

EFFECT OF THE BODY CONDITION SCORE ON SOME REPRODUCTION AND MILK YIELD TRAITS OF SWEDISH RED AND WHITE COWS

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ABSTRACT

This study examined the effect of body condition score (BCS) at calving and during the first month of lactation on some reproduction and milk yield traits of Swedish Red and White (SRW) cows organically raised in Turkey. For this purpose, SRW cows divided two groups, named as thin (BCS <3.00) and moderate (BCS \geq 3.00). The actual milk yield (815 kg) and 305 day daily milk yield (736 kg) of cows with low condition score at calving were significantly ($P<0.01$) higher than those with moderate condition score. The BCS at calving did not have an effect on the lactation length, peak daily milk yield and days to attain peak milk yield. The condition score obtained in the first month of lactation only affected the peak daily milk yield ($P<0.05$), while its impact on the other characteristics was non-significant. The service period of the cows with low condition score at calving was significantly longer (19.9 day) and their number of services per conception was significantly lower (0.37 units) ($P<0.05$) than moderate group. The condition loss was calculated as 0.0137 units in the thin group and 0.2290 units in the moderate group and this differences were significant ($P<0.01$) during the first 30 day period of lactation. The phenotypic correlation between BCS at calving and milk yield traits were negative and significant ($P<0.01$). According to this relationship, actual milk yield ($r=-0.208$), 305 day milk yield ($r=-0.248$) and peak daily milk yield ($r=-0.251$) decreased significantly ($P<0.01$) with the increase in the BCS at calving. The service periods of cows with low condition scores at calving were significantly longer ($P<0.01$).

Key words: Swedish Red, body condition score, organic dairy farming, milk yield, reproduction.

INTRODUCTION

Number of organic dairy farms in Turkey has been increased in recent years since Turkish consumers demand high quality and safe milk that is produced with minimal environmental losses, under optimal conditions for animal welfare and health (Bayram *et al.*, 2008). In Turkey, exotic cattle breeds (Holstein Friesian, Brown Swiss, Jersey and Simmental) and their crosses with native breeds have been raised in organic and conventional dairy farm for a long time. Swedish Red and White (SRW) is a most recent cattle breed imported from Sweden to Turkey in order to improve the milk production (Aksakal *et al.*, 2010).

There are a few study about SRW raised under organic dairy farming condition in Turkey. Therefore, this study was undertaken the effect of body condition score (BCS) at calving and first month of lactation on some reproduction and milk yield traits of SRW cows raised organically in Turkey.

As a result of insufficient and unbalanced nutrition, negative energy occurs, thereby negatively affecting the reproduction (Dechow *et al.*, 2002; Roche *et al.*, 2007a; Jilek *et al.*, 2008; Marsalek *et al.*, 2008) and health (Markusfeld *et al.*, 1997; Lassen *et al.*, 2003; Berry *et al.*, 2007b) of the cows. To determine such

energy using feed records in the field conditions is difficult. Body condition score (BCS) is a method commonly used to determine negative energy (NE) balance and in conducting appropriate nutrition programs (Lassen *et al.*, 2003; Samarütel *et al.*, 2006). BCS is a subjective evaluation of the amount of fat on the body decomposed during the early period of lactation and substituted in the middle or at end of the lactation. It helps designing feeding programs that meet the nutritional requirements of dairy cattle (Edmonson *et al.*, 1989).

Due to its robust and quicker result and easy applicability, BCS is commonly used to develop appropriate feeding programs in dairy cattle enterprises (Anonymous, 2010).

Some previous studies have reported on the effects of BCS during the calving, dry period and different periods of lactation and on the reproduction parameters (Tapkı *et al.*, 2005a; Roche *et al.*, 2007a), milk yield (Waltner *et al.*, 1993; Pedron *et al.*, 1993; Ruegg and Milton, 1995; Tapkı *et al.*, 2005b), milk components (Treacher *et al.*, 1986) and health of cows (Markusfeld *et al.*, 1997; Berry *et al.*, 2007b); however, there are also studies reporting that the BCS had no effect on the yield and health performances (Waltner *et al.*, 1993; Markusfeld *et al.*, 1997; Yaylak, 2003; Samarütel *et al.*, 2006; Jilek *et al.*, 2008).

