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Feeding dynamics and performance of Beetal does in relation to body condition score at the time of mating

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Abstract: The body condition of does at the time of mating may affect feeding patterns and production performance during forthcoming lactation. For investigation, 40 Beetal does available for breeding were utilized, and their body condition score (BCS) was estimated using the visual-cum-palpation method with a 9-point scale (scale of 1–5 with increments of 0.5 point). The available goats were divided into 3 groups: higher BCS ($T_{\geq 3.0}$; n =11), moderate BCS ($T_{2.5}$; n = 8), and lower BCS ($T_{\leq 2.0}$; n = 21) and maintained in 2 random groups (20 each). Beetal goats with higher BCS at breeding time spent significantly ($P < 0.01$) more time feeding comfortably and less time feeding with difficulty than moderate and lower BCS goats. $T_{2.5}$ and $T_{\leq 2.0}$ goats struggled (displacement and pushing) more at feeders, which included $T_{\leq 2.0}$ goats eating from the ground for more time ($P < 0.01$) than the other groups. $T_{\geq 3.0}$ goats had more agonistic interactions (threatening and hitting) toward moderate and lower BCS goats at feeders. Goats with higher BCS at mating had significantly ($P < 0.05$) higher milk yield during subsequent lactation; however, the composition of the milk did not differ among the groups. Mean disease incidence rate and number of days of disease per goat were significantly ($P < 0.01$) lesser in the $T_{\geq 3.0}$ group than other groups. It was concluded that Beetal goats should not have less than 3.0 BCS at the time of mating for better performance and health status.

Key words: Beetal, body condition score, feeding dynamics, mating, performance

1. Introduction

Beetal is an important goat breed of the Punjab region of India and Pakistan which is used for milk as well as meat production. Goat farming is shifting from an extensive toward an intensive or stall-fed system in most parts of the world. In an intensive system, behavioral changes adopted by the goats due to human interaction (1) necessitate improved managerial skills. Criteria like assessment of BCS and agonistic behavior (negative social behavior) are considered the most promising indicators of animal well-being (2). BCS assessment is one of the critical skills that can help goat farmers properly manage the nutrition of their flocks (3). Being an indicator of energy status, BCS can also help in predicting the health issues of animals. Some disorders, such as digestive (including displaced abomasum, milk fever, and ketosis) and locomotion problems, have also been associated with BCS in dairy cattle (4).

Early-lactation negative energy balance (NEB) may compromise the recovery of the uterus and result in metabolic changes that affect ovarian function and early embryo development (5). NEB may lead to increased risk of postpartum anestrus (6,7), or it may affect milk production status and future performance of the animals. Nutritional status of animals has been linked with aggression and stereotypies (8,9) as well. BCS of animals in a group may have direct influence on their behavior (particularly feeding and agonistic interactions) and health status under the stall-fed rearing system. Thus, the effects of BCS at the time of mating on future performance and feeding dynamics of does need to be investigated in order to create socially stable groups with improved production.

2. Materials and methods

2.1. Experimental animals

The experiment was carried out at the Goat Research Farm, Department of Livestock Production Management, College of Veterinary Sciences, Guru Angad Dev Veterinary and Animal Sciences University (GADVASU), Ludhiana (India). The Beetal breed has dual utility, i.e. milk as well as

