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Seasonal pattern of skin follicles activity and fibre growth in grazing fat-tailed Kermani sheep in the South of Iran

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ABSTRACT

Photoperiod is known to be important in regulating the pattern of wool growth in sheep. The aim of this study was to investigate the effect of natural changes in photoperiod on live weight, skin follicle activity and fiber characteristics of grazing Kermani sheep in the south of Iran, Jiroft (28° 40′ N and 57° 44′ E, elevation 650 m). Ten male and 10 female Kermani sheep with initial live weights of 31.9 ± 0.8 and 30.7 ± 0.9 kg (mean ± s.e.) respectively, were used in a 365 day study. Percentage of active primary (PAP) and percentage of active secondary (PAS) follicles, ratio of secondary to primary follicles (S/P) and follicle density (FD) were measured in skin samples, taken from the right mid-side of the animals at monthly intervals. Greasy and clean wool growth rates and fibre diameter were determined from patch samples (10 cm × 10 cm) harvested at the end of every month. The value for PAP was greatest ($p < 0.05$) in summer and spring and lowest ($p < 0.05$) in winter (98.2 ± 0.8, 84.1 ± 0.9, 75.6 ± 0.8 and 97.0 ± 1.1% for summer, autumn, winter and spring, respectively); seasonal differences in PAS were similar (99.3 ± 0.8, 88.5 ± 0.7, 82.9 ± 0.8 and 98.9 ± 0.7% for summer, autumn, winter and spring, respectively). Clean wool growth rate was greatest ($p < 0.001$) in summer and spring, and lowest ($p < 0.001$) in winter (0.7 ± 0.03, 0.4 ± 0.04, 0.3 ± 0.01 and 0.7 ± 0.05 mg/cm^2/day for summer, autumn, winter and spring, respectively). Fibre diameter was greatest in spring (34.8 ± 0.3 μm) and lowest in winter (29.1 ± 0.2 μm). The values for wool growth rates and fibre diameter were greater ($p < 0.05$) in male rather than those observed in female sheep. Fibre and skin follicle characteristics were not affected by a season × sex interaction. These results demonstrated that there is a seasonal pattern in fibre follicles activity and wool growth in grazing Kermani sheep.

1. Introduction

It has been reported that the seasonal pattern of fibre production in grazing sheep represents the balance of the interactions between photoperiod, pasture quality, genotype, and disease. In this regard, different seasonal patterns of hair follicle activity and wool growth in certain breeds of sheep have been reported. It ranges from a visible seasonal moult in wild type double-coated breeds of sheep such as Soay and Shetland, to apparently continuous wool growth throughout the year in domestic Merino sheep (Sumner and Bigham, 1993). In non-seasonal fibre-producing breeds of sheep, fibres are replaced inside follicles as older fibres are shed thus, maintaining a cover over the animal body, but in seasonal fibre-producing breeds of sheep, the regrowth of fibres from follicles may not occur for 1–3 months after shedding (McDonald et al., 1987). However, in some studies working on non-seasonal fibre-producing breeds of sheep such as domestic Merino and Polwarth, a seasonal rhythm in fibre growth with different amplitudes has been reported (Butler and Head, 1994; Schlink et al., 1999). Such seasonality in fibre growth could be due to the seasonal pattern in pasture quality and therefore changes in animal liveweight. In Merino sheep grazing seasonally variable pastures, Schlink et al. (1999) reported that the seasonal rhythm in wool growth was similar to pasture quality and liveweight changes. Similarly, McGregor (2010) demonstrated that the rate of wool growth in Merino sheep was the lowest in summer, when seasonal nutrition restrictions resulted in rapid liveweight loss. Moreover, a seasonal fluctuation of wool production and fibre diameter by Romney breed (coarse wool sheep) was recorded by Geenty et al. (1984) and Woods et al. (1995). They found lowest rate of wool growth rate and fibre diameter during winter and greatest during summer in Romney ewes.

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Fleeces suitable for the best quality carpets of intricate design are produced by most of the coarse wool sheep breeds indigenous to Iran. Among them, the fat-tailed Kermani sheep is the most important breed which is mainly reared in the Kerman province located in the south of the country. In this particular region, the pastures vary widely with season and rainfall in quality and available forage mass, which may result in seasonal reductions in wool growth and body weight. There has not yet been a characterization of the seasonal wool growth cycle in Kermani sheep breed. This could be of value in a number of ways. For instance, if wool growth in this breed is seasonal, then efficiency of feed use for fibre production could vary during the year, and most appropriate diets or supplementation strategies will differ among seasons. This experiment was therefore undertaken to investigate the seasonal pattern of body weight, fibre follicle activity, wool growth and fibre diameter in both male and female grazing Kermani sheep.

