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The Effect of Body Condition Score and Body Weight of Merghoz Goats on Production and Reproductive Performance

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Abstract

Two experiments were performed to determine the effect of body condition score (BCS) on Merghoz goats' performance. In the first experiment, 80 goats (2-4 years old, 27-43 kg), and in the second experiment, 28 Merghoz goats (2-3 years old, 26-39 kg) were divided to 4 treatments groups according to their BCS (2.0, 2.5, 3.0, 3.5). The number of kids born per kidding, kilogram kids born per goat mating, pregnancy period and kid's birth weight were determined. Blood samples to monitor the changes of blood follicle-stimulating hormone (FSH) concentrations were collected from goats, two weeks before expected kidding data and on kidding day. Blood metabolites such as glucose, total protein, albumin and globulin were determined. The results of the first experiment indicated that BCS=3.0 had a significant effect on the kilogram kids born per kilogram goat. Similarly, the kids born per kilogram goat were affected by BCS. The results of the 2nd experiment also indicated that goats with BCS = 3.0 (32-36 kg) had better performance in kids born per goat at mating and birth weight of kids was significantly affected by BCS of their dams. There was a significant effect of BCS on plasma FSH concentration in goats with BCS more than 3.0. In conclusion, BCS had a significant effect on kilogram kids born per goat, birth weight of kids and FSH concentration at mating and a score of 3.0 at mating time could optimize profitability of Merghoz goats and their kids.

Key words: body condition score, Body weight, Merghoz goats, production, reproductive performance

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Introduction

Small ruminant production is a very significant component of livestock production throughout the world and more especially in the developing countries (Ketema, 2007; Thornton et al., 2009). Asia has been the homelands of one of the first types of wild sheep and goats (Dubeuf and Boyazoglu, 2009). Body condition scoring (BCS) has been widely adopted for managing the nutrition of flocks, especially when grazing, and for selecting lambs for buying and slaughter. In Britain, and now increasingly in Europe, body scoring is based on a subjective assessment of the fat level and muscle thickness on the backbone behind the last rib (Treacher et al., 2002). The relationship between BCS at parturition and BCS loss was used to study the effect of conditioning at parturition and the subsequent severity of negative energy balance (EB) (Dechow et al., 2001). Body condition loss, as an indicator of EB, was used to study the impact of negative EB on stress symptoms, by correlating it to milk production (Dechow et al., 2001), days to first insemination, services per conception, conception rate, conception rate at first insemination (Loeffler et al., 1999; Butler, 2001; Gillund et al., 2001) and oocyte development (Snijders et al., 2000). In sheep, dietary energy restriction suppresses episodic release of luteinizing hormone (LH) (Schillo, 1992). Data on the effects of nutritional stimuli on follicle stimulating hormone (FSH) levels during the cycle are equivocal. Studying the static effect of nutrition on daily follicular development, using ultrasonography showed that the increased ovulation rate in ewes with high body condition was associated with increased FSH and decreased oestradiol concentrations during the follicular phase (Vinoles et al., 2002). Positive relationship have been shown between BCS and plasma leptin and FSH concentrations in Iranian fat-tailed ewes at mating time (Towhidi et al., 2007). Vinoles et al. (2005) indicated that lower oestradiol production by the follicles is most probably associated with the higher leptin levels inhibiting steroidogenesis in ewes in high body condition. The lower oestradiol concentrations reduce negative feedback at the hypothalamus and pituitary gland, leading to higher circulating FSH concentrations. Ewes in high BCS had a high ovulation rate accompanied by high FSH and low oestradiol concentrations during the follicular phase, compared to ewes in low BCS (Vinoles et al., 2005). The pool of follicles available for the action of glucose and metabolic hormones may play a key role in stimulating an increase in ovulation rate. Ewes in high body condition had a higher number of gonadotropin dependent follicles than did ewes in low BCS (Rhind et al., 1989; Xu et al., 1989; Vinoles et al., 2005). Ewes in very high level of BCS show an increase in ova wastage and reduced reproductive performance. Low BCS was related with prevention of estrus and fertility (Rhind et al., 1989). The reproductive performance of ewes with the BCS of 3.0 - 3.5 was better in comparison of groups with lower and higher BCS (Sejianet al., 2010).

