.80	1.39 ± 1.39	3.24 ± 0.80	18.52 ± 3.20
Shoulder	M	6.01 ± 0.80	4.63 ± 0.80	0.93 ± 0.80	2.32 ± 2.12	0.93 ± 0.80	18.52 ± 2.12
	F	6.48 ± 2.89	2.32 ± 2.12	0.0 ± 0.0	3.24 ± 1.60	1.85 ± 0.80	19.44 ± 2.40
Hip	M	9.72 ± 2.78	4.17 ± 0.0*	1.39 ± 0.0	0.93 ± 0.80	0.46 ± 0.80	16.67 ± 1.38
	F	6.94 ± 1.39	1.85 ± 0.80	0.46 ± 0.80	1.39 ± 1.39	1.85 ± 1.60	20.83 ± 2.78

Asterisks indicate significant differences between both sexes for a given body region ($P < 0.05$)

Table 2. The overall volume densities of total follicles (F), sweat glands (Sw), sebaceous glands (Se), Arrector pili muscles (Ar), blood vessels (Bv) and connective tissue (Ct) per one mm^2 of skin in different regions of Bakhtiari sheep; mean ± SD

Region	Sex	Structures					
		F	Sw	Se	Ar	Bv	Ct
Belly	M ± F	6.48 ± 3.69	3.70 ± 2.85	1.16 ± 0.57^{ab}	0.46 ± 0.72^{a}	0.93 ± 0.72^{ab}	20.60 ± 2.22
Neck	M ± F	8.79 ± 1.90	2.32 ± 1.43	0.70 ± 0.76^{a}	0.70 ± 1.16^{a}	0.70 ± 1.16^{ab}	20.14 ± 2.60
Leg	M ± F	7.87 ± 3.80	3.93 ± 2.54	2.08 ± 0.76^{b}	1.39 ± 0.88^{a}	0.46 ± 0.72^{a}	17.59 ± 4.45
Rump	M ± F	6.94 ± 3.72	2.08 ± 1.46	1.62 ± 1.05^{ab}	0.93 ± 0.72^{a}	2.78 ± 3.73^{b}	18.98 ± 3.89
Flank	M ± F	7.70 ± 1.89	2.31 ± 1.89	1.62 ± 1.05^{ab}	0.70 ± 0.76^{a}	1.39 ± 0.0^{ab}	19.44 ± 2.78
Forearm	M ± F	9.03 ± 4.19	3.01 ± 1.05	1.39 ± 1.24^{ab}	0.70 ± 1.16^{a}	1.85 ± 1.68^{ab}	17.36 ± 2.74
Shoulder	M ± F	6.25 ± 1.91	3.47 ± 1.91	0.46 ± 0.72^{a}	2.78 ± 1.76^{b}	1.39 ± 0.88^{ab}	18.98 ± 2.09
Hip	M ± F	8.33 ± 2.49	3.01 ± 1.37	0.93 ± 0.72^{ab}	1.16 ± 1.05^{a}	1.16 ± 1.37^{ab}	18.75 ± 3.01

Different superscripts within a column indicate significant differences among body regions ($P < 0.05$)

The sweat gland density of the hip region was higher in male sheep, whereas the ewes had a higher value in rump skin. The only sex-based significant difference in the volume density of sebaceous glands and blood vessels was recorded in forearm skin. The sebaceous gland values in males were higher than in females, whereas ewes had a higher value of blood vessels in this region ($P < 0.05$).

The densities of Arrector pili muscles and connective tissues in Bakhtiari sheep showed no significant differences according to sex, but the maximum arrector pili muscle density was found in the shoulder region of males. In contrast, the maximum connective tissue density was recorded in the neck and rump skin of females (Table 1).

The overall volume densities of different histological structures varied among the various regions of skin (Table 2). There were significant differences in the volume densities of sebaceous glands, arrector pili muscles and blood vessels among the various regions studied ($P < 0.05$). The maximum densities of sebaceous glands, arrector pili muscles and blood vessels were found in the leg, shoulder and rump regions, respectively.

In this study, the mean total follicle density per mm^2 in the various skin regions was 6.25–9.03. Although no significant difference was observed in the hair follicle densities among the various regions studied, the highest hair follicle density was recorded in the forearm region (9.03 ± 4.19). The lowest hair follicle density was found in the shoulder region (6.25 ± 1.91). Among all the various skin regions, the maximum volume densities of sweat glands and connective tissues were recorded in leg and belly skin samples, respectively, but differences were not significant ($P > 0.05$) (Table 2).

DISCUSSION

The mean total follicle density per mm^2 in the various skin regions was 6.25–9.03 in Bakhtiari sheep, while in Lori (Abbasi et al. 2008), Merino and their hybrids (Andrews et al. 1998), and Swedish Peltsheep (Butler et al. 1993), the respective values were 6.06, 21.7 and 14–19.

The total follicle density per mm^2 in leg and rump regions was higher in male sheep than in females ($P < 0.05$). This finding is in agreement with what was reported for some common Iranian sheep breeds (Ansari-Renani et al. 2011). Abbasi et al. (2008) reported no sex differences for follicle densities in adult Lori sheep.

When the overall follicle density per one mm^2 of flank skin in Bakhtiari sheep (7.70 ± 1.89) was compared with that of Lori sheep (6.19 ± 0.23) (Abbasi et al. 2008) and other Iranian sheep breeds (16.0 ± 0.7) (Ansari-Renani et al. 2011), it was determined that values for the Bakhtiari sheep were higher than those in Lori, but lower compared to other Iranian native breeds (Ansari-Renani et al. 2011). Also, the mean follicle density in the shoulder region in Bakhtiari sheep (6.25 ± 1.91) was higher than in Lori sheep (5.66 ± 0.26). It can be therefore concluded that the quality of Bakhtiari sheep skin is better than that of the Lori breed.

In this study, the mean follicle density in various regions of the skin in males and females were 4.16–12.04

and 4.17–8.79 respectively, while in Lori the values were 5.92 and 6.2, respectively (Abbasi et al. 2008).

Sexual dimorphism was not detected in the hair follicle densities among the various regions studied. The highest and lowest densities of hair follicles were found in the forearm and shoulder skin samples, respectively. Fibre density is subject to large variation between animals and over the skin of the same animal.

The sebaceous gland area per unit length of flank skin in Merino ewes was 24.27 ± 1.54 (Warren et al. 2008). This value in Bakhtiari sheep was 1.39 ± 1.39. Therefore, the volume density of sebaceous glands in flank skin in Bakhtiari sheep was much lower compared to Merino ewes.

It is concluded that the skin of Bakhtiari sheep shows clear sexual dimorphism in several histomorphometric parameters. The overall volume densities of different histological structures varied among the various regions of skin.

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