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Effects of photoperiod and melatonin on nitrogen partitioning and body composition in Inner Mongolia white Cashmere goats

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ABSTRACT

Thirty-six mature goats were allocated into three groups, i.e. long-day photoperiod, short-day photoperiod, natural day photoperiod groups, in each of the groups half of the goats had melatonin implanted. The results showed that there was a significant difference in body N retention and fleece N partitioning among the different photoperiod treatments and melatonin implants. Fleece N partitioning increased as the photoperiod declined, implanted subgroups had higher values than the non-implanted ones. Body composition was dramatically changed in different treatment groups.

KEY WORDS: photoperiod, melatonin, nitrogen partitioning, body composition, Cashmere goats

INTRODUCTION

It was found that altering the photoperiod and implanting melatonin had potential use in Cashmere goat feeding (Wang, 2005). Studies indicated that Cashmere could be induced by implanting melatonin or shortening the photoperiod, and both have an additive effect on cashmere production combined with variations in a series of hormones. There is no report about the effects on nitrogen partitioning, especially in Inner Mongolia Cashmere goats in China. This paper investigated the effects of photoperiod and melatonin in Inner Mongolia Cashmere goats.

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MATERIAL AND METHODS

Animals, experimental period and design

Thirty-six selected castrated Inner Mongolia Cashmere goats aged from 2.3-2.5 years old, with 23-25 kg body weight (BW) were randomly assigned to three groups, each group was sub-allocated into two equal subgroups. One subgroup of each group was implanted with melatonin at a dose of 1.86 mg/kg BW (Welch et al., 1990), the another was the control. The three groups were treated with a long-day photoperiod, natural day photoperiod and short-day photoperiod in three adjacent light-controlled rooms, respectively.

Feeding and management system

The goats' diet was formulated according to NRC (1981), and had a roughage⁄concentrate ratio of 30:70 or 40:60 and 1.2 M of feeding level and 11.04% of crude protein. Concentrate was mixed with roughage and the animals had *ad libitum* access to water.

Measurement of nitrogen partitioning and body composition

In castrated cashmere goats, retained dietary nitrogen (ΔN) is deposited in two compartments: body nitrogen (N_B) and fleece nitrogen (N_F). ΔN was detected by digestion and a metabolism trial ($\Delta N=N_{intake}-N_{faeces}-N_{urine}$), the nitrogen measurement period was 90 days. Body nitrogen retention (N_B) was measured by body protein (CP) content which was determined by a validated formula for live goats (Panaretto and Till, 1963) using TOH (tritiated water) dilution techniques.

$$N_B = BN_{end} - BN_{beg} (BN_{beg} = CP_{beg} \times 16\%, BN_{end} = CP_{end} \times 16\%)$$

Fleece nitrogen partitioning (N_F) was calculated by the formula:

$$N_F = \Delta N - N_B$$

Fleece sampling and cashmere measurement

The fleece samples were collected from an area of 2 × 2 cm behind the shoulder blade of the goats. The fibres in the sampling area were dyed at the beginning of the experiment and were cut to skin level monthly until the end of the experimental period. By the end of the experiment, 5 × 5 cm fleece sample were collected.

Blood sampling and hormone determinations

Thirty days after the start of the experiment, 5 ml of blood was drawn from the jugular vein of each goat every 2 h during a 24-h period. Blood was sampled through a clean syringe through jugular vein catheters fixed on the goat's neck in advance. Melatonin, prolactin, insulin, IGF-I and leptin were determined.

Statistical analysis

The data were analysed using a randomized block ANOVA, the treatment means were compared using Duncan's multiple range test.

RESULTS AND DISCUSSION

Photoperiod and melatonin had significant effects on nitrogen retention and partitioning in Cashmere goats in telogen (Table 1). The total nitrogen retention in the goats subjected to the three patterns of daily photoperiod increased with the declining of the photoperiod: nitrogen retention was 107.8±8.9 g in long-day photoperiod (LDPP), 112.0±40 g in natural day photoperiod (NDPP), and 121.1±12 g in the short-day photoperiod (SDPP). The retained nitrogen percentage as dietary nitrogen intake was 12.2±1.50, 12.2±4.09 and 12.7±1.17%, respectively. In the same photoperiod treatment groups, the implanted subgroups had higher values than the non-implanted subgroups: retained nitrogen was 16.1±0.54% in group LDPP, 15.8±1.65% in NDPP and 17.2±4.83% in SDPP, respectively. Groups LDPP and NDPP have similar values because they underwent nearly the same photoperiod in spring and summer, but both have lower values than in group SDPP and further analysis indicated there was an intensive interaction between photoperiod and melatonin ($P<0.01$).