Caldeira et al. (2007) reported a variation in blood metabolic status at the different BCS. Metabolites could potentially be useful as indicators for predicting the nutritional status. Blood metabolic profiles included different tests dependent on the specific purpose. (Lee et al., 1978; Kida, 2002) including the Compton Metabolic Profile Test (Rowlands., 1980; Payne and Payne, 1987). Information gained from some strategic metabolic indicators and BCS can possibly provide a more substantial basis regarding the knowledge of the metabolic status of the goat and therefore, diets can be adjusted and metabolic disorders prevented together with improved production. Despite worldwide importance of goats farming system studies on goats` BCS are scant compared to cattle and sheep. There is a little information of BCS in Merghoz or Merkhoz goat- a native mohair breed- scattered in west of Iran. Jalilian and Moeini (2012) indicated that BCS had a significant effect on the kids born per goat at mating. In that study goats with BCS 3.0 (28-33 kg) had normal estrous cycles while goats with low BCS had shorter estrous period. The present study was designed to investigate the effect of different BCS and body weight on blood metabolites, production and reproductive performance of Merghoz goats in west Iran.

Materials and Methods

Two experiments were conducted in Jihad Research Center and Razi University Farm located in Kermanshah province in the west of Iran. In the first experiment, 80 Merghoz goats (2-4 years old 27-43 kg), and in the second experiment, 28 Merghoz goats (2-3 years old, 26-39 kg) were divided to four treatment groups according to their BCS (2.0, 2.5, 3.0, 3.5 and more). Goats were transferred to individual cages four weeks before the expected time of mating. They were fed alfalfa hay and concentrate (corn, soybean meal, barley, wheat bran) according to body weight requirements for dairy cattle (NRC 2001) (Table 1). Goats were homogeneous for the time of kidding and estrus was synchronized with two intramuscular injections of prostaglandin given 9 days apart. Estrous behavior was detected by testing the goats every 12 hour with vasectomized buck from the day of the second PG injection and from day 15 of the next estrous cycle. A week before the mating time, the goats were weighed and scored according to their BCS. Classification of BCS considered the dorsal palpation technique using the technique of Santucci and Maestrini (1985), at an interval range of 0.5 points. The BCS was determined by the joint agreement of three judges. Blood samples were collected from goats three weeks before expected kidding data and at kidding day.

Immediately after parturition, their newborn kids were taken away from goats and were housed in individual pens. The blood samples were taken by heparinized venepuncture on day 1 (when goats showed estrus sign) and at mating time (day 2). The blood tubes were centrifuged (15 min at 4°C and 3000×g) and

Table1. Components, ingredients and nutrient composition of diets

Ingredient	Alfalfa	Wheat	Corn	Soybean	Barley	Wheat bran	Total
DM (%)	55.0	15.3	12.6	8.1	5.4	3.6	100.0
ME(Mcal/kg)	0.995	0.469	0.190	0.240	0.150	0.091	2.130
CP(%DM)	7.7	1.72	1.134	4.04	0.76	0.62	15.90
NDF(%DM)	31.90	1.48	3.52	1.20	1.51	1.83	41.44
Ash(%DM)	3.85	0.31	0.24	0.58	0.22	0.25	5.43
Se(mg/kg)	0.090	0.007	0.008	0.041	0.009	0.015	0.110
Cu(mg/kg)	7.54	1.19	1.00	1.81	0.46	0.50	11.49
Zn(mg/kg)	12.16	4.59	1.75	4.61	2.39	4.60	27.09
Fe(mg/kg)	93.50	6.12	11.42	14.98	4.86	4.60	135.48

the plasma sample was stored at -20°C until FSH assay. FSH was measured by ELISA (Enzyme Linked Immuno Sorbent Assay) using a commercial kit (DRG diagnostics, EIA-1561, DRG instrument GmbH, Germany/2003).