2. Materials and methods

2.1. Location and duration

This experiment was conducted on the Animal Farm, Faculty of Agriculture, University of Jiroft, Jiroft, Iran (28° 40′ N and 57° 44′ E, elevation 650 m) for a total period of 12 months (from May 2013 until May 2014). The year was divided into the four geographical seasons based on the solar calendar, with winter (from 21st December to 21st March), spring (from 21st March to 21st June), summer (from 21st June to 21st September) and autumn (from 21st September to 21st December). Climatic data for location during the experimental period are presented in Table 1. Summer and autumn is a period of decreasing daylength, in contrast winter and spring is a period of increasing daylength. Because of low annual rainfall, the grazed pastures of the region were irrigated.

2.2. Animal management and pasture measurements

Ten male and 10 female healthy Kermani sheep aged about 20 months with initial live weights of 31.9 ± 0.8 and 30.7 ± 0.9 (mean ± s.e.) kg respectively were used. The male and female sheep were separately grazed at conservative stocking rates in the same paddock for the duration of the experiment. Pastures were sampled by harvesting 10 quadrats (0.25 m^2) across the paddock at monthly intervals. Quadrat pasture samples were dried at 60 °C for a minimum of 48 h, weighed, bulked, subsampled and ground through a 1 mm screen. The total nitrogen (Tector Kjeldahl Technique) and dry matter digestibility (Faichney and White, 1983) were measured in the samples. The animals were weighed at weekly intervals. A general management program for de-worming, disease prevention and hoof trimming was followed during experiment. Fresh tap water was offered *ad libitum*.

2.3. Sample collection and measurements

2.3.1. Fibre

Fibre growth measurements were carried out by taking patch samples (10 × 10 cm) from the left mid-side area of the sheep at intervals of 28 days commencing on day 0 as recommended by Gifford (1989). Greasy, un-conditioned weight of the wool samples were recorded. The fibre harvested was then washed in a 10 μm nylon filter folded in a funnel. Six 200-mL aliquots of 0.3% Tween 80 detergent at 60 °C were poured through the fibre, followed by 6 rinses with deionised water at 40–50 °C and two 200-mL alcohol (100%) rinses. The washed fibre was then air-dried at room temperature and weighed to calculate the clean fibre yield. Individual clean fibres (n = 100) from each sample were randomly selected to measure fibre diameter using an inverted microscope fitted with an eyepiece measuring graticule. The minimum detectable difference in diameter that could be measured was 1 μm.

2.3.2. Skin

Skin biopsy samples (10 mm) were collected from the right mid-side of the animals following a subcutaneous injection of 1 ml of local anesthetic (1% lidocaine) by using a 1 cm diameter trephine, every one month throughout the experiment. After collection of skin samples, the animals were given an antibiotic treatment (Terramycin, Oxytetracycline®, Pfizer Ltd., Aana Salai, Chennai, India) as well as an antimicrobial skin spray for the next 3 days. The Animal Ethics Committee of the University approved this experiment. Biopsies were immediately fixed and stored in 10% buffered formalin (w/v) for histological processing. Fixed samples were dehydrated through a series of graded ethanol, cleared in histoclear using a Citadel tissue processor (Histokinette 200, Cambridge Instruments Company) and embedded in paraffin using Leukhardt blocks.

Approximately 60 sections, 8 μm thick, were cut per sample, but only every alternate series of 5 sections were retained (12 sections per sample). A base sledge microtome (Model Leica rm 213s, Nussloch, Germany) was used for cutting the transverse sections. The sections were then placed on slides and stained by using the Sacpic staining procedure (Nixon, 1993). The level immediately under sebaceous gland was used for carrying out microscope observations. Original primary follicles were identified according to their position within the groups, accessory glands and arrector pili muscles. The counted follicles classified as inactive or active based on the absence or presence of fibre and a distinct bright red-stained inner root sheath, respectively. To estimate the follicle activity, for each sample, 12 complete follicle groups were recorded. Approximately 300 follicles per sample were recorded. Additional primary follicles were counted to improve the accuracy of mean values for the primary follicle activity. To measure the ratio of secondary to primary follicles (S/P) and the follicle density (FD), a single transverse section for each sample were used. For this purpose, the numbers of both primary and secondary follicles were recorded per 1 mm^2 of skin. A correction factor (area of mounted skin section/area of the trephine) was used to adjust follicle densities for shrinkage in the diameter of the transverse sections during excision, fixation, and processing (Ryder and Stephenson, 1968).

2.4. Statistical analyses

All data were analysed as repeated measures using the Proc Mixed of SAS software (version 6.12, 1996), with the following model:

$$Yijkl = \mu + Si + Gj + (SG)ij + b(xijk\text{-}x) + \varepsilon ijkl$$

Table 1
Climatic data for Jiroft city during the experimental period.

	Ambient temperature (°C)			Relative humidity (%)			Day length (h)			Rainfall (mm)
Season	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	
Summer	34.0	24.8	43.3	31.2	11	51	13:33	12:03	14:29	0.0
Autumn	21.9	12.5	31.4	35.5	14	57	11:33	10:02	12:03	13.5
Winter	15.7	8.7	22.6	61.5	37	86	11:20	10:01	11:33	18.2
Spring	29.5	20.4	38.6	35.5	13	58	12:45	11:35	14:27	5.2