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Relationship between BCS during Prepartum, Calving and Postpartum Periods and Fertility of Korean Brown Cattle

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Abstract : This study evaluated the correlation between the body condition score (BCS) during prepartum, calving and postpartum periods and the reproductive performance of Korean brown cattle. The BCSs of 33 cows who underwent 73 calvings over a two and a half period [the parities of the cows ranged from 1 to 4 (mean ± SD, 2.0 ± 0.9)] were scored at months 2 and 1 prepartum, calving, and every month postpartum until month 7. A marked prepartum loss of BCS in the month preceding calving was noted. The correlations between the interval from calving to conception and the month 1 prepartum, calving and months 1 and 2 postpartum BCSs were analyzed by Pearson correlation analysis. The correlation between the interval from calving to conception and the prepartum body condition loss was also evaluated. The interval from calving to conception correlated positively with the month 1 prepartum BCS ($r = 0.389$, $P = 0.0007$) and the prepartum body condition loss ($r = 0.488$, $P < 0.0001$) but did not correlate significantly with the BCS at calving ($r = -0.070$, $P = 0.56$) or months 1 ($r = 0.107$, $P = 0.37$) or 2 ($r = 0.102$, $P = 0.39$) postpartum. The prepartum body condition loss correlated positively with the month 1 prepartum BCS ($r = 0.587$, $P < 0.0001$). In conclusion, the month 1 prepartum BCS may be a good criterion for predicting subsequent reproductive performance. Moreover, the prevention of obesity and/or excessive prepartum body condition loss may result in higher fertility in Korean brown cattle.

Key words **:** body condition score, calving, Korean brown cattle, pre- and postpartum, reproductive performance.

Introduction

Reproductive competence is a principal factor that limits the production efficiency of beef farms (13). In particular, it is very important for the beef industry that an optimal calving interval of 12 months is maintained (15). That reproductive success in cattle is influenced strongly by nutrition is now well established (2,17,32). For example, it is known that, as with dairy cattle, the nutritional status of beef cattle in the periparturient period influences their subsequent fertility (6). Moreover, a reduced dietary intake during the prepartum period prolongs the interval between calving and first estrus and reduces the pregnancy rate (1,23,29). Inadequate postpartum nutrition was also shown to result in a higher incidence of anestrous cows and lower pregnancy rates (7,22,25-27,34). Moreover, beef cows receiving severely reduced nutrition during late pregnancy and the postpartum period were shown to have a lower pulse frequency of lutenizing hormone (LH) in the serum and poor folliculogenesis that resulted in the absence of larger follicles (21). Thus, careful nutritional management during the periparturm period may be crucial for maintaining the optimal reproductive performance of cattle.

The body condition scoring system has been used to monitor the nutritional status of cattle and to predict their subsequent fertility (5,8,19,23,30,32,33). Prepartum changes in body weight and the body condition score (BCS) have been shown to affect subsequent reproductive performance as a negative correlation has been observed between the change in prepartum BCS and the interval from calving to conception (18). However, a change in the BCS during the prepartum period has not been shown to affect subsequent fertility when the cows had a BCS of 5-7 (1-9 scale) at calving (5,19). One study also showed that a greater BCS at calving resulted in a shorter calving interval (20). However, another report found that the BCS at calving did not affect reproductive performance (3) while yet another study showed that the BCS at both calving and the breeding period, but not the pre- or postpartum BCS, affected pregnancy rates (24). Thus, previous studies examining the relationship between beef cattle nutritional status using BCS and subsequent reproductive performance have led to varying outcomes. These discrepancies may be due to the confounding effect of interactions between prepartum and postpartum nutrition, suckling, herd health management, and other environmental factors (11,16,17,25).

We sought to determine useful criteria that would help to predict fertility. To do so, we evaluated the BCS of Korean brown cattle at month 1 prepartum, calving, and months 1 and 2 postpartum (which represent the beginning of the breeding period). Since we observed a sharp drop in BCS

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from one month prepartum to calving, we also calculated this body condition loss (hereafter referred to as the prepartum body condition loss). We then determined how these measures of body condition correlated to the subsequent reproductive performance of the cattle, namely, the interval between calving and conception.

Materials and Methods

Experimental animals

This study was performed from May 2005 through to Nov. 2007 at a Korean brown cattle farm located in Chungbuk province, Korea. Seventy three calvings from 33 head of cattle whose average parity was 2.0 ± 0.9 (mean ± SD, range of 1 to 4) were included. The cows were kept in free-stall facilities and fed with rice straw, tall fescue hay, and concentrates. They had free access to water and mineral salts. Calves were weaned from their mothers at the age of 2 months.

