The Effect of the Body Condition Score at Artificial Insemination on Prolificacy Traits in Slovenian Alpine Goats

Angela CIVIDINI (✉)
Mojca SIMČIČ

Summary

In this study, the body condition score (BCS) of 55 Slovenian Alpine goats at artificial insemination was recorded over a period of two years. The effect of the doe BCS at insemination on the litter size at birth, the number of weaned kids, the birth weight of the kids, and the interval between parities was studied. The BCS at artificial insemination significantly affected the litter size at birth ($P < 0.001$) and, the number of weaned kids ($P < 0.05$). The number of kids born and weaned per doe was the highest in does with a BCS of 2.0 and 2.5 compared to does with a BCS of 1.5, 3.0 or 3.5. The results suggest an optimum BCS between 2.0 and 2.5 at insemination or mating to achieve a higher litter size per female. The birth weight of the kids differed significantly depending on the BCS of the does ($P < 0.05$) with the highest birth weight occurring in the kids of does with a BCS of 3.5, 3.0 and 1.5. Considering all these results, body condition scoring could be an effective method for the goat breeders to optimally manage body reserves and thus increase the production efficiency in terms of prolificacy in their flocks.

Key words

Slovenian Alpine goat, BCS, artificial insemination, litter size, birth weight, prolificacy

University of Ljubljana, Biotechnical Faculty, Department of Animal Science, Jamnikarjeva 101, SI-1000 Ljubljana, Slovenia
✉ e-mail: angela.cividini@bf.uni-lj.si

Received: May 1, 2017 | Accepted: September 12, 2017

Introduction

Nutritional requirements and feed intake of goats vary over the production cycle depending on the stage they are going through. During low production stages and/or when feed is abundant and does have a positive energy balance, energy surpluses are stored as body reserves in the form of fat depots. When feed availability is low and/or nutritional requirements are high (energy balance is negative), does mobilize their body reserves (Mendizabal et al., 2007; Mendizabal et al., 2011). According to nutritional requirements and feed resources, which could vary quite substantially over the year, there is an alternation of feed supply (surpluses and deficits). The goat breeder's ultimate goal should thus be to optimize the nutrition in a way as to maximize the ability of the goats to store and mobilize their body reserves. Body condition scoring (BCS) is of great interest as a tool for proper nutrition management and management of body reserves. The processes of storage and mobilization of fat reserves in adult goats are principally based on variation in adipocyte size. Therefore, BCS could be a good method for predicting the nutritional status of goats (Mendizabal et al., 2007). For this purpose, it is important to score the body condition at the beginning of each production stage (Mendizabal et al., 2011). There is an optimum BCS for each doe and for each production stage.

In dairy goats, nutritional requirements decrease at approximately the third month of lactation when does start to replenish their body reserves, resulting in weight gain and an increase of the BCS. It is crucial that body reserves recover during late lactation and that does achieve a proper BCS for the next upcoming mating period. A link between the recovery of body reserves during late lactation and better reproductive performance in the next kidding period, especially with regard to the growth rate of the kids, was observed (Kharrat and Bocquier, 2010). An appropriate BCS at the time of mating is needed to make sure that the doe can come into oestrus with an ovulation rate that is sufficient for the desired fertility and prolificacy. Several studies reported an effect of the BCS on the reproductive performance of sheep (Vatankhah et al., 2012; Yilmaz et al., 2011; Abdel-Mageed and Abo El-Maaty, 2012) and goats (De Santiago-Miramontes et al., 2009; Kharrat and Bocquier, 2010; Martin et al., 2004; Gallego-Calvo, 2015), but only one study considered the relationship between the BCS and prolificacy traits in goats (Gallego-Calvo et al., 2015). In sheep, ewes with a low BCS showed higher prenatal and neonatal losses and a lower lamb survival rate (Yilmaz et al., 2011; Abdel-Mageed and Abo El-Maaty, 2012). Different optimal ewe BCS at mating have been reported depending on the breed of the ewe, for example a BCS of 2.01 to 3.0 for the Kivircik breed.

The aim of this study was to determine the effect of the BCS on the litter size at birth, the number of weaned kids, the birth weight of the kids, and the interval between parities in a flock of Slovenian Alpine goats that were reared under organic and conventional conditions.