Table 1. Dietary nitrogen retention efficiency and partitioning ratio in Cashmere goats in different treatments

Treatments	N intake (IN) g	Total N retention, ΔN, g	ΔN/IN %	Body N partitioning N_B, g	$N_B/\Delta N$ %	Fleece N partitioning N_F, g
LDPP	891.7 ± 31^a	107.8 ± 8.9^a	12.2 ± 1.50^a	82.2 ± 6.3^a	76.4 ± 0.46^a	25.6 ± 2.60^a
LDPP+MT	913.2 ± 33^a	146.8 ± 1.1^a	16.1 ± 0.54^a	97.4 ± 1.4^a	66.3 ± 0.42^b	49.5 ± 0.26^a
NDPP	896.8 ± 39^a	112.0 ± 40^a	12.2 ± 4.09^a	84.4 ± 29.6^a	75.7 ± 0.62^a	27.6 ± 10.3^a
NDPP+MT	938.5 ± 14^a	149.0 ± 16^a	15.8 ± 1.65^a	96.7 ± 9.9^a	65.0 ± 0.67^b	52.4 ± 6.58^a
SDPP	949.1 ± 12^a	121.1 ± 12^a	12.7 ± 1.17^a	80.4 ± 8.8^a	66.3 ± 0.64^b	40.6 ± 3.81^a
SDPP+MT	892.5 ± 17^a	151.6 ± 40^a	17.2 ± 4.83^a	96.1 ± 24.3^a	63.9 ± 0.79^b	55.5 ± 15.7^a

nitrogen partitioning in the Table was calculated over 90 days; means in the same column with different superscripts differ significantly, the same letter represents $P<0.05$

Not only was nitrogen retention influenced by photoperiod and melatonin, but so was nitrogen partitioning (Table 1). Body nitrogen partitioning (N_B) differed from fleece nitrogen partitioning (N_F). Body nitrogen partitioning decreased with shortening of photoperiods, whereas fleece nitrogen partitioning increased. In the three photoperiods, the body nitrogen percentage was 76.4±0.46 (LDPP), 75.7±0.62 (NDPP) and 66.3±0.64 (SDPP), nitrogen partitioning decreased as the photoperiod declined. In the same photoperiod, body nitrogen partitioning in implanted groups was lower compared with non-implanted ones, equaling 66.3±0.42 for LDPP+MT, 65.0±0.67 for NDPP+MT and 63.9±0.79 for SDPP+MT, respectively. LDPP+MT and NDPP+MT treatments had similar values because their photoperiod was not very different, but they were distinct from SDPP+MT. Further analysis showed that there was an intensive interaction between photoperiod and melatonin ($P<0.01$).

On the other hand, the fleece nitrogen percentage increased with shortening of the photoperiod and equaled 23.6±0.46, 24.3±0.62 and 33.7±0.64 for LDPP, NDPP and SDPP, respectively. Groups LDPP and NDPP showed comparable values because they experienced similar photoperiods, but they were significantly lower compared with group SDPP. In the same photoperiod, implanted subgroups had greater fleece nitrogen retention than the non-implanted groups. Their nitrogen percentage was 33.7±0.42, 35.0±0.67 and 36.1±0.79 for LDPP+MT, NDPP+MT and SDPP+MT, respectively, which was enhanced by shortening of the photoperiod. There was an intensive interaction between photoperiod and melatonin ($P<0.01$).

As a result of differences in nitrogen partitioning, the goats' body composition changed dramatically under different treatments (Table 2). As shown, the body fat percentage increased with shortening of the photoperiod: 14.16±0.59 in group LDPP, 15.78±0.45 in NDPP and 23.60±3.87 in SDPP; SDPP was evidently higher than LDPP and NDPP. Under the same photoperiod, the implanted groups had markedly higher values than the non-implanted ones, except groups SDPP and SDPP+MT, in which body fat did not differ and equaled 23.60±3.87 and 24.67±1.41%, respectively. There was an intensive interaction between photoperiod and melatonin ($P<0.01$).

