Small Ruminant Research 123 (2015) 103–109

Contents lists available at ScienceDirect

Small Ruminant Research

journal homepage: www.elsevier.com/locate/smallrumres

Influence of nutrition supplementation on the seasonal change in fiber growth and skin follicle activity in both male and female Sanjabi lambs

N. Naderi [a], Z. Salehian [a], M. Souri [a,*], F. Hodjabri [a], R. Mirmahmoudi [b]

[a] Department of Animal Science, College of Agriculture, Razi University, Kermanshah, Iran
[b] Department of Animal Science, Faculty of Agriculture, University of Jiroft, P.O. Box 364, Jiroft, Iran

ARTICLE INFO

Article history:
Received 3 November 2013
Received in revised form 16 July 2014
Accepted 7 October 2014
Available online 23 October 2014

Keywords:
Dry matter intake
Photoperiod
Sanjabi
Sheep
Wool
Fiber follicle activity
Follicular density

ABSTRACT

The present work aimed to investigate the effect of nutrition supplementation on skin follicle activity and wool growth rate in male and female Sanjabi lambs during the autumn and winter seasons, when the natural daylength is declining and being shortest. Twenty male (control and male (CM), $n = 10$; treatment and male (TM), $n = 10$) and 20 female (control and female (CF), $n = 10$; treatment and female (TF), $n = 10$) Sanjabi lambs were housed in individual pens, under natural daylength condition at west of Iran, Kermanshah (34°18′ N and 47°3′ E and 1420 m above sea level). Lambs in control groups received a diet consisting of 80% alfalfa and 20% concentrate, providing 2.18 Mcal and 130.0 g per kg DM ME energy and crude protein, respectively. In treatment groups, lambs were fed a diet consisting of 65% alfalfa and 35% concentrate, providing 2.34 Mcal and 160.0 g per kg DM ME energy and crude protein, respectively. Raw and clean fiber growth rates and fiber diameter were measured from left mid-side patches harvested at the end of every month. Percentage of active primary and secondary follicles (PAP and PAS), follicular density (FD) and the ratio of secondary to primary follicles (*S*/*P*) were measured from skin biopsies, taken from the right mid-side of the lambs in monthly intervals. PAP and PAS in autumn were significantly ($p < 0.01$) higher than those observed in winter season. There was a positive effect of feeding supplementation on both PAP and PAS but, similar values for *S*/*P* ratio and FD were observed in control and treatment groups. All hair follicle parameters viz. PAP, PAS, *S*/*P* ratios and FD were significantly greater in females compared to male lambs. The rate of wool growth was significantly lower in winter compared to autumn season, although similar fiber diameter was recorded in two seasons. Male lambs compared to females had greater body weight, DMI and the rate of wool growth. It is concluded that the fiber follicle activity and therefore wool growth in Sanjabi lambs is mainly under influence of nutrition, nonetheless little monthly fluctuation in follicle activity and fiber growth and diameter was observed. Likewise, there was a different pattern of wool production in male and female Sanjabi lambs.

* Corresponding author. Tel.: +98 831 8323728; fax: +98 831 4277602.
E-mail addresses: m.souri@razi.ac.ir, msouri2000@yahoo.com (M. Souri).

http://dx.doi.org/10.1016/j.smallrumres.2014.10.004
0921-4488/

1. Introduction

Many factors, including nutrition, age, inheritance, reproduction and environment influence the quantity and quality of fiber produced by sheep breeds (Bedard and Beaulieu, 1988; Adams and Cronjé, 2003). In various breeds of sheep such as Merino, having an apparently continuous wool growth throughout the year, there is a large effect of nutrition on wool growth. In contrast, the double-coated breeds of sheep such as Soay and Shetland which have a visible seasonal molt, the responsiveness of fiber growth is relatively insensitive to nutrition (Sumner and Bigham, 1993; Reis and Sahlu, 1994). Likewise, in other breeds of sheep (e.g., Romney) the wool growth is less responsive to nutrition during the winter season, when the daylength is short (Allden, 1979; Sumner and Bigham, 1993).

In this regards, a positive association has been demonstrated between fiber growth and the seasonal fluctuations in feed intake and body weight. For instance, in Merino sheep grazing seasonally variable pastures, Schlink et al. (1999) reported that the seasonal pattern in fiber growth was similar to pasture quality and body weight. Similarly, McGregor (2010) demonstrated that the rate of fiber growth in Merino sheep was the lowest in summer, when seasonal nutrition restrictions resulted in rapid liveweight loss. In addition, a seasonal rhythm in the fiber growth with different amplitudes has been reported in domestic Merino and Polwarth breeds of sheep (Butler and Head, 1993; Schlink et al., 1999).

