REPRODUCTIVE PERFORMANCE AS AFFECTED BY LACTATION STATUS AND BODY FAT IN BEEF COWS[1]

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ABSTRACT - Seventy-one mature Brangus cows, 38 nonlactating (NL) and 33 in late stage of lactation (L) were fed for 192 days (Phase I) a low energy diet (L). During Phase II (65 days) 19 NL and 17 L cows were fed a high energy diet (H). The other nonlactating (19) and lactating (16) cows remained on the low energy diet. Energy restriction during Phase I did not affect ($P > 0.05$) cyclic ovarian activity although losses in body weight and condition were substantial. Rapid changes in body weight, condition, and percent empty body lipid (EBLP) during Phase II did not substantially influence fertility, although a five-fold difference in EBLP was observed (NL-H vs. L-L). Treatment groups did not differ ($P > 0.05$) in conception rate, days from the beginning of the breeding season to breeding and to conception, conception at first service, and number of services per conception. Values observed for these parameters for NL-H, L-H, NL-L, and L-L groups were respectively: 68.4%, 13.2, 23.3, 36.8%, and 1.68; 82.4%, 12.7, 19.5, 58.8%, and 1.29; 68.4%, 10.2, 17.4, 47.4%, and 1.41; 68.8%, 12.4, 19.5, 43.7%, and 1.50.

Index terms: conception, suckling, body lipid.

DESEMPENHO REPRODUTIVO DE VACAS DE CORTE INFLUENCIADO PELA LACTAÇÃO E PERCENTUAL DE GORDURA DO CORPO

RESUMO - Setenta e uma vacas Brangus adultas, 38 secas (NL) e 33 em fase final de lactação (L), receberam por 192 dias (Fase 1) uma dieta baixa em energia (L). Durante a Fase 2 (65 dias), 19 vacas NL e 17 L receberam uma dieta alta em energia (H). As restantes 19 vacas secas 16 lactantes permaneceram na ração de baixa energia. A restrição de energia na Fase 1 não afetou ($P > 0,05$) a atividade cíclica ovariana, embora as perdas em peso vivo e condição corporal tenham sido substanciais. Mudanças rápidas em peso vivo, condição e percentagem de gordura do corpo (EBLP) durante a Fase 2 não influenciaram substancialmente a fertilidade, embora uma diferença de até cinco vezes em EBLP tenha sido observada entre os grupos NL-H e L-L. Os tratamentos não diferiram ($P > 0,05$) em taxa de concepção, número de dias do início do período de monta para a cobrição e para a concepção, concepção ao primeiro serviço e número de serviços por concepção. Os valores observados para estes parâmetros nos grupos NL-H, L-H, NL-L e L-L foram, respectivamente: 68,4%, 13,2, 23,3, 36,8% e 1,68; 82,4%, 12,7, 19,5, 58,8% e 1.29; 68,4%, 10.2, 17.4, 47,4% e 1,41; 68,8%, 12,4, 19,5, 43,7% e 1,50.

Termos para indexação: concepção, amamentação, lipídeo.

INTRODUCTION

Many scientists have associated reduced reproductive performance with plane of nutrition and body condition. Level of energy, both before and after calving, influences the lenght of the postpartum interval to first estrus and conception (Joubert 1954, Wiltbank et al. 1962, Dunn et al. 1969, Bellows & Short 1978).

Condition of the cow and whether she is gaining or losing weight are critical factors to determine length of the postpartum interval (Wiltbank 1978, Topps 1977); however their effects on likelihood of pregnancy are little once estrus is expressed (Whitman 1975). It appears that a minimum lipid percent is necessary for estrus and conception to occur in postpartum beef cows (Butler 1980).

Prolonged postpartum intervals and decreased reproductive efficiency were observed in cows suckling calves (Wiltbank & Cook 1958, Graves et al. 1968). Oxenreider & Wagner (1971) concluded that the length of the postpartum interval is related to the strength of the suckling stimulus.

The studies above mentioned are related to animals in early lactation. Literature reports concerning reproductive performance of beef

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cows in nonlactating or late-lactating status are practically inexistent. The present study was designed to provide some information on this aspect.

MATERIALS AND METHODS

Data for this experiment were taken from a group of 71 four-year-old Brangus cows maintained under dry-lot conditions. Of these animals, 38 were nonlactating and 33 were in late stage of lactation (five to six months). Both groups were initially submitted to a 192-day pre--experimental period (Phase I) during which cows were fed a low energy ration, estimated to provide about 50% National Research Council (1976) recommendation for maintenance, in order to decrease body condition and reduce cyclic estrous activity. Animals were group-fed once daily. Diet was composed of ground alfalfa hay, cotton seed hulls, and a supplement including cottonseed meal, milo, molasses, dicalcium phosphate and urea. During this period (Phase I) cows were observed twice daily for estrous behavior, between 06:00 and 7:00 a.m. and between 5:00 and 6:00 p.m. Ovaries of cows observed in estrus were examined by rectal palpation to detect ovulation.