The BCS of the cows were scored at months 2 and 1 prepartum, calving and months 1 to 7 postpartum at monthly intervals by using the visual technique developed by Edmonson *et al.* (10), which utilizes a scale ranging from 1 to 5. The prepartum body condition loss was measured by month 1 prepartum BCS-calving BCS. Cows that came into estrus 25 or more days after calving were inseminated artificially. Pregnancy was determined 40 to 60 days after artificial insemination by rectal palpation.

Study design and statistical analyses

We evaluated the correlation between the interval from calving to conception and the BCSs at month 1 prepartum, calving and months 1 and 2 postpartum. We also measured the correlation between the interval from calving to conception and the prepartum body condition loss. In addition, the correlation between the prepartum body condition loss and the BCS at month 1 was evaluated. Pearson correlation analysis was used to determine all correlations. The change of BCS from month 2 prepartum through calving until month 7 postpartum was analyzed by using ANOVA. Mean values were compared by using Duncan's multiple comparison test. Statistical analyses of the data were performed by using SAS Version 8.1 (28). A probability level of $P < 0.05$ was considered significant.

Results

Fig 1 shows how the BCS of 33 Korean brown cows undergoing 73 calvings over a two and a half year period changed over the two months before and seven months after calving. In the month before calving, the BCS exhibited a sharp drop (this drop is reflected in the prepartum body condition loss measure). This drop continued for one month postpartum. Thereafter, the BCS gradually increased over the postpartum period ($P < 0.0001$). Great variation in body condition was observed during the experimental periods, as indicated by the BCS distributions at month 1 prepartum (3.25 to 4.75), calving (3.25 to 4.50), and months 1 (3.00 to 4.50) and 2 postpartum (3.00 to 4.50). The prepartum body condition

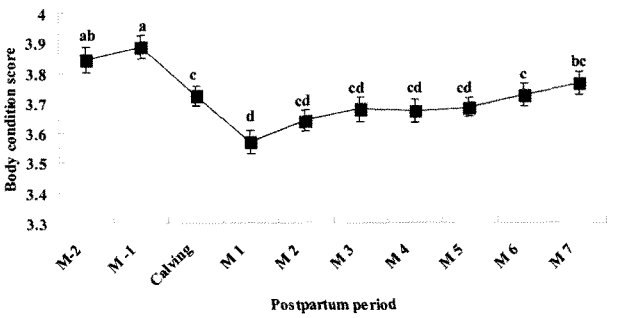

Fig 1. Average changes in BCS from two months prepartum through to calving through to seven months postpartum in 33 Korean brown cows who underwent 73 calvings over a two and a half year period. The values shown are the mean BCSs ± SEM. [abcd] Values with different letters differ significantly from each other ($P < 0.0001$).

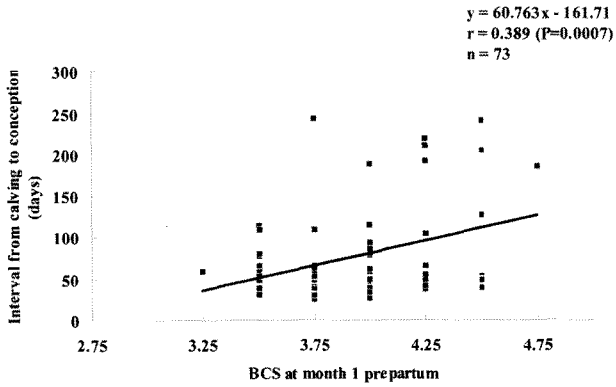

Fig 2. Correlation between the interval from calving to conception and the month 1 prepartum BCS. A positive correlation ($r = 0.389$, $P = 0.0007$) was observed.

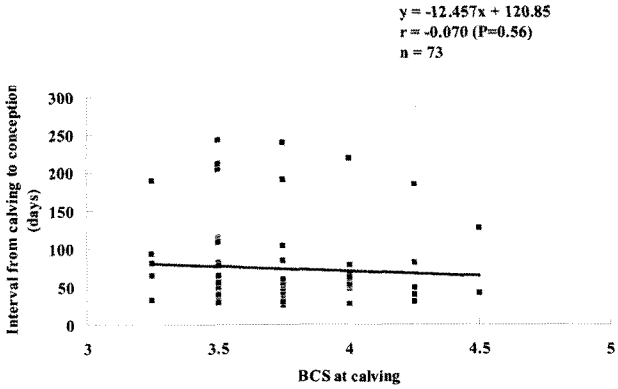

Fig 3. Correlation between the interval from calving to conception and the BCS at calving. No correlation ($r = -0.070$, $P = 0.56$) was observed.