From birth to four weeks of age kids were housed in individual pens. For the first 48 hour of life, kids of all groups were fed colostrum from their respective goat at 8 – 10 hourly intervals. Colostrum production of goats was recorded during the first 72 hours in lactation.

The BCS, as experimental treatment parity, was considered as a block and the weight was considered as a covariate. The experimental design was randomized. A complete block with 20 (1^{st} experiment) or 8 (2^{nd} experiment) replications and four treatments was used at enrolment. Goats were blocked by weight. Serum samples were analyzed by GLM procedure of SAS using repeated measure (SAS, 2003). The relationships between reproductive variables were determined and the statistical model was:

$$Y_{ijkmn} = M + A_{i} + B_{j} + E_{k} + S_{m} + D_{n}(S_{m}) + E_{ijkmn}$$

where M is the overall mean, A is BCS of goats, E is age of goats B is Body weight, S is Buck effect D(S) is goats effect/ Buck effect and Eijkmn is the experimental random error.

Results

The reproductive performances of the first experiment are shown in Table 2. This result indicated that BCS = 3.0 had a significant effect ($P < 0.05$) on the kilogram kids born per goat. However, the birth weight of kids was unaffected by the BCS. Likewise, the BCS had no effect on the kids' weaning weight.

The reproductive parameters of the second experiment are shown in Table 3. The result of this study showed that the kilogram kids born in mated goats with the BCS of 2.5 – 3.0 were significantly higher than other groups. Additionally the kids' birth weights were affected by the treatments. The kids' birth weight was higher in BCS of 3.0 compared with other groups. The kids' weights during the four week experiment were not affected by the treatments (Table 4). Additionally, the average gestation lengths did not differ among treatments. However, the pregnancy lengths reduced by increasing BCS. The mean of plasma FSH concentrations were not different in experimental groups at day one. On the other hand, the mean of plasma FSH concentrations in the goats with the BCS of 3.0 and 3.5 were significantly higher than other experimental groups at day two (Table 4). Colostrum production during the first three days and daily milk productions during the first four weeks of lactation are shown in Table 5. Colostrum and milk tended to increase in goat with BCS >3.0 than other treatments ($P = 0.06$). Blood concentrations of glucose, total protein, albumin, insulin, HDL, LDL and total cholesterol did not differ among groups (Table 6).

Table 2. Mean reproductive parameters (1st Exp.)

Parameters	BCS 2	BCS2.5	BSC 3	BSC >3.5	SEM
Mated goat/ pregnancy	1.2	1.3	1.2	1.2	0.07
Kids born / mated goat (%)	119^{ab}	125^{ab}	135^{a}	100^{b}	8.9
Kg kids born / mated goat	4.60^{ab}	4.61^{ab}	5.30^{a}	3.44^{b}	0.55
Kids birth weight (kg)	3.22	3.10	3.30	3.34	0.11
Kids weaning weight(kg)	18.5	18.83	19.4	19.7	0.74

Values in the same row with different superscript are significantly different ($P < 0.05$)

Table 3. Mean (± SE) reproductive parameters (2nd Exp.)

Parameters	BCS 2	BCS2.5	BSC 3	BSC >3.5
Gestation length (days)	159±3.70	160±2.92	158±3.44	157±4.44
Kids born / mated goat (%)	116.7±38	125.0±49	133.3±45	100.0±30
Kg kids born / mated goat	$2.3±0.20^{b}$	$2.9±0.30^{a}$	$3.4±0.29^{a}$	$2.2±0.25^{b}$
Kids birth weight (kg)	$1.9±0.30^{b}$	$2.5±0.21^{a}$	$3.0±0.20^{a}$	$2.2±0.50^{b}$
Kids weight at 4th week (kg)	3.2±0.91	3.6±0.98	3.8±0.96	3.3±0.94

Values in the same row with different superscript are significantly different ($P < 0.05$)

Table 4. Body weight (Mean ± SEM) and FSH concentration of Merghoz Goat (2nd Exp.)