Following this period, cows in each group were randomly assigned by weight and body condition score to two treatments (Phase II). The first group was fed a low energy diet estimated to provide 50% recommendation for maintenance (National Research Council 1976). The second group was fed a high energy diet estimated to provide about 120% National Research Council (1976) recommendation for maintenance. Ingredients of the diet were the same used during Phase I and the high level of energy was attained by adding milo grain according to lactation status of each group. Both diets met or exceeded maintenance levels of digestible protein, calcium, phosphorus and other minerals. The four treatment groups were designated as nonlactating-high energy (NL-H), lactating-high energy (L-H), nonlactating-low energy (NL-L), and lactating-low energy (L-L). Numbers of animals per treatment were 19, 17, 19, and 16, respectively. Although these numbers were apparently small, they were adequate to achieve the primary objectives of this work.

After a fifteen day period under differential feeding conditions, bulls were placed in all subgroups for mating. The breeding period was 50 days long. Cows bred were identified by "chin-ball marker" device used on the bulls as well as by twice daily visual checking. Bulls were rotated daily among pens to minimize differences in libido and fertility. A rectal examination of the reproductive tract was performed 35 to 45 days after the end of the breeding period to determine pregnancy.

Weights were taken at approximately 28-day intervals throughout the study. Each cow was given a body condition score ranging from 5 to 15 (5 to 7 = thin; 8 to 10 = moderate; above 10 = good) at the time weights were taken. Height of each cow at the hooks was measured in centimeters at the beginning and at the end of Phase II and a weight to height ratio calculated. Chemical analyses of carcass samples (Marchello et al. 1979) were performed to estimate empty body lipid percentage (EBLP) values (Garret & Hinman 1969). EBLP values were also estimated in live animals by using a prediction equation in which condition score and weight: height ratio were the independent variables (Butler 1980). This prediction equation was developed by Butler (1980) also for Brangus females and was as follows:

$$\text{EBLP} = -23.7 + (2.816 \times \text{condition score}) + (3.588 \times \text{weight : height ratio})$$

Based on the high prediction accuracy shown by the equation, the values for the beginning and end of Phase II obtained by this method were selected for use in the analysis of body fat and reproductive performance of the different treatment groups.

Data were statistically analyzed by means of one-way and two-way analysis of variance techniques for Phase I and Phase II, respectively. Chi-squared procedures (Steel & Torrie 1960) were used to analyze differences in conception rate. Simple correlations were computed between conception and body weight, condition score, and EBLP values.

RESULTS

Body weight changes

During Phase I (192 days) lactating cows lost 0.15 kg per day, whereas nonlactating cows lost 0.21 kg per day. Initial and final weights of the cows are presented in Table 1. During Phase II, nonlactating cows on the high TDN level (NL-H) gained 29.2 kg whereas those on the low level (NL-L) lost 36.8 kg. Lactating cows gained 11.3 kg on the high energy diet (L-H) but there was a loss of 45.1 kg for those on low energy diet (L-L). Both factors, lactation and level of energy, had a highly significant effect ($P < 0.01$) on weight changes during this phase.

Body condition changes

A decrease in body condition was observed in both lactating and nonlactating cows, fed a low level of energy during Phase I. A significant difference between groups occurred, with the lactating cows showing a more severe decrease in

TABLE 1. Weights and weight changes (kg) of cows as affected by lactation and energy level.

Parameter	Lactation status	Energy level[a]		Mean
		High	Low	
Weight at the beginning of Phase I	NL	484.2	475.2	479.7[b]
	L	399.8	397.3	398.6[c]
	Mean	444.4	439.6	
Weight at the end of Phase I	NL	440.8	438.6	439.7[b]
	L	369.0	369.7	369.3[c]
	Mean	406.9	407.1	
Weight at the end of Phase II	NL	470.0	401.8	435.9[b]
	L	380.4	324.5	353.3[c]
	Mean	427.7[d]	366.5[e]	
Weight changes during Phase I	NL	-43.4	-36.5	40.0
	L	-30.8	-27.5	-29.2
	Mean	-37.4	-32.4	
Weight changes during Phase II	NL	29.2	-36.8	- 3.8[b]
	L	11.3	-45.1	-16.0[c]
	Mean	20.7[d]	-40.6[e]	

[a] About 120% (high) and 50% (low) the recommended TDN levels, based on initial weights.
[b,c] Column means with different superscripts differ (P < 0.01).
[d,e] Row means with different superscripts differ (P < 0.01).

condition (P < 0.05) than the nonlactating ones. Table 2 shows the initial and final condition scores for cows on all treatment groups. During Phase II, changes in body condition were significantly influenced by the level of energy intake (P < 0.01), although there was no difference in these changes between nonlactating and lactating cows. Cows on the high energy diet gained in condition score (from 9.55 to 10.63) with the nonlactating cows showing a tendency to greater increase than the lactating ones (1.21 vs. 0.94). Lactating cows on the low energy diet (L-L) showed the most severe decrease in condition score not only during Phase II, but also during the entire experimental period (from 9.81 to 6.68).