Table 2. Body composition of the goats in different treatments, %

Treatments	Water	Fat	Protein	Ash
LDPP	65.84 ± 0.59^{a}	14.16 ± 0.59^{c}	15.35 ± 0.11^{a}	3.84 ± 0.03^{a}
LDPP+MT	59.18 ± 0.66^{b}	21.23 ± 0.47^{b}	13.78 ± 0.15^{b}	3.44 ± 0.04^{b}
NDPP	63.98 ± 0.23^{a}	15.78 ± 0.45^{c}	15.01 ± 0.09^{a}	3.75 ± 0.02^{a}
NDPP+MT	55.96 ± 3.42^{c}	24.1 ± 3.45^{ab}	12.99 ± 0.88^{bc}	3.25 ± 0.22^{bc}
SDPP	56.46 ± 3.82^{bc}	23.60 ± 3.87^{ab}	13.06 ± 1.02^{bc}	3.26 ± 0.25^{bc}
SDPP+MT	55.42 ± 1.93^{c}	24.67 ± 1.41^{a}	12.71 ± 0.38^{c}	3.17 ± 0.09^{c}

the percentage of body components was based on liveweight. Means in the same column with different superscripts differ significantly, the same letter represents $P<0.05$

On the other hand, body protein % was quite different compared with body fat percentage. The percentages increased as the photoperiod lengthened, the corresponding values were 13.06±1.02 in SDPP, 15.01±0.09 in NDPP and 15.35±0.11 in LDPP. Under the same photoperiod, the implanted groups had lower values than the non-implanted subgroups, fat content was 12.71±0.38% in SDPP+MT, 12.99±0.88% in NDPP+MT and 13.78±0.15% in LDPP+MT. A strong interaction between photoperiod and melatonin was observed ($P<0.01$). Body water and ash percentages had the same trend as body protein.

The results of blood hormone concentrations are listed in Table 3.

Table 3. Main related hormones in different treatments

Treatments	MT/pg/ml	PRL/ng/ml	IGF-I/ng/ml	INS/ng/ml	LEP/ng/ml
LDPP	62.5 ± 8.3^{b}	28.5 ± 5.38^{a}	228.9 ± 7.7^{a}	13.2 ± 0.93^{c}	8.0 ± 0.53^{a}
LDPP+MT	317.6 ± 28.5^{a}	1.2 ± 0.03^{b}	174.1 ± 4.4^{b}	19.6 ± 3.43^{b}	7.2 ± 0.43^{ab}
NDPP	67.7 ± 14.6^{b}	7.4 ± 2.09^{b}	197.2 ± 6.8^{b}	14.5 ± 0.94^{bc}	7.4 ± 0.58^{ab}
NDPP+MT	282.7 ± 20.9^{a}	3.2 ± 1.18^{b}	178.5 ± 6.3^{b}	17.6 ± 0.93^{bc}	6.5 ± 0.41^{ab}
SDPP	87.9 ± 14.1^{b}	6.4 ± 2.31^{b}	185.3 ± 6.7^{b}	15.5 ± 1.31^{bc}	7.3 ± 0.58^{ab}
SDPP+MT	332.5 ± 56.2^{a}	2.5 ± 0.63^{b}	121.9 ± 3.6^{c}	31.2 ± 3.44^{a}	6.2 ± 0.44^{b}

In groups LDPP and NDPP, the blood melatonin concentrations were low. In SDPP and implanted subgroups, the blood melatonin level rose, which suppress the effects of PRL. In groups LDPP and NDPP, the IGF-I concentration in the goats' blood was high. But in SDPP and implanted groups, it weakened the protein synthesis with the reduction of IGF-I. Photoperiod and melatonin implants had similar effects on LEP, the change, however, was not strong compared with PRL and IGF-I.

REFERENCES

NRC, 1981. Nutrient Requirements of Goats: Angora, Dairy, and Meat Goats in Temperate and Tropical Countries. National Research Council. National Academy Press. Washington, DC

Panaretto B.A., Till A.R., 1963. Body composition in vivo.II.The composition of mature goats and its relationship to the antipyrine tritiated water, and N-acetyl-aminoantipyrine space. Aust. J. Agr. Res. 14, 926-943

Wang L.F., 2005. Effects of photoperiod and implanted melatonin on nitrogenous compounds partitioning Cashmere growth and its manipulation in Inner Mongolia White Cashmere goats. PhD. Thesis, Inner Mongolia Agricultural University

Welch R.A.S., Gurnsey M.P., Betteridge K., Mitchell R.J., 1990. Goat fiber response to melatonin given in spring in two consecutive years. Proc. N.Z. Soc. Anim. Prod. 50, 335-338