According to previous studies of BCS, certain complications such reduced milk yield, increase in metabolic diseases, delay in the postpartum estrus cycle of emaciated cows, may occur due to a lack of usable reserves in the early period of lactation. In addition, difficulty in calving, increase in metabolic diseases and decrease in milk yield of fat cows could occur due to a reluctance to consume dry food (Waltner *et al.*, 1993 Ferguson *et al.*, 1994; Dechow *et al.*, 2002). To avoid such complications of emaciation or obesity, the cows should have a BCS of at least 3.5 out of 5 at calving period (Roche *et al.*, 2007b).

Rapid developments are occurring in organic dairy cattle production, particularly within the EU countries. In parallel with such developments, increases are also observed in the number of cattle, enterprises and animal production. As in conventional production systems, it is also necessary in organic production systems to examine the applicability of BCS and its relationship to some reproduction and milk yield traits.

There are few published studies examining the effect of BCS on yield traits of organically raised cows. The present study was conducted with SRW cows that were raised organically in Turkey.

MATERIALS AND METHODS

This study was conducted at a private organic dairy cattle enterprise in the Kelkit district of Gümüşhane province, Turkey. The trial was conducted between December 2007 and December 2008 with 135 SRW cows that all of them genetically pure. Detailed information regarding the reproduction and milk yield traits of SRW cows raised in this enterprise was previously reported by Aksakal *et al.* (2010).

Within this enterprise, matters such as care, nutrition, accommodation and veterinary intervention are carried out in accordance with the "Regulation Pertaining to the Principles and Implementation of Organic Agriculture", issued by the Ministry of Agriculture and Rural Affairs in June 2005 and October 2006 (Anonymous, 2005; Anonymous, 2006). The cattle were accommodated in free-stall barns during the whole year. The daily feed ratios of the cows in lactation contained 60% roughage feed and 40% concentrate feed. In addition, with the permission of the controlling institution, the percentage of concentrate feed can increase to 50% in postpartum cows for a period of three months. In case of a shortage of organic feed, 5% of the total annual feed requirements can be supplied from conventional enterprises (Anonymous, 2006). All feeds offered to the cows were grown organically in this region.

Concentrate feeds used in the enterprise mainly consist of corn, barley, *Vicia sativa*, lentil flour and organic concentrated milk feed; and roughage feeds include corn silage, organic clover and herbage. The

cows are milked twice a day. Daily milk yield was automatically recorded on a computer via transponders carried by each cow. The average dry period in the enterprise was 2 months. Traits such as actual milk yield and 305 day milk yield traits were calculated from computer-records. The Swedish Red and White (SRW) herd first established by 350 female animals imported from Sweden to Turkey in 2006 year. Since the heifers were brought from enterprises making extensive production, only the records of the cows in 2nd lactation were used in order to remove the amount of effect deriving from lactation process. All of the tested cows were individually scored using a 5-item scoring system, according to the body condition scoring system developed by Edmonson *et al.* (1989). In this system, the scoring interval was 0.25 and the scores varied between 1 (emaciated), 2 (thin), 3 (moderate), 4 (fat) and 5 (obese). All cows scored near the calving and first month of second lactation by trained personnel.

The cows were divided into two groups, named as thin (BCS<3.00) and as moderate cows (BCS≥3.00). To determine the effect of such a grouping on reproduction (calf birth weight, service period, number of services per conception) and milk yield (actual milk yield, 305 day milk yield, lactation length, peak daily milk yield, days to attain peak milk yield) traits, the reproduction and milk yield records of the cows in the following lactation (second lactation) period were assessed. In addition, condition losses during the period between calving and the first month of lactation were calculated and the cows were divided into two groups, those with BCS loss (BCS -) those and without BCS loss (BCS +).

To determine the effect of both BCS and change in condition on the reproduction and milk yield traits above, the following linear models were used (SPSS, 2004).

