J. Trop. Agric. and Fd. Sc. 33(1)(2005): 107–113

Influence of energy intake during late gestation and early post-calving on reproductive performance of beef cattle

(Kesan pengambilan zat tenaga pada masa akhir bunting dan peringkat awal selepas beranak terhadap prestasi pembiakan lembu pedaging)

H.I. Mohd. Sukri*, M.Y. Nordin** and A. Ahmad*

Key words: beef production, reproductive performance, semi-intensive, energy

Abstract

The effect of energy level in diets of beef cows (at late pregnancy and early lactation) on the reproductive performance was studied. A total of 70 mature Kedah-Kelantan (KK) cows mated to Charolais-KK (CK) crossbred bulls were divided into three treatment groups at late pregnancy and fed concentrate with different energy levels under semi-intensive management system based on *Brachiaria decumbens* grazing. The concentrate feeds, offered at 40% of dry matter intake, contained 13.0 Mcal/kg (Concentrate A), 11.0 Mcal/kg (Concentrate B) and 9.0 Mcal/kg (Concentrate C) of metabolizable energy (ME). The treatments were maintained until 4 months post-calving and cows were returned to the breeding herd after weaning. Data on reproductive performance were recorded for 3 years.

Cows in Concentrates A and B performed better *($p < 0.05$)* than cows in Concentrate C in terms of calving interval and postpartum conception. Calving interval (days) and postpartum conception (days) of cows in Concentrates A, B and C were 396.7 and 126.7; 375.3 and 105.5; and 436.2 and 166.2, respectively. Data collected on body condition score showed that cows in all treatments reduced body scores after calving but improved in the third week postpartum. However, the pre- and postpartum body scores of cows in Concentrate A were relatively higher than cows in Concentrates B and C. This experiment has shown that feeding KK cows at late pregnancy until 4 months of lactation with high energy concentrate (13.0 Mcal/kg, ME) under semi-intensive system of *Brachiaria decumbens* grazing had improved their overall reproductive performance.

Introduction

The major causes of poor reproductive performance in cattle especially in the tropical regions are anoestrus and low fertility which are influenced by nutritional level. A relationship between plane of nutrition and fertility has been documented by various researchers (Zimmerman et al. 1961; Wiltbank et al. 1965; Dunn et al. 1969; Davis et al. 1977). The infertility in cattle is associated with a rapid loss of live weight and condition; especially during periods of high lactational stress. Other investigations have shown affected cows to

*MARDI Station Kluang, P.O.Box 525, 86009 Kluang, Johor, Malaysia
**MARDI Station Bukit Ridan, P.O. Box 62, 26700 Muadzam Shah, Pahang, Malaysia
Authors' full names: Mohd. Sukri Hj Idris, Nordin Mohd. Yusof and Ahmad Aman
E-mail: mshi@mardi.my

exhibit varying degrees of hypoglycaemia and fatty liver.

Restricting dietary intake during late pregnancy and the beginning of lactation reduces reproductive performance of beef cows by delaying return to cyclic oestrus and decreasing fertility (Dunn et al. 1969; Bellows and Short 1978; Williams 1980). The ovarian activity is particularly affected by the diet energy level. Low energy levels seem to lower the ovarian activity, whereas high energy levels seem to increase the ovulation rate markedly.

Several short-term studies on the interaction of nutrition with reproductive performance in beef heifers showed that energy intake influenced birth weight more than protein intake. With prolonged deprivation, discrepancies of approximately 10.0 kg were reported between birth weights from cows with high and low energy intakes. Cyclic ovarian function and expression of oestrus are inhibited by low levels of feeding and acute fasting in heifers.