EBLP changes

Estimation of EBLP by using a prediction equation based on weight:height ratio and condition score taken at the beginning and end of Phase II yielded consistent results as demonstrated by its high positive correlation (0.87) with EBLP estimated by chemical analysis.

Empty body lipid percentage for cows on different treatments are shown in Table 3. Changes in EBLP were significantly influenced by level of energy (P < 0.01). Body fat of cows on the high energy diet increased (+ 3.5%) whereas body fat of cows fed the low energy diet showed a substantial decline (-5.9%). However, lactation status did not affect these changes (P > 0.05), although lactating cows tended to lose more body fat than those nonlactating (-1,59 vs. -0,70). A five-fold difference in body fat was observed between NL-H and L-L cows (21.4 vs. 4.1%) at the end of Phase II.

Reproductive performance

Underfeeding during Phase I did not induce any nonlactating cow to cease estrous cyles although losses in body weight and condition were substantial. In the lactating animals only two cows (6%) stopped cyclic estrous activity.

Table 4 presents the fertility data for different treatment groups during the 50-day breeding period. There was no significant effects (P > 0.05)

TABLE 2. Body condition scores and condition score changes as affected by lactation and energy levels.

Parameter	Lactation status	Energy level[a] High	Energy level[a] Low	Mean
Score at the beginning of Phase I	NL	11.10	11.21	11.15[b]
	L	9.88	9.81	9.84[c]
	Mean	10.52	10.57	
Score at the end of Phase I	NL	10.36	10.47	10.42[b]
	L	8.64	8.43	8.54[c]
	Mean	9.55	9.54	
Score at the end of Phase II	NL	11.57	8.89	10.23[b]
	L	9.58	6.68	8.18[c]
	Mean	10.63[d]	7.88[e]	
Score changes during Phase I	NL	-0.73	-0.73	-0.73[b]
	L	-1.23	-1.37	-1.30[c]
	Mean	-0.97	-1.02	
Score changes during Phase II	NL	1.21	-1.57	-18.0
	L	0.94	-1.75	- 0.36
	Mean	1.08[d]	-1.65[e]	

[a] About 120% (high) and 50% (low) the recommended TDN levels, based on initial weights.

[b,c] Column means with different superscripts differ ($P < 0.05$).

[d,e] Row means with different superscripts differ ($P < 0.01$).

of either lactating status or energy level on conception rate; however, a tendency for lactating cows to have a higher conception rate was observed when compared to those nonlactating and low energy-fed cows, respectively. Chi-squared analysis showed no difference in conception rates among NL-H (68.4%), L-H (82.4%), NL-L (68.4%), and L-L (68.8%).

Individually comparing cows that did or did not conceive failed to identify any differences in relation to any animal measurements, taken during the experimental period. Simple regression analyses showed very low correlation coefficients, indicating no relationship between conception and body weight (0.01), condition score (0.04), or EBLP changes (0.03).

Treatment groups also did not differ ($P > 0.05$) in (1) days from the beginning of the breeding season to breeding, (2) days from the beginning of the breeding season to conception, (3) number of services per conception, and (4) conception at first service (Table 4).

DISCUSSION

Extremely low planes of nutrition have been shown to result in the cessation of estrous cycles (Joubert 1954, Hale 1975). Weight losses in this experiment (Phase I) averaged only 8% of initial weight. This could partly explain the failure to stop cyclic estrous activity in a higher proportion of animals, as previous work by Hale (1975) where complete cessation of estrus was achieved, only when the animals lost at least 20% of their live weight. Lower weight loss percentages would require a longer period to cease estrous cycles, as occurred in the work by Rakha & Igboeli (1971). Another contributing factor could be the good body condition ($\overline{X} = 10.5$) both groups of animals had when the underfeeding period began.

The conclusion of Oxenreider & Wagner (1971), later confirmed by Wettemann et al. (1978), that ovarian activity is related to the strength of the suckling stimulus and that this phenomenon is probably independent of nutritional influences,

TABLE 3. Mean empty body lipid percentages (EBLP) as affected by lactation and energy level.