Model 1, $Y_{ijklm} = \mu + a_i + b_j + c_k + d_l + e_{ijklm}$

In model 1, Y_{ijklm} = reproduction and milk yield traits, μ = overall mean, a_i = effect of the calving year (i: 2007, 2008) b_j = effect of the calving season (j: Winter, Spring, Summer, Autumn) c_k = effect of body condition classes (k: thin (BCS < 3.00), moderate (BCS ≥ 3.00), e_{ijkl} : random error

Model 2, $Y_{ijklm} = \mu + a_i + b_j + c_k + d_l + e_{ijklm}$

In model 2, Y_{ijklm} = reproduction and milk yield traits, μ = overall mean a_i = effect of the calving year (i: 2007, 2008) b_j = effect of the calving season (j: Winter, Spring, Summer, Autumn) c_k = effect of body condition loss classes (k: the group without condition loss (BCS+), the group with condition loss (BCS-), e_{ijkl} : random error

In addition, phenotypic correlations were measured between reproduction and milk yield traits and the BCS at calving and in the first month of lactation (SPSS, 2004).

RESULTS

The average BCS of SRW cows at second calving and first month of lactation were 3.14 ± 0.01 and 3.03 ± 0.01 , respectively.

Table 1 shows the effect of BCS at calving and in the first month of lactation on milk yield traits. The actual milk yield and 305 day milk yields of the cows with low condition score at calving were significantly higher ($P < 0.01$) than in animals with moderate condition score. Condition score of at calving did not have an effect on the peak daily milk yield and days to attain peak milk yield. The condition score at the first month of lactation only affected the peak daily milk yield ($P < 0.05$), while its effect on the other traits was non-significant.

Table 2 shows the effect of BCS at calving and in the first month of lactation on some reproduction traits. The service periods of the cows with low condition scores at calving were longer ($P < 0.05$) but their number services per conception was lower ($P < 0.05$) than the other cows.

The study determined the condition losses during first 30-day period of lactation. The loss was calculated as 0.0137 in the thin group and 0.2290 in the moderate group and this difference was found to be statistically significant ($P < 0.01$). The average condition loss during this period was 0.1126 units. The cows were divided into two groups those with condition loss (BCS-) and those without condition loss (BCS+). Table 3 shows the effect of the grouping on some reproduction and milk yield traits.

Table 1. The effect of body condition score of calving and first month of lactation on milk yield traits

Traits	BCS at calving		BCS at lactation	
	(BCS < 3.00) (N=73)	(BCS ≥ 3.00) (N=62)	(BCS < 3.00) (N=74)	(BCS ≥ 3.00) (N=61)
	Mean±S.E	Mean±S.E	Mean±S.E	Mean±S.E
Actual milk yield (kg)	7326 ± 186	6511 ± 201**	7072 ± 165	6625 ± 225 ^{ns}
305 day milk yield (kg)	6877 ± 182	6141 ± 197**	6651 ± 161	6234 ± 251 ^{ns}
Lactation length (day)	322 ± 6.32	300 ± 7.89 ^{ns}	311 ± 4.68	311 ± 7.40 ^{ns}
Peak daily milk yield (kg)	35.7 ± 0.68	33.2 ± 0.74 ^{ns}	35.2 ± 0.69	32.8 ± 0.69*
Days to attain peak milk yield (day)	62.2 ± 4.98	63.8 ± 5.37 ^{ns}	61.84 ± 4.93	64.23 ± 5.09 ^{ns}

NS: non-significant, *: $P < 0.05$, **: $P < 0.01$

Table 2. The effects of body condition score of calving and first month of lactation on some reproduction traits.

Traits	BCS at calving		BCS at lactation	
	(BCS < 3.00) (N= 73)	(BCS ≥ 3.00) (N= 62)	(BCS < 3.00) (N= 74)	(BCS ≥ 3.00) (N=61)
	Mean±S.E	Mean±S.E	Mean±S.E	Mean±S.E
Service period (day)	122.2 ± 9.03	102.3 ± 6.25*	114.5 ± 7.32	102.8 ± 7.26 ^{ns}
Number of services per conception	1.52 ± 0.16	1.89 ± 0.112*	1.81 ± 0.132	1.74 ± 0.131 ^{ns}
Birth weight (kg)	41.0 ± 0.46	41.5 ± 0.46 ^{ns}		

NS: non-significant, *: $P < 0.05$.