In beef cows, the induction of anoestrus by low-plane feeding is accompanied by a decrease in the frequency of luteinizing hormone (LH) pulses (Richards et al. 1989). During the last 45 days of pregnancy underfeeding does not significantly affect oestrogen levels, but progesterone level increases proportionally by 0.24. During the first 45 days of lactation, underfeeding decreases the number of cows showing oestrus and significantly decreases both luteinizing hormone (LH) and follicle stimulating hormone (FSH) levels at 5, 15 and 30 days postpartum. A high-energy diet fed chronically (150 d) to heifers is associated with higher serum concentrations of progesterone (P4) as compared with heifers fed maintenance and low-energy diets. The purpose of this study was to evaluate the effects of energy levels in the diet fed to beef cows at late pregnancy and early lactation on the subsequent reproductive performance.

Materials and methods

Experimental treatments and management of animals

A total of 70 mature Kedah-Kelantan (KK) cows were naturally mated to Charolais-KK (CK) crossbred bulls and managed under free-grazing system of *Brachiaria decumbens*. Once diagnosed pregnant, they were separated from the breeding herd to another grazing paddock of pregnant animals. Approximately 70 days before expected calving date, the animals were randomly grouped into three treatments based on the calculated ME contents of the concentrates *(Table 1)* fed to the animals.

The ME values of Concentrates A, B and C were 13.0, 11.0 and 9.0 Mcal/kg of dry matter, respectively. The concentrates were fed at the rate of 40% of estimated daily dry matter intake. Each group was kept in separate pasture paddock of *B. decumbens* with a stocking rate of two animals per hectare. The concentrate was fed to the animals in paddock. The concentrate feeding was maintained until 4 months post-calving

Table 1. Ingredient composition of the concentrate feeds (% dry matter basis)

Ingredient	Concentrate A (low energy)	Concentrate B (medium energy)	Concentrate C (high energy)
Palm kernel cake (PKC)	–	30.0	17.0
Palm oil mill effluent (POME)	–	–	50.0
Wheat pollard	–	37.0	20.0
Maize	88.0	24.0	–
Soya bean meal (SBM)	10.0	6.0	10.0
Urea	1.0	–	–
Vitamin-mineral premixture	1.0	1.0	1.0
Limestone	–	2.0	2.0

at which time calves were weaned and cows returned to the breeding herd.

The mating and management procedures were continuously repeated during the experimental period of 3 years and data on cow reproductive performance and calf growth were recorded. Three CK crossbred bulls were used for mating but only one was used at any time and they were rotated in every 6 months. Cows were palpated at 8th week post-mating and at every 12th week thereafter.

Feed intake and estimated ME per day

Under semi-intensive management system, animals were group-fed with controlled amounts of concentrate feeds (40%) and *B. decumbens* grazing (60%). The ingredient composition of the concentrate feeds is shown in *Table 1*. Concentrates feed ingredients and *B. decumbens* grass were sampled every four months, oven-dried, ground and composited for nutrient composition analysis (AOAC 1980). All diets (concentrate and grass) were formulated to supply adequate protein, vitamins and minerals at the expected rates of feeding based on the Agricultural Research Council (ARC 1981). Late pregnancy (week 4 to 0 prepartum) energy requirement was based on ARC and estimated to be 33.8 Mcal/kg of ME per day.

The use of energy supplement (concentrate) was to reduce the intake of roughage and increase total energy intake. Based on the estimated dry matter intake of 2.5% body weight$^{0.75}$, animals in Concentrate A (high energy), Concentrate B (medium energy) and Concentrate C (low energy) received an amount of feed expected to supply 71.0, 66.2 and 59.3 Mcal of ME per day, respectively.

Body condition scoring

Body condition scoring was described according to the amount of fat tissue cover over the transverse processes of the lumber vertebrae (pin bone) and around the tail head. Cow body condition score was recorded one week before the expected calving date and at every three consecutive weeks after calving. The scoring of the week 1 after calving was done within 24 h after calving. Condition scoring to the nearest 0.50 score was carried out by the same operator at all times.