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meat. The standardization of the body condition scoring technique in the Beetal goats was done by performing it in all of the goats available at the goat farm for a period of about 1 month before the actual onset of experiment. Body condition scoring was standardized in the Beetal goats using the visual-cum-palpation technique (9-point scale from 1.0 to 5.0 with 0.5 decimal divisions). In this method, each goat was first observed from the front, side, and rear at a short distance (30–90 cm). The body frame of the animal was judged by carefully examining various body parts, i.e. ribs, hook bone, pin bone, and lumbar and sternal regions. Thereafter, the goat was palpated in different anatomical locations (ribs, hook bone, pin bones, and lumbar and brisket regions) to assess fat and muscle reserves in these anatomical locations. BCS was then assigned accordingly. Different divisions of BCS were defined as per the modified Solaiman (10) method shown in Table 1. Forty Beetal goats (1.5–4 years of age) had BCS ranging from 1.5 to 3.5; these were divided into 3 groups, i.e. higher BCS ($T_{\geq 3.0}$; n = 11), moderate BCS ($T_{2.5}$; n = 8), and lower BCS ($T_{\leq 2.0}$; n = 21). Goats were kept in 2 random groups (20 each) during the experiment and exposed to the same breeding bucks for a period of 45 days. This resulted in conception of 10, 7, and 14 does (total 31) among the $T_{\geq 3.0}$, $T_{2.5}$, and $T_{\leq 2.0}$ groups, respectively. Nonpregnant does were removed from the pens after the pregnancy diagnosis, and the rest of the group remained throughout the study period, i.e. until 3 months postkidding. Similar conditions were maintained at the farm for all of the experimental animals.

2.2. Housing and feeding of animals

Goats were housed in 2 pens having an east–west orientation of the long axis, with a *pucca* floor in both covered and open areas. Pregnant goats (31 total) were shifted to 2 kidding pens 2 weeks before the expected date of kidding (EDK) without mixing (i.e. maintaining their pen grouping). Animals were fed concentrate and green fodder as per the standard practices followed at the farm. Concentrate feed was offered early in the morning (7:00–8:00) followed by a supply of green fodder twice daily (11:00 and 16:00). During the late pregnancy and early lactation period of the goats, concentrated feed was offered twice a day, in the morning and evening. The concentrate mixture was made of maize (40%), soybean meal (15%), wheat bran (16%), deoiled rice bran (26%), mineral mixture (2%), and common salt (1%), having CP = 15.7%, TDN = 68 %, and CF = 4.4%. Concentrate was offered at the rate of 300, 400, and 500 g per day per goat during breeding until advanced pregnancy (4 months of gestation), advanced pregnancy (4 months pregnancy onwards), and the early lactation period (3 months postkidding), respectively. Green fodder (5 kg per day per goat) included maize and cowpea during the summer months, and berseem and oats during the winter months. Potable water was available to the goats around the clock. Goats were fed in wall-mounted linear channel feeders during pregnancy, while in the kidding pens they were fed in hexagonal feeders (2 large feeders per pen) with an average of 40 cm feeder space per goat.

2.3. Behavioral observations

Behavioral activities of experimental does were recorded manually using a Nikon p530 (Nikon Pvt. Ltd.) camera. Behavior of goats was recorded for 30 min after feed was offered to study interactions among goats of different BCS. On the basis of the behavioral activities observed, a standardized ethogram was established (Table 2). At the beginning of the experiment, a 1-week adaptation period was given, and thereafter, the behavior of the animals (Figures 1–3) was recorded in both of the pens on alternate days 3× in each month (i.e. a monthly total of 6 observations) for 8 months. The behavior of the goats was studied using the continuous scan sampling method (11).

Table 1. Body condition score chart used for Beetal goats.

BCS	Body condition	Description
1.5	Very thin, frame visible	Wasting in appearance; ribs visible; individual spinal processes evident and depressions obvious (rib, hips) and sunken between pins and hooks; sternum easily palpable.
2.0	Slightly thin	Spinous processes (dorsal/transverse) are prominent and sharp; thin flesh covering between hooks and pins; some ribs visible; definite depression between hooks; sternum palpable.
2.5	Frame covered, balanced	Spinous processes smooth; transverse processes have smooth concave curve; hooks and pins smooth; muscle becoming obvious; sternum palpable.
3.0	Slightly fleshy, smooth cover	Spinous processes rounded; spinous to transverse processes smooth sloped; hooks and pins covered; slight depression between hooks and pins; sternum less defined.
3.5	Frame not visible, fleshy	No spinous processes noticeable, ribs not visible, hooks and pins rounded with some cover; flatness between hooks; difficult to palpate sternum; more skin fold thickness.

Table 2. Ethogram of goats after offering of feed.