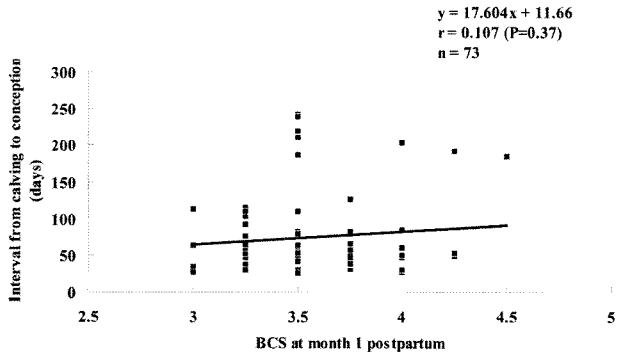

Fig 4. Correlation between the interval from calving to conception and the month 1 postpartum BCS. No correlation (r = 0.107, P = 0.37) was observed.

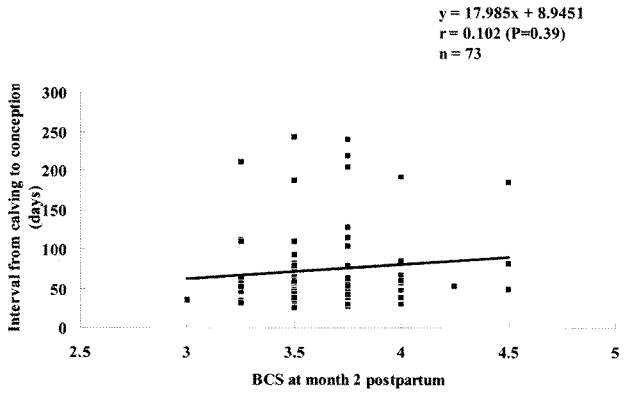

Fig 5. Correlation between the interval from calving to conception and the month 2 postpartum BCS. No correlation (r = 0.102, P = 0.39) was observed.

loss also varied (–0.5 to 1.0). The overall reproductive performance of the cows was as follows: the mean (± SD) interval from calving to first service was 55.6 ± 27.0 (range of 21 to 188) days; the mean (± SD) interval from calving to conception was 74.5 ± 53.3 (26 to 243) days; the mean (± SD) number of services per conception was 1.3 ± 0.7 (1 to 4).

How the interval from calving to conception correlated with the BCSs during the prepartum, calving and postpartum periods is shown in Figs 2 to 5. We also examined how the interval from calving to conception correlated with the prepartum body condition loss, as shown in Fig 6. The interval from calving to conception correlated positively with the month 1 prepartum BCS (r = 0.389, P = 0.0007) and the prepartum body condition loss (r = 0.488, P < 0.0001). However, the interval from calving to conception did not correlate significantly with the BCS at calving (r = –0.070, P = 0.56), or months 1 (r = 0.107, P = 0.37) or 2 (r = 0.102, P = 0.39) postpartum. We also found that the prepartum body condition loss correlated positively with the month 1 prepartum BCS (r = 0.587, P < 0.0001, Fig 7).

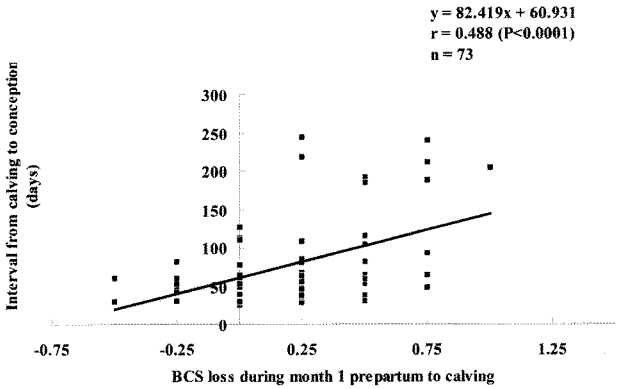

Fig 6. Correlation between the interval from calving to conception and the prepartum body condition loss. A positive correlation (r = 0.488, P < 0.0001) was observed.