Material and methods

Data and management

The study was carried out at the Educational and Research Animal Husbandry Centre Logatec at the Biotechnical Faculty of the University of Ljubljana (Slovenia). A flock of 55 does of the Slovenian Alpine goat breed was included. BCS at artificial insemination were scored over a period of two years (2016-2017). The flock was divided into two groups, where half of the does was fed an organic and the other half was fed a conventional feed ration. Prolificacy traits were recorded at kidding as follows: litter size at birth, number of weaned kids, birth weight of kids and interval between parities. The data set comprised 89 records of BCS at artificial insemination, which were assessed over a period of two years, and the respective prolificacy traits recorded after kidding as well as the birth weight of the kids (Table 1). BCS at insemination was subjectively scored by a single expert who mastered the technique and was trained before the study. The breeding season of the Slovenian Alpine goats ranged from late August till early November (autumn). Oestrus synchronisation was conducted using controlled internal drug release (CIDR) technology (first week of October), and the does were artificially inseminated (last week of October) in each breeding season. The BCS was scored a few days before the insemination procedure each year. Kidding was condensed to a period between March 15^{th} and April 4^{th} in 2016 and between March 19^{th} and April 10^{th} in 2017. Two different feed rations were used for the two different groups of goats, in which the percentage of feed was the same but the origin of the components differed (organic or conventional). During winter time (December, January, February, March), the does were kept indoors but had free outdoor access, and they were fed 56% hay, 43% commercially prepared concentrate feed, and 1% mineral-vitamin supplements. For the rest of the year, the does were grazed on pastures with additional mineral supplementation. During the grazing season, hay was available *ad libitum* and commercial concentrates were supplemented to balance energy deficiencies during grazing. The concentrates were offered individually twice per day when animals were kept at the milking parlour. After weaning, at 40 days of age, the kids were fattened and slaughtered.

Measurements

In this study, the BCS was assessed based on the method by Villaquiran et al. (2005), which determines the amount of muscle and fat that covers and surrounds the lumbar vertebrae. Both the vertical (spinous process) and horizontal protrusions (transverse process) of the vertebrae in the loin region were used as landmarks when palpating the fullness of the muscle and the fat cover to determine the BCS. Scoring was performed using a BCS scale that ranges from 1.0 to 5.0 with 0.5 increments. A BCS of 1.0 equals an extremely thin goat with no fat reserves and a BCS of 5.0 equals a very fat (over-conditioned) goat. The 0.5 score increments were used when goats scored intermediate between two BCS. If the spinous and transverse processes were rough, prominent and distinct with no fat cover and very little muscle (concave loin eye muscle), the BCS assessment was 1.0. At a BCS of 2.0, the spinous process of the lumbar vertebrae was evident and the muscle (which is still concave) could be felt between the skin and the bone. At a BCS of 3.0, the transition from the spinous to the transverse process equalled a smooth slope and the loin eye muscle was flat with some fat cover. At a BCS of 4.0, the spinous process formed a continuous line; there was a rounded transition from the spinous to the transverse process (convex loin eye muscle). The transverse process could not be felt and the loin eye muscle was full with a thick fat cover. If the

Table 1. Descriptive statistics for the prolificacy traits

Trait	N	Mean	SD	Min	Max
Body condition score, BCS (1.0 – 5.0)	89	2.60	0.52	1.5	3.5
Litter size at birth (number of kids)	91	1.97	0.70	1.00	4.00
Number of weaned kids	91	1.85	0.74	0	4.00
Birth weight of kids (kg)	168	3.69	0.86	1.10	6.30
Interval between parities (days)	79	340.64	47.21	275.00	657.00

N – number of records, SD – standard deviation, Min - minimum, Max - maximum

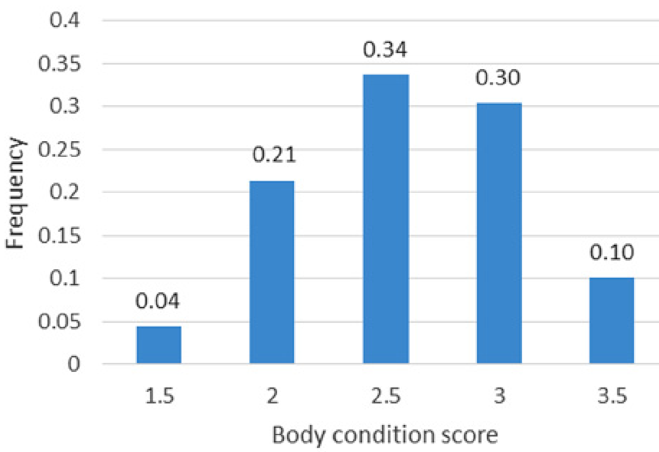

Figure 1. Frequency distribution of BCS at insemination in does

spinous process formed a depression along the backbone and there was a bulging transition from the spinous to the transverse process, the BCS was assessed with 5.0.