Behavioral activities	Definition
Feeding-related activities	
Feeding comfortably (F_C)	Occupying more than 1 foot of feeder space per goat while feeding.
Feeding normally (F_N)	Feeding with sufficient feeder space (approximately 1 foot) without getting pressed/pushed.
Feeding with difficulty (F_D)	Feeding with insufficient feeder space and witnessing continuous pressing/pushing by neighboring goats.
Feeding from ground (F_G)	Feeding from ground (fallen feed).
Waiting/queuing (W)	Waiting and watching feeder at one location for its turn to feed.
Waiting and walking (W_w)	Walking around the feeder to have its turn feeding.
Agonistic activities	
Displaced (D)	Leaving the initial position from feeder and going to another location after getting threatened/ pushed/hit by another goat.
Pushing performed (P_P)	Exerting force on other/neighboring goat to move it aside.
Pushing received (P_R)	
Threatening performed (T_P)	Warning another goat not to come close or to move away by waving the head/hitting the ground with forelimbs toward the other goat without any physical contact.
Threatening received (T_R)	
Fighting/wrestling (F)	Bipedal stance and head-to-head hitting by both goats. Long-duration event with both goats showing aggression.
Hitting performed (H_P)	One goat striking another quickly and forcefully, generally by horns/head. Short-duration event with one-sided aggressiveness.
Hitting received (H_R)	
Shifting dominance (S_D)	Dominant goat leaves its position and hits another goat in a different location and returns to its original position.
Miscellaneous activities	
Resting (R)	Animal is recumbent or standing away from the feeder without performing any physical activity nor feeding.
Walking (W_N)	Walking neutrally away from the feeder.
Self-grooming (G)	Licking/scratching own body parts using tongue or horns.
Urination (U)	Voiding the urine.
Defecation (De)	Voiding feces.
Drinking (Dr)	Drinking water with face inside the waterer.

For differentiation of goats of different BCS groups while feeding, colored ribbon codes were tied at the neck and pastern joint (hind limb).

2.4. Milk traits and health observations

The milk yield of each individual goat was measured (g) with the help of an electronic weighing balance at weekly intervals for 3 months during the postkidding period. The total milk yield of the 90-day period was estimated on the basis of weekly test-day milk yield. Milk composition was estimated at fortnightly intervals using samples from the whole morning milk (avoiding the initial and last stripping) of each individual goat for the analysis. All sample bottles were properly capped, labeled, and transported in an ice-packed cooler box to the laboratory at the College of Dairy Science and Technology, GADVASU, Ludhiana (India). A Lactoscan milk analyzer (Milkotronic Ltd., Nova Zagora, Bulgaria) calibrated to Indian standards was used to analyze milk constituents, i.e. fat, protein, solids-not-fat (SNF), and total solids.

Goats were examined and treated daily in the morning by the veterinarian on duty for any deviation in physical activity, and the services of Veterinary Hospital, GADVASU were also utilized whenever required. The following ailments were noticed in the goats during the experiment: diarrhea, respiratory distress, dystocia, premature kidding, fever, caseous lymphadenitis, retention of fetal membranes,