Table 3. The effects of condition losses on some milk and reproduction traits

Traits	Change body condition score	
	(BCS+) (N= 58)	(BCS-) (N=77)
	Mean±S.E	Mean±S.E
Actual milk yield (kg)	7091 ± 182	6872 ± 167 ns
305 days milk yield (kg)	6692 ± 195	6500 ± 158 ns
Lactation length (day)	311 ± 7.86	310 ± 5.43 ns
Peak daily milk yield (kg)	34.8 ± 0.74	34.7 ± 0.57 ns
Days to attain peak milk yield (day)	62.5 ± 4.59	69.1 ± 4.66 ns
Service period (day)	114.1 ± 7.21	104.4 ± 6.33 ns
Number of service per conception	1.87 ± 0.134	1.96 ± 0.127 ns

NS: non-significant.

The change in BCS did not have an effect on the reproduction and milk yield traits. Table 4 shows the phenotypic correlations between the BCS at calving and

in the first month of lactation and some reproduction and milk yield traits.

Table 4. Phenotypic correlations between body condition score at calving and first month of lactation and some milk and reproduction characteristics.

BCS _{calving}	Milk yield traits					Reproduction traits		
	Actual milk yield	305 day milk yield	Lactation length	Peak daily milk yield	Days to attain peak milk yield	Service period	Number of services per conception	Birth weight
	-0.208*	-0.248**	0.142	-0.251**	-.074	-0.242**	-0.024	0.06
BCS _{lactation}	-0.074	-0.095	0.098	0.027	-0.179*	-0.137	-0.005	-

S: significance, ns: non-significant, *: P<0.05, **, P<0.01

Significant, moderately negative relationships (P<0.05) were found between the reproduction and milk yield traits and BCS at calving.

DISCUSSION

The average BCS of the SRW cows at the second calving was 3.14 ± 0.01 . This value was below the lower boundary of optimum BCS (3.00-3.50) reported for calving (Roche *et al.*, 2004; Samarütel *et al.*, 2006).

Contrary to some other studies conducted under conventional conditions (Waltner *et al.*, 1993; Domecq *et al.*, 1997; Samarütel *et al.*, 2006; Berry *et al.*, 2007a, Roche *et al.*, 2007b), in this study actual milk yield (815 kg) and 305 day milk yield (736 kg) of thin cows were significantly higher than those of the moderate cows (P<0.01).

Samarütel *et al.* (2006) reported that, thin cows at the calving could not achieve their genetic milk yield potentials due to lack of body reserves that would support increasing the milk yield at the beginning of lactation. However, no other reason was identified regarding the positive impact of body condition score at calving on the milk yield, except for the intake of required nutrition from the tissues. Two presumptions were suggested regarding this positive relation: first is the increase in the mammary cells of the cows with high condition scores during the calving period and the second suggestion is the reduction in the decomposition of foods (Roche *et al.*, 2007b).

In parallel with the results of this study, Bouska *et al.* (2008) reported that cows with low condition score had the highest milk yield among all body condition classes (≤ 3.5 , 4, ≥ 4.5) during the dry period (7 345, 6 980, 6 868 kg). These researchers indicated that cows with high condition score during the calving period had higher negative energy balance, thus producing lower milk yields than other cows due to the consumption of less feed. A review by Broster and Broster (1998) showed that increasing body condition score resulted in reduced dry food intake.

Roughage and concentrate feed ratios for organically raised cattle are fixed. According to the Turkish organic agriculture principals, cows in lactation are fed 60% roughage feed and 40% concentrate feed. In addition, with the permission of the organic regulatory institution, the percentage of concentrate feed can increase to 50% in the first 90-day of postpartum.

Individual feeding programs cannot be used due to the fixed roughage and concentrate feed ratios specified. In other words, there is no special feeding program for fat cows with high milk yield. This may result in reduced milk yield among cows with high condition score and with high milk yield at the beginning of lactation.

Some studies reported that the BCS at calving did not have an effect on milk yield (Pedron *et al.*, 1993; Ruegg and Milton, 1995; Domecq *et al.*, 1997; Jilek *et al.*, 2008). The disparate results of studies examining the effect of BCS on milk yield may result from the use of different scoring systems and classifications, different mathematical models and different factors such as the breed, milk yield and raising techniques etc.