BCS	Body weight (kg)	Body weight after kidding	FSH(ng/ml)	
			Day 1	Day 2
2.00	23.8±2.9	25.0±2.8	1.22±0.14	$2.54±0.10^{b}$
2.50	28.7±1.8	29.6±2.0	1.25±0.13	$2.70±0.20^{ab}$
3.00	34.9±2.3	35.4±2.1	1.30±0.11	$2.95±0.13^{a}$
>3.5	39.7±1.5	41.5±1.8	1.29±0.14	$2.93±0.13^{a}$

Values in the same row with different superscript are significantly different ($P < 0.05$)

Table 5. Colostrum production of Merghoz goats (mg; Mean ±SEM) (2nd Exp.)

BCS	First day	Second day	Third Day
2.00	200±63	208±70	250±83
2.50	158±66	180±66	241±86
3.00	175±52	200±60	242±72
>3.5	275±73	280±68	300±90

Table 6. Effect of Body condition score on blood metabolites of the Merghoz goats

Parameters (mg/dL)	BCS 2	BSC >3.5	BSC 3	BSC >3.5
Glucose	53±4.2	51±3.9	60±5	55±4.8
Total protein	5.0±0.7	4.7±0.5	5.3±0.7	4.4±0.6
Insulin(ng/ml)	1.24±0.09	1.20±0.07	1.18±0.8	1.23±0.07
Albumin	3.8±0.4	3.56±0.6	4.05±0.6	3.32±0.5
Globulin	1.16±0.11	1.14±0.12	1.25±0.14	1.08±0.10
HDL	64.3±8.5	66.7±6.4	70.1±8.3	65.2±7.6
LDL	24.7±5.2	20.2±4.9	19.5±5.0	22.7±4.8
Total cholesterol	98±7.4	51±3.9	60±5.0	55±4.8

Discussion

The result of the first experiment indicated that BCS = 3.0 had a significant effect ($P < 0.05$) on the kilogram kids born per goat. Similarly, Jalilian and Moeini (2012) found that the kilogram kids born in mated Merghoze goats with the BCS of 3.0 were significantly higher than other groups. In their study, the Merghoze goats with the BCS of 3.0 had a better performance in terms of kidding rate and total kilogram kids born per goat, while the kidding rate decreased in goats with the BCS of 3.5 or more. The result of the second experiment showed that the kilogram kids born in goats mated with BCS of 2.5-3.0 were significantly more than other groups. Also the kids' birth weights were affected by treatment. Similarly, Jalilian amd Moeini (2012) concluded that the BCS did not affect the kids' weight at birth. Likewise, Rhind et al. (1989) reported that in ewes with high BCS (more than 4.0) the primary embryo wastage increased and reproductive performance decreased. In beef cattle, BCS had an impact on fertility rates (Vargas et al., 1999). Rhind et al. (1989) showed that the BCS of more than 3.0 at mating caused low lamb production and the number of born lambs per ewe at mating was highest in the ewes with BCS of 2.75 similar to results of the present study. The BCS did not affect the lambs' weight but increased numerically from 2.0 to 3.0 (Aliyari et al., 2012). BCS had a significant effect on kilogram lamb born in ewes with BCS of 3.0, which had a better reproductive performance, while the lambing rate reduced in ewes with BCS of 3.5 or more (Aliyari et al., 2012). Kenyon et al. (2004) showed that in groups of ewes, condition score and live weight at mating positively affected reproductive performance measured at the time of mating and at scanning. However, no reproductive advantage was evident above a minimum condition score. The increased ovulation rate in ewes with high BCS was associated with increased FSH and decreased oestradiol concentrations during the follicular phase (Vargas et al., 1999). Several studies have shown high correlation between FSH level and ovulation rate in ewes (Korzecka and Bobwiec, 2003). Positive relationships have been shown between BCS and plasma leptin and FSH concentrations in Iranian fat-tailed ewes at mating time (Towhidi et al., 2007). FSH concentrations were significantly different after maintaining on restricted diet (Towhidi et al., 2003). They recommended flushing of ewes with low BCS before mating. The nutritional state is closely regulated by neuroendocrine and hormonal cues and energy restriction produces harmful consequences in BCS. The relationship between feeding and FSH production is directly pertinent to the above issues.