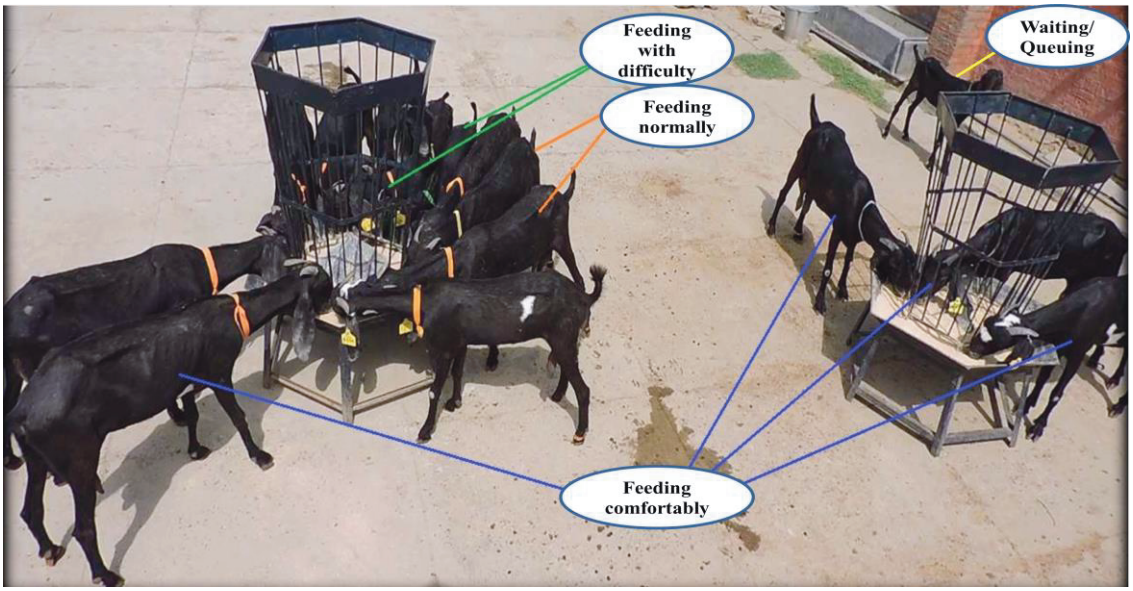

Figure 1. Social hierarchy of Beetal goats at feeders.

Figure 2. Hitting activity.

Figure 3. Fighting activity.

mastitis, lameness, anorexia, etc. The number of disease days was also counted for the incidence of all ailments.

2.5. Statistical analysis

Collected data was arranged and analyzed using standard statistical methods with SPSS 20.0 software. Comparison between different BCS groups was made using a Tamhane T2 test, and significance was tested at 1% ($P < 0.01$) and 5% ($P < 0.05$) levels.

3. Results

3.1. Effect of BCS at mating on behavior of Beetal goats

Beetal does of higher BCS ($T_{\geq 3.0}$) at mating spent significantly ($P < 0.01$) more time feeding comfortably, while $T_{2.5}$ goats spent the maximum time feeding normally, and $T_{\leq 2.0}$ goats spent the most time feeding with difficulty (Table 3). Gradual decline in BCS resulted in increased feeding-related constraints, i.e. feeding with difficulty, eating from the ground, queuing and walking around the feeder, etc. (Figure 4). $T_{2.5}$ and $T_{\leq 2.0}$ goats struggled (displacement and pushing) more at feeders, which included $T_{\leq 2.0}$ goats eating from the ground for more time ($P < 0.01$) than the other

Table 3. Feeding and related behavioral activities (s) of goats having different BCS at mating.

Activities	$T_{\geq 3.0}$	$T_{2.5}$	$T_{\leq 2.0}$	Overall	Effect of BCS
Feeding comfortably (F_C)	1071.48 ± 36.53[a] (59.53)	220.73 ± 19.23[b] (12.26)	106.83 ± 10.98[c] (5.94)	531.39 ± 34.22 (29.52)	**
Feeding normally (F_N)	506.89 ± 30.35[c] (28.16)	1049.10 ± 24.54[a] (58.28)	711.59 ± 30.04[b] (39.53)	696.65 ± 22.10 (38.70)	**
Feeding with difficulty (F_D)	36.92 ± 7.03[c] (2.05)	258.83 ± 25.72[b] (14.38)	543.53 ± 34.95[a] (30.20)	273.83 ± 20.72 (15.21)	**
Feeding from the ground (F_G)	6.53 ± 4.62[b] (0.36)	10.42 ± 4.63[b] (0.58)	67.90 ± 14.01[a] (3.77)	30.45 ± 5.99 (1.69)	**
Waiting (W)	30.74 ± 2.08[c] (1.71)	48.23 ± 4.17[b] (2.68)	82.47 ± 7.90[a] (4.58)	53.86 ± 3.55 (2.99)	**
Waiting and walking (Ww)	39.21 ± 2.42[b] (2.18)	51.33 ± 4.06[a] (2.85)	56.17 ± 3.51[a] (3.12)	48.12 ± 1.92 (2.67)	*

Means bearing different superscripts within a row differs significantly (**P < 0.01, *P < 0.05); values in parentheses indicates percentage of total observed time.