Litter size at birth, number of weaned kids per female, and birth weight of kids were recorded at kidding.

The number of records and descriptive statistics are presented in Table 1. The maximum BCS value was 3.5 and the minimum was 1.5. In this study, there were no does with a BCS of less than 1.5 or higher than 3.5.

The mean BCS value was 2.60. The overall frequencies of the BCS are graphically displayed in Figure 1. The distribution of BCS frequencies at mating showed that 85% of the does scored between BCS values of 2.0 and 3.0, which reflected the dietary management of the flock. A BCS of 2.5 was most frequent in the flock (34%), followed by a BCS of 3.0 (30%) and a BCS of 2.0 (21%).

Statistical analysis

Statistical analysis was performed by a general linear model (GLM) procedure using SAS/STAT® Software Version 9.4 (SAS Inst. Inc., 2014). The following model (1) for prolificacy traits such as litter size at birth, birth weight of kids, number of weaned kids, interval between parities (y_{ij}) considered the body condition score at insemination (C_i) (i=1.5, 2.0, 2.5, 3.0, 3.5) and the parity of the doe (P_j) (j=1-3) as fixed effects.

$$y_{ij}=\mu+C_i+P_j+e_{ij} \qquad \text{(Model 1)}$$

The effect of the group within the flock (organic or conventional feed ration) and the interaction between parity and body condition score (BCS) were not significant and were excluded from the model.

Results and discussion

The BCS at artificial insemination significantly affected the litter size at birth ($P < 0.001$) and, the number of weaned kids ($P < 0.05$). The least square means (LSM) for prolificacy traits are presented in Table 2. The number of kids born and weaned per doe was the highest in does with a BCS of 2.0 or 2.5 compared to other does (BCS of 1.5, 3.0 and 3.5). The standard errors (SE) of the litter size were the highest in does with a BCS of 1.5 and 3.5 due to the lower frequency at which these BCS were observed. The results suggested that a BCS between 2.0 and 2.5 at artificial insemination or mating is optimal to achieve a higher litter size per female. Likewise, Martin et al. (2004) reported that undernutrition hinders the reproductive performance in ruminants. Severe undernutrition may cause embryonic losses in sheep. There is also evidence that overfeeding in the first few weeks after fertilisation can cause problems (Martin et al., 2004). Gallego-Calvo et al. (2015) hypothesized that the reproductive performance of does, i.e. their response to the male effect, differed depending on increasing or decreasing BCS at the time of mating. Therefore, during the seasonal anoestrus, they divided the non-pregnant does into two groups depending on their body weight and BCS. Does with a low weight and a low BCS were fed 1.9 times their maintenance requirements to achieve a gain in body weight and to increase the BCS. Does with a high body weight and high BCS were fed 0.4 times their maintenance requirements to achieve a decrease of their BCS. They found that reproductive performance (ovarian and oestrus responses as well as productivity) was reduced when the does' BCS decreased. The mean BCS at mating in Blanca Andaluza does with decreasing BCS and increasing BCS were 2.53 and 2.77, respectively (Gallego-Calvo et al., 2015). However, the corresponding numbers of born kids per female with decreasing BCS and increasing BCS were 1.31 and 1.46, respectively, and did not differ significantly. They concluded that large decreases of BCS due to nutrition might explain the poor reproductive performance and influenced the concentration of reproductive hormones. The suggested optimal BCS of the doe at insemination (2.0 and 2.5) in this study was in agreement with the conclusions of Gallego-Calvo et al. (2015) and could be summarized as follows: (1) increasing the BCS of the doe during the mating period causes better reproductive performance; (2) an optimal BCS of the doe at insemination (2.0 and 2.5) results in a higher litter size per doe; and finally (3) in the period before and during mating, a poorer BCS is suggested, which would increase later with the appropriate feed management, which in turn leads to better reproductive performance of the does.

There were no kid losses till weaning (data not shown) in does with BCS 3.0 and 3.5, and some minor kid losses in does with BCS 2.0 and 2.5. The highest percentage of kid losses was found in does with a BCS of 1.5.