The result of this experiment indicated that BCS = 3.0 had a significant effect ($P < 0.05$) on the kg kids born per goat. Goats with BCS = 3.0 had a better performance in percent kids born per goat at mating. Birth weight of kids was significantly affected by BCS of their dams ($P < 0.05$). Likewise, there was a significant effect of BCS on plasma FSH concentration in goats with BCS more than 3.0 but no significant differences were observed in blood metabolites in this study. It is concluded that, the BCS of 3.0 at mating could optimize profitability of Merghoz goats.

The volume of colostrums and milk during the first four weeks of lactation showed a trend to be increased in goat with BCS 3.0 and above. However, Cabiddu et al. (1999) expressed that from day 120 of lactation, there was a tendency towards a higher average milk yield in the herd with the highest BCS, as shown by Branca and Casu (1989) and by Atti et al. (1995) in sheep. The slight negative correlation between mean BCS and the mean milk yield is in agreement with the finding of Morand-Fehr et al. (1989). This correlation is indeed much influenced by the inverse relationship during lactation between yield and BCS. In contrast, Cabiddu et al. (1999) expressed that at the beginning of lactation, milk yield was not correlated with BCS. BCS changes throughout the lactation, responding to changes in her energy balance (Coffey et al., 2003). As milk yield peaks and demand for energy exceeds intake of energy, the lipid reserves are mobilized and get thinner. This process is related to the daily milk yield curve, which is almost exactly opposite to the energy balance and BCS curves (Coffey et al., 2002; Coffey et al., 2003). Branca and Casu (1989) showed that the animals experience nutritional imbalances that can result in a marked decrease in milk yield, low milk fat and protein content and abrupt changes of BCS. A constant BCS is associated with the ability to produce milk while maintaining its energy balance (Banos et al., 2004). Studies relating BCS to milk production have provided inconsistent results with some studies (Pedron et al., 1993; Ruegg and Milton, 1995; Domecq et al., 1997) reporting no significant effect of BCS on subsequent milk production while others reported the contrary (Waltner et al., 1993; Markusfeld et al., 1997; Roche et al., 2007). On the other hand, Cabiddua et al. (1999) showed that, under the specific conditions of their study in goats, a negative overall correlation was found between the mean BCS and milk yield. Garnsworthy and Jones (1987) speculated that the quality of diet may influence the association between BCS and milk production. Nonetheless, the impact of greater BCS loss on higher milk production is more consistent across studies (Roche et al., 2007) with high milk production associated with greater BCS loss in early lactation.

The blood metabolites did not differ among groups. However, Thomas et al. (1987) resulted that BCS at the end of pregnancy was significantly improved, the blood, glucose, globulin and total protein concentrations increased but not blood albumin. The responses of plasma insulin and glucose to dietary protein were consistent with the results of Van de Ligt et al. (2002) who indicated that equal amounts of amino acids were used by peripheral tissue and excellent glucogenic regulation was executed by pigs in a fasting state. This ability for glucogenic regulation ability may be similarly possessed by ruminants. Insulin action, glucose and cholesterol metabolism, and lipogenesis in both liver and adipose tissue correlated with dietary protein levels (Santos et al., 2001; Sun et al., 2007).

Conclusion

It is concluded that BCS had a significant effect on the birth weight, kilogram kids born per goats and FSH concentration of Merghoze goat ($P < 0.05$). The BCS of 3.0 (32-36 kg) at mating time could optimize profitability of goats. Goats with the BCS of 3.0 had also a better performance in the percent of kids born per goat, while the kidding rate and total kilogram kids born per goats reduced in goats with the BCS of 3.5 or more. Birth weight of kids was significantly affected by BCS of their dams. Blood metabolites were not affected by BCS, except plasma FSH concentration that was greater in goats with BCS more than 3.0 compared to other groups. Colostrum and milk production showed a tendency to be increased in goats with BCS of 3.0 and greater.

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