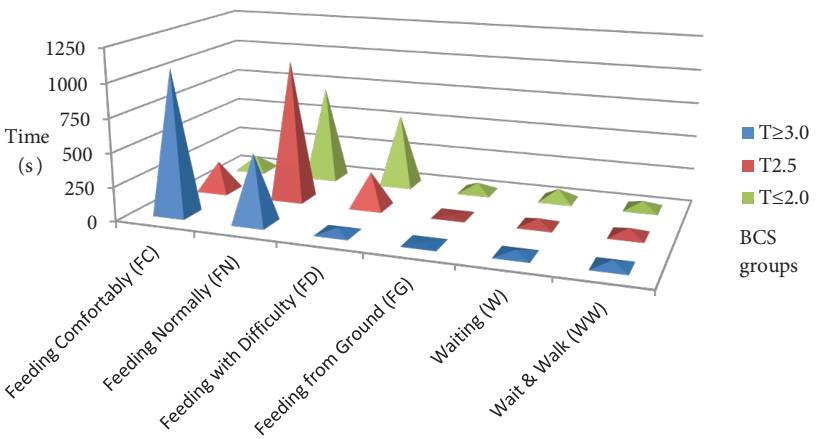

Figure 4. Feeding pattern of Beetal goats with different BCS at mating.

groups. $T_{\geq 3.0}$ goats performed more agonistic interactions (threatening and hitting) toward moderate and lower BCS goats at feeders (Table 4). Shifting dominance activity was shown mainly by $T_{\geq 3.0}$ goats toward other goats, while some goats showed it among themselves toward the end of feeding. Goats of the $T_{\leq 2.0}$ group spent more time than $T_{\geq 3.0}$ goats in activities like resting, walking (P < 0.01), urination (P < 0.05), etc. after the offering of feed (Table 5).

3.2. Effect of BCS at mating on lactation traits of Beetal goats

Beetal goats with higher BCS at mating ($T_{\geq 3.0}$) had significantly (P < 0.05) higher estimated 90-day daily milk yield than moderate and lower BCS goats in the subsequent lactation (Table 6). Daily milk yield of goats during the early lactation period decreased in relation to the decrease in BCS at the time of breeding. However, composition of milk (fat, protein, solids-not-fat, and total solids) did not differ among the groups.

3.3. Effect of BCS at mating on the health status of Beetal goats

Mean disease incidence rate and number of disease days per goat were significantly (P < 0.01) lesser in the $T_{\geq 3.0}$ group than in the other groups during the 8-month study period of pregnancy and early lactation (Table 7).

4. Discussion

The results indicate that goats with higher BCS at mating occupy the upper ranks in the social hierarchy and

Table 4. Agonistic behavioral activities (s) of goats having different BCS at mating.

Activities	$T_{\geq 3.0}$	$T_{2.5}$	$T_{\leq 2.0}$	Overall	Effect of BCS
Displaced (D)	3.66 ± 0.60^{b} (0.20)	22.23 ± 1.82^{a} (1.24)	25.69 ± 1.75^{a} (1.43)	15.81 ± 1.05 (0.88)	**
Pushing performed (P_P)	5.81 ± 0.53^{b} (0.32)	9.25 ± 0.87^{a} (0.51)	11.93 ± 0.97^{a} (0.66)	8.83 ± 0.49 (0.49)	**
Pushing received (P_R)	2.85 ± 0.47^{b} (0.16)	12.54 ± 1.19^{a} (0.70)	14.44 ± 1.03^{a} (0.80)	9.23 ± 0.61 (0.51)	**
Threatening performed (Tp)	25.53 ± 1.38^{a} (1.42)	6.71 ± 0.75^{b} (0.37)	2.67 ± 0.52^{c} (0.15)	13.01 ± 0.94 (0.72)	**
Threatening received (T_R)	3.74 ± 0.40^{b} (0.21)	18.79 ± 1.23^{a} (1.04)	22.48 ± 1.10^{a} (1.25)	13.93 ± 0.77 (0.77)	**
Fighting/wrestling (F)	0.88 ± 0.32 (0.05)	1.46 ± 0.47 (0.08)	1.09 ± 0.36 (0.06)	1.08 ± 0.21 (0.06)	NS
Hitting performed (Hp)	12.04 ± 0.90^{a} (0.67)	3.63 ± 0.531^{b} (0.20)	1.82 ± 0.377^{c} (0.10)	6.44 ± 0.519 (0.36)	*
Hitting received (H_R)	1.84 ± 0.42^{b} (0.10)	7.75 ± 0.81^{a} (0.43)	8.93 ± 0.51^{a} (0.50)	5.74 ± 0.38 (0.32)	**
Shifting dominance (S_D)	1.30 ± 0.33^{a} (0.07)	0.00 ± 0.00^{b} (0.00)	0.40 ± 0.40^{ab} (0.02)	0.69 ± 0.21 (0.04)	**