Cows with low condition score were milked about 22 days more than the other group, but this difference was not statistically significant (P>0.05). However, such a difference may mean that cows with moderate condition score had to end lactation early due to insufficient feed intake. The low actual milk yield and 305 day milk yield of cows with moderate condition score is indicative of both their short lactation period and some other problems. This could be attributed to either insufficient or low-level nutrient content of the feed given at the particular enterprise or the insufficiency of the ratios specified in the regulation. More detailed studies are required to clarify these factors.

In parallel with some other studies (Pedron *et al.*, 1993; Markusfeld *et al.*, 1997; Berry *et al.*, 2007a), this study found no effect of BCS at calving on peak daily milk yield (35.7 and 33.2 kg) and days to attain peak milk yield (62.2 and 63.8 days). However, Waltner *et al.* (1993) and Roche *et al.* (2007b) reported that the BCS at calving had a positive effect on the peak daily milk yield.

The average BCS of organically raised SRW cows approximately 1 month after calving was 3.03 ± 0.01 . During this period, 54.8 % (74) of the cows were classed as being thin and 45.1 % (61) of the cows were fat.

BCS obtained 1 month after calving had no effect on the milk yield (except for the peak daily milk yield). During this period, although the cows with low condition score had higher actual and 305 day milk yield,

the differences observed between two groups were not statistically significant ($P>0.05$). Jilek *et al.* (2008) reported that cows with low BCS within the month after calving had significantly higher daily milk yield ($P<0.01$) during the first five months of lactation. According to the researchers, this was because cows with genetically high milk yield potential are more inclined to consume the food reserved on their bodies to lactate more and these cows had lower BCS at the first month of lactation but had higher milk yield. Similarly, Samarütel *et al.* (2006) reported that cows with low BCS gave more daily milk yields in the first two months of lactation.

In the first month of lactation, cows with low BCS had a significant more milk yield (2.4 kg) at the peak point than those with moderate BCS ($P<0.01$). Lower peak daily milk yield or extension of milk period may be expected due to insufficient reserves in emaciated cows and due to the insufficient dry food intake in obese cows.

The service period of the cows with low condition score at calving was significantly longer (19.9 days) and their number of services per conception was significantly lower (0.37 unit) ($P<0.05$). In line with the results of this study, Heuwieser *et al.* (1994) reported that service period was 6.4 days shorter and the number of insemination per gestation was 0.16 units more in cows with a BCS above 3 compared with those with a BCS below 3.00. Yaylak (2003) classified the cows as thin (<3.00) and obese (≥ 4) during the dry period and reported the service period and number of services per conception as 121 and 111 days, and 1.54 and 1.75 units, respectively. Another study conducted in Turkey (Tapkı *et al.*, 2005a) reported significant differences between the service period (78 and 94 days) and number of services per conception (1.27 and 1.53) in the fat (≤ 4) and over fat (> 4) groups during the dry period.

When compared with previous studies, the service period found in the present study was longer (19.9 day). This indicates that the BCS at calving must be at least 3.00 or above to achieve successful reproduction traits in this private organic dairy production enterprise. Extended service period and increased number of services per conception were also reported in cows with low BCS at calving due to late postpartum ovulation or excessive inactive ovum (Lopez-Gatius *et al.*, 2003, Roche *et al.*, 2007a).

Although the birth weight of calves born to the cows with low BCS was 0.5 kg lower than the other cows, this difference was not significant ($P>0.05$). Although the service period and number services per conception of cows with low BCS were higher than the other group in the first month of lactation, this difference was non-significant ($P>0.05$). However, Jilek *et al.* (2008) reported that the service period and number services per conception of thin cows increased after the calving period. Since the low BCS derived from the

negative energy balance during the early lactation period resulted in low LH release and weak follicle formation, it causes extended postpartum estrus cycle and extended service period. Markusfeld *et al.* (1997) indicated that service period was shortened by 6 days with each unit of increase in BCS at calving.

Although the negative energy balance causes body condition loss and is considered physiologically normal, its amount and duration negatively affect both health and reproduction traits (Koenen *et al.*, 2001). As the nutrients obtained through the ration is insufficient for lactation during the first 60-90-day period of lactation, body reserves are used to attempt to meet the necessary energy requirement. Ferguson *et al.* (1994) reported that the body condition loss at that period must be less than 1 point.