Shorter intervals between two parities were determined in does with a BCS equal to and less than 3.0 compared to does with

Table 2. LSMeans (± SE) of prolificacy traits in Slovenian Alpine does according to parity and the body condition score (BCS)

	N	Litter size at birth	Number of weaned kids	Interval between parities (days)	N	Birth weight of kids (kg)
BCS		***	*	ns		*
1.5	4	$1.36^{ac} \pm 0.34$	$1.12^{a} \pm 0.37$	337.22 ± 11.36	6	$3.66^{abc} \pm 0.35$
2	19	$2.23^{b} \pm 0.16$	$2.19^{c} \pm 0.17$	329.75 ± 6.30	42	$3.44^{ab} \pm 0.14$
2.5	30	$2.28^{b} \pm 0.13$	$2.03^{bc} \pm 0.14$	334.11 ± 6.19	64	$3.29^{a} \pm 0.12$
3	27	$1.85^{c} \pm 0.15$	$1.88^{ab} \pm 0.16$	332.88 ± 6.63	45	$3.83^{c} \pm 0.14$
3.5	9	$1.68^{c} \pm 0.22$	$1.70^{ab} \pm 0.24$	345.98 ± 8.65	14	$3.93^{c} \pm 0.22$
Parity		ns	*	***		**
1	8	1.99 ± 0.34	$1.96^{ab} \pm 0.26$	$321.62^{a} \pm 14.38$	17	$3.23^{a} \pm 0.21$
2	49	1.63 ± 0.12	$1.49^{a} \pm 0.13$	$318.08^{a} \pm 3.94$	86	$3.93^{b} \pm 0.12$
3	34	2.01 ± 0.12	$1.91^{b} \pm 0.13$	$368.27^{b} \pm 4.14$	72	$3.74^{b} \pm 0.12$
R^2		0.24	0.19	0.62		0.15

$^{a, b, c}$ - different superscripts in the same column reflect significant differences at P < 0.05, * = significant at P < 0.05, ** = significant at P < 0.01, *** = significant at P < 0.001, ns = not significant; BCS = body condition score; R^2 = coefficient of determination.

a BCS of 3.5. However, differences in interval length between parities according to BCS were not significant. De Santiago-Miramontes (2009) reported that subtropical does with a BCS of 2.7 have a longer breeding season, less abnormal oestrus cycles and more ovulations than does with a BCS of 1.9.

Birth weights of the kids differed significantly depending on the body condition score of the doe (P < 0.05). The birth weight of kids was the highest in does with a BCS of 3.5, 3.0, and 1.5 with 3.93, 3.83, and 3.66 kg, respectively, and differed significantly compared to doe BCS of 2.0 and 2.5. Similar results were found in Lori-Bakhtiari sheep, where the total litter weight (kg) at birth per ewe was the highest in ewes with a BCS of 3.5 at mating followed by does with a BCS of 3.0, 2.5, 1.0, and 2.0 (Vatankhah et al., 2012). The total litter birth weight of lambs was found to be related to the ewe BCS at mating in the form of a quadratic regression (Vatankhah et al., 2012). Vatankhah et al. (2012) suggested that the decreasing trend for total lamb birth weight in ewes with a BCS lower than 3.0–3.5 may be attributed to improper nutrition of the ewes during the final stage of gestation. The decreasing trend for total lamb birth weight in ewes with a BCS higher than 3.5, on the other hand, could be attributed to their higher maintenance requirements, as ewes with a BCS over 3.5 were heavier than others. Their suggestion cannot explain the association between changes in the birth weight of the kids and the BCS of the does in this study, since the feeding regime was proposed as proper management. In addition, the birth weight of kids from does with a BCS of 1.5 did not differ significantly compared to the birth weight of kids from does with any other BCS. In this study, the observed trend of birth weights depending on the BCS of the does could be due to the low number of records, especially the low number of does with a BCS of 1.5. In addition, it is known that does with lower litter size presumably have heavier kids, which was confirmed in this study as does with a BCS of 1.5 had smaller litter sizes with heavier kids.