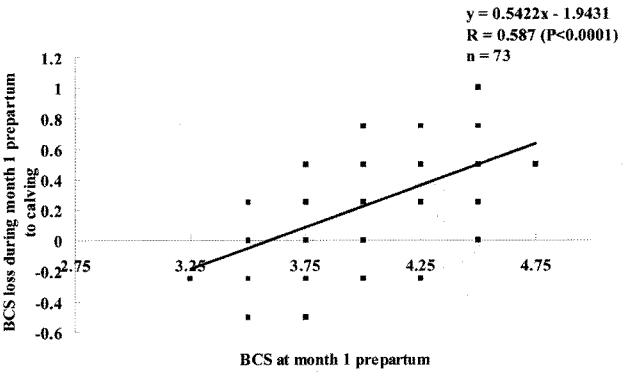

Fig 7. Correlation between prepartum body condition loss and the month 1 prepartum BCS. A positive correlation (r = 0.587, P < 0.0001) was observed.

Discussion

We evaluated whether the BCS at month 1 prepartum, calving, and months 1 and 2 (the beginning of breeding period) postpartum, or the prepartum body condition loss, correlated with the reproductive performance of Korean brown cows to determine useful criteria that would help to predict subsequent fertility in these cattle. We observed that the interval from calving to conception correlated positively with the month 1 prepartum BCS and the prepartum body condition loss. Moreover, we found that the prepartum body condition loss correlated positively with the month 1 prepartum BCS. Thus, the BCS at month 1 prepartum may be a good criterion for predicting subsequent reproductive performance. Moreover, our observations suggest that preventing obesity and/or body condition loss during the prepartum period results in higher fertility in Korean brown cows.

The general pattern of BCS change over the prepartum, calving, and postpartum periods demonstrates that the cows

lose body condition just prior to calving and that this loss continues until one month postpartum. This may reflect the negative energy balance associated with lactation. After one month postpartum, however, the BCS gradually recovers. These observations are consistent with those of a previous report (20). However, we did observe great variation in the BCSs at month 1 prepartum (3.25 to 4.75), calving (3.25 to 4.50), and months 1 (3.00 to 4.50) and 2 postpartum (3.00 to 4.50). There was also considerable variation in the prepartum body condition loss (–0.5 to 1.0). Thus, cows, even those that are in the same herd, vary greatly in body condition during the various reproductive periods.

That the interval from calving to conception correlated positively with the month 1 prepartum BCS and the prepartum body condition loss indicates that high BCSs (obesity) and marked condition loss prior to calving affects the subsequent reproductive performance unfavorably. Our results are supported by the observations of Selk *et al.* (29), who found that cows with precalving BCSs between 4 and 6 (1-9 scale) had higher pregnancy rates than cows that were thinner or fatter. They also showed that BCS change during 2 months before calving was a slightly better predictor of potential pregnancy status than was body weight change. This suggests that minimal prepartum condition loss is needed to ensure quick subsequent conception. However, Morris *et al.* (18) found that for cows under the age of 5 years, the prepartum change in body condition and liveweight correlated negatively with the inter-calving interval. Interestingly, in this study, the prepartum body condition loss correlated positively with the month 1 prepartum BCS. Clark *et al.* (4) have also observed that cows with a high prepartum BCS exhibited greater prepartum BCS loss due to negative energy balance during parturition. In addition, it has been shown that greater body condition losses in the prepartum period are associated with subsequent larger body condition losses in the early postpartum period, and that this is associated with a higher incidence of metabolic and reproductive disorders and lower fertility in cows (12,14,27). When all of these observations are taken into account, it appears that the reproductive performance of beef cows may be improved by preventing the cows from having high BCSs (obesity) and/or prepartum condition loss.

We did not observe a correlation between the BCS at calving and subsequent reproductive performance in this study. This is consistent with a previous report that showed that BCS at calving did not affect the estrus, ovarian function, or reproductive performance of beef cows (3). In contrast, Richards *et al.* (25) observed that the body condition at calving had a critical effect on subsequent reproductive performance as beef cows calving with a BCS that was equal to or greater than 5 (1-9 scale) had shorter intervals from calving to estrus and pregnancy than thinner cows, irrespective of postpartum nutritional management. Another study also observed that a higher BCS at calving was associated with a shorter calving interval (20). Moreover, cows with a BCS of 6 at calving (1-9 scale) had a shorter interval from calving to estrus and a higher pregnancy rate than cows with a BCS of 4 or 5 (31). Furthermore, cows with a BCS of 6 at calving (1-9 scale) had higher plasma glucose and lower nonesterified fatty acids levels during the breeding season than cows with a BCS of 4 or 5 (32). Thus, contrary to our observations, several previous reports have emphasized the importance of BCS at calving. However, it may be that the BCS at calving reflects the nutritional management during the prepartum period. In addition, the effect of the BCS at calving on the subsequent reproductive performance may be masked or enhanced by BCS changes in the prepartum and postpartum periods (24).