BCS loss was found to be very low in the present study (-0.119 unit). Many other studies reported condition losses of between 0.29 and 1.20 units (Ruegg and Milton, 1993; Waltner *et al.*, 1993; Koenen *et al.*, 2001; Dechow *et al.*, 2002; Samarütel *et al.*, 2006; Marsalek *et al.*, 2008). It was remarkable that condition losses were higher in the studies conducted with dairy cattle, especially among Holstein Friesian cows. More detailed studies are required to clarify whether the low condition loss in this study was derived from the SRW cows studied or from the husbandry techniques.

Similarly some previous studies (Waltner *et al.*, 1993; Domecq *et al.* 1997, Dechow *et al.*, 2002; Samarütel *et al.*, 2006; Bouska *et al.*, 2008), in this study condition loss among cows with moderate BCS at calving was higher ($P<0.01$) during the first month of lactation. Dechow *et al.* (2002) found a significant positive phenotypic correlation (0.54) between the BCS at calving and condition loss. In other words, condition losses increase with the increase in BCS. More detailed studies are required to clarify whether such a loss is derived from insufficient feed consumption among lactating cows with high BCS or from the high milk yield of these cows.

In this study, 17.7 % (24) of the cows showed condition gain while 25.1 % (34) showed no change and 57.1 (77) showed condition loss ranging between 0.01 and 0.90 units. The change in the condition score did not have a significant effect on the reproduction and milk yield traits. However, some studies reported higher milk yields in cows with high BCS losses (Dechow *et al.*, 2002; Roche *et al.*, 2007; Berry *et al.*, 2007). Dechow *et al.* (2002) indicated a genetic correlation between the BCS loss and milk yield characteristics as between 0.17 and 0.55.

Although the service periods of the cows without condition loss were longer (10.4 days) and their number services per conception were lower (0.06 unit), these differences were not statistically significant ($P>0.05$). Contrary to the results of this study, many other

studies indicated that service period was longer since the period between the birth and first estrus extended in the cows with condition loss (Domecq *et al.*, 1997; Dechow *et al.*, 2002; Marsalek *et al.*, 2008). A review by Butler (2000) specified that condition loss of 1 or more points during the early lactation period reduced the gestation between 17% and 38%. In case of condition loss as a result of negative energy balance, LH hormone level in the animals decreases and the response to LH reduces to a low level. As a result, there is a decrease in the available follicle number and thus in the number of ovule and follicle. Dechow *et al.* (2002) found a genetic correlation between the condition loss and service period ranging from 0.29 to 0.68. According to this relationship, service period extends with the increase in BCS loss.

Medium level and negative phenotypic correlations were found between the calving BCS and milk yield traits (except from the lactation length). There were significant negative relationships ($P < 0.05$, $P < 0.01$) between actual milk yield (-0.208) and 305 day milk yield (-0.248) and the BCS at calving. According to these relationships, the BCS of organically raised SRW cows at calving increases in relation to a considerable decrease in the actual milk yield and 305-day milk yield. Bouska *et al.* (2008) reported this relation as -0.11 for the 305-day milk yield, while Dechow *et al.* (2002) determined the genetic correlation as ranging between -0.27 and -0.31 for various milk yield traits. This study showed that peak daily milk yield reduces considerably ($P < 0.01$) with the increase in the calving BCS.

The phenotypic correlation between the BCS obtained during the first month of lactation and milk yield traits was generally weak and non-significant. There is only a significant ($P < 0.05$) and negative (-0.179) relationship between the BCS during that period and days to attain peak milk yield. According to this relationship, peak point time is shorter in cows with high condition during the first month of lactation.

There was a negative (-0.244) and significant ($P < 0.01$) relationship between the BCS at calving and service period. According to this relationship, service period gets shorter as BCS increases at calving. No significant relationship was found between the BCS and reproduction characteristics during the first month of calving.

Conclusions: In conclusion, organically raised SRW cows, milk yield traits of cows with low BCS at the calving and during the first month of lactation were better. Further studies should examine whether such a positive performance is derived from the condition class or from the lack of rations reported in the organic agriculture regulation. That is because roughage and concentrate feed ratios are fixed in the organic agriculture regulation.

Significant relationships correlations were found between the reproduction and milk yield traits and BCS of the organically raised cattle. This indicates that the BCS could be used in the organic system as well as the conventional system. However, additional studies are required to test the marginal condition effect.

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