Means bearing different superscripts within a row differs significantly (**P < 0.01, *P < 0.05); NS: nonsignificant; values in parentheses indicates percentage of total observed time.

Table 5. Miscellaneous behavioral activities (s) of goats having different BCS at mating.

Activities	$T_{\geq 3.0}$	$T_{2.5}$	$T_{\leq 2.0}$	Overall	Effect of BCS
Walking (W_N)	20.99 ± 3.92^{b} (1.17)	34.65 ± 5.89^{ab} (1.93)	44.77 ± 5.43^{a} (2.49)	32.78 ± 2.96 (1.82)	**
Resting (R)	9.95 ± 3.61^{b} (0.55)	19.69 ± 6.05^{b} (1.09)	70.46 ± 13.76^{a} (3.91)	34.76 ± 5.82 (1.93)	**
Self-grooming (G)	9.70 ± 1.03 (0.54)	10.08 ± 1.75 (0.56)	14.09 ± 1.80 (0.78)	11.43 ± 0.89 (0.64)	NS
Urination (U)	0.78 ± 0.19^{b} (0.04)	1.56 ± 0.54^{ab} (0.09)	1.78 ± 0.33^{a} (0.10)	1.32 ± 0.19 (0.07)	*
Defecation (D_E)	0.10 ± 0.07 (0.01)	0.94 ± 0.35 (0.05)	0.69 ± 0.25 (0.04)	0.50 ± 0.12 (0.03)	NS
Drinking (D_R)	9.06 ± 1.30 (0.50)	12.08 ± 2.87 (0.67)	10.28 ± 1.52 (0.57)	10.15 ± 0.98 (0.56)	NS

Means bearing different superscripts within a row differs significantly (**P < 0.01, *P < 0.05); NS: nonsignificant; values in parentheses indicates percentage of total observed time.

Table 6. Milk traits of Beetal goats having different BCS at mating.

Parameters	$T_{\geq 3.0}$	$T_{2.5}$	$T_{\leq 2.0}$	Overall
Daily milk yield (g)	1374.59 ± 46.54[a]	967.66 ± 34.12[b]	849.85 ± 39.83[c]	1058.71 ± 27.68
Estimated 90-day milk yield (kg)	124.18 ± 8.69[a]	88.98 ± 5.61[b]	76.67 ± 11.96[b]	95.60 ± 7.29
Fat (%)	4.59 ± 0.13	4.56 ± 0.13	4.74 ± 0.71	4.66 ± 0.68
Protein (%)	3.73 ± 0.06	3.62 ± 0.07	3.78 ± 0.05	3.72 ± 0.04
Solids-not-fat (%)	9.00 ± 0.14	8.88 ± 0.19	9.06 ± 0.14	8.99 ± 0.09
Total solids (%)	13.60 ± 0.26	13.44 ± 0.25	13.80 ± 0.20	13.65 ± 0.14

Means bearing different superscripts within a row differs significantly ($P < 0.05$).

Table 7. Effect of BCS at mating on disease occurrence in goats.