The BCS of the beef cattle was lowest one month postpartum but neither this value nor the month 2 postpartum BCS (during the breeding period) was significantly associated with the interval from calving to conception. In contrast, Selk *et al.* (29) demonstrated that the BCS at the beginning of breeding as well as the precalving BCS were the most accurate predictors of subsequent reproductive performance. In addition, Renquist *et al.* (24) reported that an adequate BCS (4.5-5.5; 1-9 scale) in the breeding season should be maintained to prevent a decline in fertility. Curiously, Houghton *et al.* (11) showed that fleshy cows with a BCS greater than 3.3 (1-5 scale) had lower conception rates than thinner cows, which suggests that high BCSs may have an unfavorable effect on reproductive performance. However, Osoro and Wright (20) showed that an increase in BCS at breeding resulted in a shorter calving interval, and detrimental effects of over-conditioning were not observed. We observed that the minimum BCS of the cows during the beginning of breeding was 3.00 (1-5 scale). This may explain why we did not observe a correlation between the BCS at breeding and subsequent reproductive performance in this study. When theses observations are all taken into account, it appears that one should at least avoid a poor condition score at breeding to prevent low fertility. Supporting this is the observation that cows that are thin at calving, as reflected by a low BCS, require high levels of concentrate in the postpartum period if estrus is to occur early in the breeding season (7,34). However, it should be noted that feeding cows with low BCSs after calving with high concentrate diets is expensive and could have adverse effects on subsequent reproductive performance by stimulating milk production (1). Thus, it is recommended that to improve subsequent reproductive performance, body condition monitoring should begin during the gestation period so that the cows have an adequate peripartum BCS. Moreover, as indicated by our results, a high prepartum BCS should be avoided.

In conclusion, the one month prepartum BCS may be a good criterion for predicting subsequent reproductive performance. Moreover, the prevention of prepartum obesity and/or large prepartum body condition loss may result in higher fertility in Korean brown cows.

Acknowledgements

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한우에서 분만 전, 분만 시 및 분만 후의 body condition score와 이후의 번식능력과의 상관관계

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요 약 : 한우에서 분만 전, 분만 시 및 분만 후의 body condition score(BCS)와 이후의 번식능력과의 상관관계를 조사하였다. 2년 6개월에 걸쳐 33두의 한우에서 얻은 73회의 분만 산차(평균 2.0 ± 0.9)에 대한 BCS 평가를 위하여 분만 2개월 및 1개월 전, 분만 시, 그리고 분만 후 7개월까지 매 1개월 간격으로 수행하였다. 분만 전 현저한 BCS의 감소에 대해서도 조사하였다. 분만 후 임신까지의 간격과 분만 1개월 전, 분만 시 그리고 분만 1개월 및 2개월 후 BCS 사이의 상관관계에 대하여 Pearson correlation analysis를 이용하여 분석 하였다. 분만 후 임신까지의 간격과 분만 전 BCS의 감소에 대한 상관관계도 또한 분석하였다. 분만 후 임신까지의 간격은 분만 1개월 전 BCS ($r = 0.389$, $P = 0.0007$) 및 분만 전 BCS의 감소($r = 0.488$, $P<0.0001$)와는 정의 상관관계를 나타내었으나, 분만 시($r = -0.070$, $P = 0.56$) 그리고 분만 1개월($r = 0.107$, $P = 0.37$) 및 2개월 후($r = 0.102$, $P = 0.39$)의 BCS와는 유의적인 상관관계를 나타내지 않았다. 분만 전 BCS의 감소는 분만 1개월 전 BCS와 정의 상관관계를 나타내었다($r = 0.587$, $P < 0.0001$). 본 연구의 결과는 한우에서 분만 1개월 전 BCS는 이후의 번식능력을 예측하는데 유용한 기준으로 활용될 수 있으며, 또한 분만 전 비만 및 과도한 BCS의 감소의 예방은 번식능력을 증진시킬 수 있음을 보여 준다.

주요어 : body condition score, 분만, 번식능력, 한우