Among Iranian native breeds of sheep, the triple purpose Sanjabi is the most important fat-tailed sheep breed in the Western provinces. In the west of the country, the pastures for Sanjabi sheep vary widely with season and rainfall in quality and available forage mass, which may result in seasonal reductions in wool growth and body weight. This study was therefore undertaken to investigate (a) the pattern of live weight, DMI, hair follicle activity and wool growth rate changes in both male and female Sanjabi ram lambs independent of natural variations in food availability and (b) whether or not the seasonality of wool growth in both male and female Sanjabi lambs can be overcome by adjusting feeding level during the winter and summer seasons.

2. Materials and methods

2.1. Location and duration

This study was conducted on the Animal Farm, Faculty of Agriculture, Razi University, Kermanshah, Iran (34°18′ N and 47°3′ E and 1420 m above sea level) for a total period of 9 months (from September 2012 until May 2013). Based on the solar calendar, autumn and winter seasons were defined as the time from 21st September to 21st December and from 21st December to 21st March, respectively.

Climatologically, the data for this location during the experimental period is summarized in Table 1. Summer and autumn is a period of direction of decreasing daylength, in contrast winter and spring is a period of direction of increasing daylength.

2.2. Animals and management

Forty 8-months-old Sanjabi lambs were randomly divided into four groups of 10 comprised of 10 males and 10 females. Ten male and 10 female lambs were assigned into two separate control groups (CM and CF, respectively) and were fed a diet consisting of 80% dehydrated alfalfa hay and 20% concentrate (based on barley, corn, soybean and minerals and vitamins), providing 2.18 Mcal and 130.0 g per kg DM ME energy and crude protein, respectively. In two treatment groups, 10 male and 10 female lambs (TM and TF, respectively) were offered a diet consisting of 65% dehydrated alfalfa hay and 35% concentrate (based on barley, corn, soybean and minerals and vitamins), providing 2.34 Mcal and 160.0 g per kg DM ME energy and crude protein, respectively. All animals were housed in individual pens and were subjected to natural lighting via windows and skylights.

They were offered a dry matter, according to their body weight, to meet the current estimates of requirements for low rate of increase in live weight (150.0 g per day) and 2.0 kg wool production per year plus 10% of the requirements (NRC, 1985). The diet was offered daily in two equal portions at 09.00 h and 16.00 h. Body weight, average daily gain (ADG), feed refusals and dry matter intake (DMI) were recorded weekly. The amount of feed offered to each animal was adjusted following weekly measurement of body weight. Fresh tap water was offered ad libitum. A general management program for de-worming, disease prevention, and hoof trimming was followed during the experiment.

2.3. Sample collection and measurements

2.3.1. Fiber

Fiber growth measurements were carried out by taking patch samples (10 cm × 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, unconditioned fiber weights were recorded. The fiber 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 fiber, followed by 6 rinses with deionised water at 40–50 °C and two 200-mL alcohol (100%) rinses. The washed fiber was then air-dried at room temperature and weighed to calculate the clean fiber yield. Hundred clean fibers from each sample were randomly selected to measure the mean fiber diameter of the samples, 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 × 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., Anna 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. Transverse sections of 8 μm thickness were cut using a base sledge microtome (Model Leica rm 213s, Nussloch, Germany). The sections were placed on slides and stained by using the Sacpic staining procedure (Nixon, 1993). The level immediately under sebaceous gland was used for carrying out microscopical observations.

Primary and secondary follicles were identified according to their size, shape and associated glands and counted per 1 mm^2 of 12 clusters in each histological section. The counted follicles classified as inactive or active according to the absence or presence of fiber and a distinct bright red-stained inner root sheath, respectively. The recorded data were used to calculate the follicle density (FD) per 1 mm^2 field, the ratio of secondary to primary follicles (*S*/*P*) and the percentage of active follicles. 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 statistical analyses were conducted in SAS software (version 6.12, 1996) using the Proc Mixed with the following model:

$$Yijkl = \mu + Si + Gj + Fk + (SG)ij + (SF)ik + (GF)jk + (SGF)ijk + b(xijkl - x) + \varepsilon ijkl$$