The effect of parity significantly affected the number of weaned kids (P > 0.05), the interval between parities (P < 0.001), and the birth weight of kids (P < 0.01). The number of weaned kids was 1.96, 1.49, and 1.91 in the first, second and third parity, respectively. The observed difference in the number of weaned kids was only between the second and the third parity with a higher number of weaned kids in the third parity. Likewise, the lower number of first parities needs to be taken into consideration. Zahraddeen et al. (2007) reported that litter size in Bauchi goats increased significantly (P < 0.001) with increasing number of parities.

In this study, the birth weight of kids significantly increased from the first (3.23 kg) to the second parity (3.93 kg). Between the second and the third parity, there were no significant differences in birth weight of kids. The increasing birth weight with the increasing number of parities was in agreement with Zahraddeen et al. (2007).

Although the results of this study were sufficiently informative, the study should be supplemented with more BCS records per doe since does with a BCS of 1.0, 4.0, and 5.0 were missing. Continuing BCS scoring in this young flock, which showed a maximum of three parities per doe, was suggested.

Conclusion

To achieve the best possible litter size in Slovenian Alpine goats, an optimal doe BCS at insemination between 2.0 and 2.5 was suggested. Does with a BCS of 2.0 and 2.5 at insemination reached the highest number of born and weaned kids per doe. Moreover, a very low kid losses was observed in does with a BCS of 2.0 and 2.5. On the other side, to increase the kids' birth weight the results suggested the best BCS at insemination like 3.0 or 3.5. Likewise, no kid losses was observed in does with BCS 3.0 and 3.5. Summing up all these results, we could suggest the optimal BCS at insemination for the does of the Slovenian Alpine goat to be between 2.0 and 3.5. When the doe BCS at insemination was between 2.0 and 3.5, the litter size was between 2.23 and 1.68 kids as well as the birth weight of kids was between 3.29 kg and 3.93 kg. Due to a small dataset used in the study, a further investigations have to be conducted in this field. However, the tested method for evaluating the doe body score condition could be simply applicable in the breeding management.

References

Abdel-Mageed I.I., Abo El-Maaty A.M. (2012). The effect of backfat thickness at mating on the reproductive and productive performance of ewes. Small Rum Res 105: 148-153

De Santiago-Miramontes M.A., Malpaux B., Delgadillo J.A. (2009). Body condition is associated with a shorter breeding season and reduced ovulation rate in subtropical goats. Anim Reprod Sci 114: 175-182

Gallego-Calvo L., Gatica M.C., Guzmán J.L., Zarazaga L.A. (2015). Reproductive performance to the male effect in goats is improved when doe live weight/body condition score is increasing. Anim Reprod Sci 156: 51-57

Kharrat M., Bocquier F. (2010). Impact of indoor feeding at late lactation stage on body reserves recovery and reproductive performances of Baladi dairy goat fed on pastoral system. Small Rum Res 90: 127-134

Martin G.B., Rodger J., Blacje D. (2004). Nutritional and environmental effects on reproduction in small ruminants. Reprod Fertil Dev 16: 491-501

Mendizabal J.A., Delfa R., Arana A., Equinoa P., Purroy A. (2007). Lipogenic activity in goats (Blanca Celtibérica) with different body conditions scores. Small Rum Res 67: 285-290

Mendizabal J.A., Delfa R., Arana A., Purroy A. (2011). Body condition score and fat mobilization as management tools for goats on native pastures. Small Rum Res 98: 121-127

SAS Institute Inc. 2014. SAS/STAT® 13.2 User's Guide. Cary, NC: SAS Institute Inc.

Vatankhah M., Talebi M.A., Zamani F. (2012). Relationship between ewe body condition score (BCS) at mating and reproductive and productive traits in Lori-Bakhtiari sheep. Small Rum Res 106: 105-109

Villaquiran M., Gipson T.A., Merkel R.C., Goetsch A.L., Sahlu T. (2005). Body condition scoring for improved management. Proc. 20th Ann. Goat Field Day, Langston University, Langston, OK, 111-117. https://www.researchgate.net/publication/242204676 (20.4.2017)

Yilmaz M., Altin T., Karac O., Cemal I., Bardakcioglu H.E., Yilmaz O. Taskin T. (2011). Effect of body condition score at mating on the reproductive performance of Kivircik sheep under an extensive production system. Trop Anim Health Prod 43: 1555-1560

Zahraddeen D., Butswat I.S., Mbap S.T. (2007). Factors affecting birth weight, litter size and survival rates of goats in Bauchi, Nigeria. Anim Prod Res Advan 3(1): 46-51

---

acs82_49