Ailments	$T_{\geq 3.0}$	$T_{2.5}$	$T_{\leq 2.0}$	Overall
Total occurrences	2	14	28	44
Total disease days	10	71	163	244
Mean occurrences/animal	0.18 ± 0.12[b]	1.75 ± 0.16[a]	1.33 ± 0.19[a]	1.1 ± 0.9
Mean disease days/animal	0.91 ± 0.61[b]	8.88 ± 0.85[a]	7.76 ± 1.25[a]	6.10 ± 0.86

Means bearing different superscripts within a row differs significantly ($P < 0.01$).

therefore dominate feeding activities. Lower-BCS goats seemed to have lower social ranking in the groups and did not get adequate access to feed, as has been reported in low-social-ranking goats (12), but not based on BCS. The goats with higher BCS occupied more feeder space and ate more comfortably, as also indicated by similar observations that goats with higher BCS remain more comfortable than lower-BCS goats who remain more active and excited (13), although not at the time of feeding. In order to avoid fighting or hitting, the lower-BCS goats waited and rested to get their turn to eat, or walked to nearby places where they could eat with less hindrance. This observation simulates that of an earlier study (14), which concluded that low-ranking goats generally preferred to consume feed when dominant animals were idle in order to avoid any conflict with them. In order to avoid any serious aggression, they may even be forced to eat feed that has fallen on the ground. Pressing/pushing was more frequent in lower-BCS groups because they had limited space available for feeding, and they mostly tried to access the feed between 2 other goats by pushing. A higher incidence of threatening and hitting by dominant goats led to more frequent displacement and waiting and walking activity in lower-BCS goats. Frequency of active fighting/wrestling did not differ significantly among the various BCS groups, as it was observed commonly between goats with the same or similar BCS. Lower-BCS goats tended to walk, rest, and urinate more during feeding time due to high competition. Very scant information is available regarding behavior of animals in relation to BCS.

Goats of BCS 3.0 or 3.5 at the time of breeding had better health statuses during pregnancy and the early lactation period than goats with moderate or lower BCS. Koyuncu and Öziş Altınçekiç (15) stated that a herd of goats in good body condition will be less susceptible to metabolic disorders, diseases, mastitis, and reproductive problems. Lameness has been associated with lower BCS as one of its causes in sheep (16). In the present study, cases of lameness were reported in the moderate- and lower-BCS groups (≤2.5), while the higher-BCS (3.0 and above) group had no cases of lameness. Similarly, cases of mastitis were more frequent in lower-BCS groups, as has been reported previously in sheep (17). Occurrences of diarrhea were more frequent in lower-BCS groups than in higher ones. Diarrhea is a common manifestation of endoparasitic infestation which has been associated with lower BCS scores (18,19). These findings validate that goats with higher BCS have better resistance/immunity (20). Hence, goats with BCS of 2.5 or lower should have the provision of separate feeding or additional feed in order to improve their BCS and in turn, their health prospectus.

Studies (21–23) have indicated that goats with higher BCS yield more milk than those with lower BCS, although this was based on immediate BCS or BCS at the time of

parturition. This study showed that higher nutrient reserves at the time of mating have direct implications on the milk yield of subsequent lactation. Negative correlation between the BCS and milk yield has also been noted in some studies (24). The findings are consistent with the results of Cimen and Topcu (25), who found no difference in milk composition between BCS 1.0 and BCS 2.0 groups during the entire experimental period. Milk yield significantly increased with an increase in BCS between 2 and 4, with no influence on protein and fat content of milk in Etawa Crossbreed goats (22). Milk constituents did not differ in goats up to 3.5 BCS, while in the high BCS group (3.50–5.00) it changed only during the first 2 weeks of lactation (26). In the present study, a group above BCS 3.5 was not available for comparison. On the contrary, a negative relationship between milk protein and BCS has also been noted in Peranakan Etawah goats (21). These variations could be due to differences in breed, climate, and management conditions, but the key difference in the present investigation is that it was based on BCS at the time of mating, unlike other BCS-based studies.

5. Conclusion

It is concluded that Beetal goats should not have less than 3.0 BCS at the time of mating for better performance and health status. Goats with lower BCS at the time of mating should be grouped together for relatively homogeneous access to feed resources and avoiding intense agonistic interactions.

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