Parameter	Lactation status	Energy level[a] High	Energy level[a] Low	Mean
EBLP beginning of Phase II	NL	17.4	17.7	17.5[b]
	L	10.8	10.4	10.6[c]
	Mean	14.1	14.0	
EBLP end of Phase II	NL	21.4	12.2	16.8[b]
	L	13.8	4.1	9.0[c]
	Mean	17.6[d]	8.1[e]	
EBLP changes during Phase II	NL	4.0	-5.5	-0.70
	L	3.0	-6.3	-1.59
	Mean	3.5[d]	-5.9[e]	

[a] About 120% (high) and 50% (low) the recommended TDN levels, based on initial weights.

[b,c] Column means with different superscripts differ ($P < 0.05$).

[d,e] Row means with different superscripts differ ($P < 0.01$).

TABLE 4. Reproductive performance of beef cows as affected by lactation and energy levels.

Parameter	Lactation status	Energy level[a] High	Energy level[a] Low	Mean
Conception rate (%)	NL	68.4	68.4	68.4
	L	82.4	68.8	75.8
	Mean	75.0	68.6	
Days from beginning of breeding period to: Breeding	NL	13.2	10.2	11.8
	L	12.7	12.4	12.6
	Mean	13.0	11.2	
Conception	NL	23.3	17.4	20.4
	L	19.5	19.5	19.5
	Mean	21.3	18.4	
Conception at first service (%)	NL	36.8	47.4	42.1
	L	58.8	43.7	51.5
	Mean	47.2	45.7	
Service per conception	NL	1.68	1.41	1.55
	L	1.29	1.50	1.38
	Mean	1.49	1.45	

[a] About 120% (high) and 50% (low) the recommended TDN levels, based on initial weights.

may explain the negligible lactation effect on reproductive performance of the experimental animals during Phase II. The fact that cows were in late lactation and calves were creep-fed may have reduced the suckling intensity.

The explanation for the clear tendency shown by L-H cows to achieve a higher pregnancy rate may be related to the higher feeding level they were provided and to the background of the nonlactating cows.

The low correlation coefficients observed between conception rate and body weight, condition and body fat clearly suggest that pregnancy was influenced by factors other than changes in these traits. This conflicts with several studies (Wiltbank et al. 1962, Dunn et al. 1969, Corah et al. 1975, Butler 1980) where body weight and condition have been shown to affect reproductive performance.

In the present study, body weight changes did not influence conception rate, although severe losses in the low energy group (0.62 kg/day) and substantial gains in the high energy group (0.32 kg/day) were observed. In the first group, there were cows that lost over 25% of their initial live weight from the beginning of Phase I to the end of Phase II and still conceived. On the other hand, cows on the high energy diet, that gained over 25% of their initial live weight during the same period, were not able to conceive.

The fact that all treatment groups did not differ in terms of reproductive performance also cannot be attributed to insufficient changes in body condition as such changes did follow patterns similar to weight changes. About 40% of open cows were in moderate and good condition (10.0 and over) at the beginning of the breeding period, whereas about 30% of pregnant cows showed condition score of 8.0 less.

The association of highest pregnancy rate with treatments resulting in the least amount of weight and condition loss postpartum (Wiltbank et al. 1962, Butler 1980) or among cows gaining the most weight (Dunn et al. 1969) could not be confirmed in the present study since the cows were in late stage of lactation. The results obtained with late-lactating cows are more in agreement with Bellows & Short (1978) and Corah et al. (1975) where body condition was shown not to affect pregnancy rate.

The concept that a "target body weight" (Lamond 1970) must be attained before pregnancy is likely to take place cannot be supported by the present study. There was no relationship between conception and body weight changes. Mean body weights were similar for open and pregnant cows (400 vs. 404 kg). Also, some cows that conceived were as light as 288 kg, which is approximately 63% of mature weight for this breed.

Significant differences in EBLP during Phase II did not influence conception rate. This conflicts with Butler (1980), where pregnancy rates were significantly higher (84 vs. 45%) for cows with EBLP above 13% as compared to those with EBLP below this value. This suggestion that an EBLP of less than 13% would result in reduced reproductive performance during a restricted breeding season could not be confirmed in the present study. Paradoxically, lactating cows that had EBLP less than 13% ($\overline{X}$ = 10.6) at the beginning of Phase II tended to have a higher pregnancy rate (75.8 vs. 68.4%) than nonlactating cows with EBLP above 13% ($\overline{X}$ = 17.5). Of the 51 cows that conceived in this experiment, 24 (47%) had less than 13% EBLP, whereas among the 20 cows that failed to conceive, 12 (60%) had more than 13% EBLP.

Similar EBLP values for pregnant (14.2) and nonpregnant cows (14.1) also demonstrate no body fat influence on the conception rates observed.

CONCLUSIONS

1. Body fat does not appear to be as important for fertility during late lactation as it is during the early postpartum period.

2. It appears that changes in body weight, condition and body fat have little effect on likelihood of pregnancy in nonlactating and late--lactating beef cows once estrous cycles are reinitiated after parturition.

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