Determination of postpartum ovarian activity and conception

Postpartum ovarian activity was monitored from the changes of progesterone (P4) concentration in blood plasma taken from 33 cows (11 from each group). Blood samples were collected from the jugular vein in evacuated tubes containing EDTA weekly from day 10 to day 90 postpartum. Blood samples were placed on ice after collection and centrifuged immediately. The plasma was separated and stored at –20 °C until analysed for progesterone concentrations. Plasma progesterone was determined by radio-immunoassay (RIA) using RIA kit supplied by FAO/IAEA. Days to postpartum conception was determined by subtracting 285 days from the subsequent calving interval.

Statistical analysis

Data were analysed by least squares analysis of variance using the general linear model procedure of the Statistical Analysis System (SAS Inst. 1985) for the effect of treatment on the reproductive parameters (intervals from calving to resumption of postpartum ovarian activity and conception and inter-calving intervals), body condition score and on calf growth rate. Means were compared by the least significant difference (LSD) and Chi-square was employed on enumeration data.

Results and discussion

Chemical composition and digestibility of feeds

The concentrate feeds were formulated isonitrogenous and contained an average of 16.7% crude protein and *B. decumbens* had 8.6% *(Table 2)*. The ether extract content in

Table 2. Chemical composition of the concentrate feeds and *Brachiaria decumbens* grass (on DM basis)

	Concentrate A (low energy)	Concentrate B (medium energy)	Concentrate C (high energy)	*Brachiaria decumbens*
Dry matter (%)	89.6	88.4	89.8	28.1
Crude protein (%)	16.7	16.8	16.6	8.6
Ether extract (%)	4.31	3.17	7.32	2.20
Crude fibre (%)	4.44	10.66	14.28	35.00
Nitrogen free extract (%)	73.35	62.67	51.81	53.00
Ash (%)	2.02	4.05	7.02	5.6
Calcium (%)	0.7	0.9	0.9	0.4
Phosphorus (%)	0.3	0.7	0.7	0.2
Metabolizable Energy (Mcal/kg)	13.0	11.4	9.1	7.1
Dry matter digestibility (%)	82.7	76.7	75.0	nd

nd = not determined

Table 3. Effect of energy levels on resumption of postpartum ovarian activity, postpartum conception and calving interval

	Energy levels			
	High	Medium	Low	LSD
Postpartum interval to resumption of ovarian activity (days)	36.7 ± 13.4	37.5 ± 8.2	49.6±20.4	–
Proportion of cows resumed ovarian activity within 60 days postpartum (%)	81.8 (9/11)	63.6 (7/11)	45.4 (5/11)	–
Postpartum interval to conception (days)	126.7a	105.5a	166.2b	10.34
Calving interval (days)	396.7a	375.3a	436.2b	10.33

LSD = Least significant difference for the means
Values with different letter in the same row are significantly different (p <0.05)

Concentrate C was higher than the other concentrate feeds as its ingredients were based mainly on palm oil by-products which were relatively high in lipid. The crude fibre content in Concentrate C was also comparatively higher than the other concentrate feeds, however *B. decumbens* contained the most fibre. The crude fibre content in Concentrates A, B, C and *B. decumbens* were 4.44%, 10.66%, 14.28% and 35.00%, respectively. Nitrogen-free extract (NFE), ME and dry matter (DM) digestibility were comparatively higher in Concentrate A. The NFE percentage in Concentrates A, B, C and *B. decumbens* were 73.35, 62.67, 51.81 and 53.00, respectively. Concentrates A, B and C were formulated to contain high (13.0 Mcal/kg), medium (11.0 Mcal/kg) and low (9.0 Mcal/kg) ME, respectively. The ME in *B. decumbens* was 7.1 Mcal/kg. The results on digestion trials showed that Concentrate A was relatively high in DM digestibility (82.7%) as compared to Concentrate B (76.7%) and Concentrate C (75.0%). As for the percentages of calcium and phosphorus, generally all the concentrate feeds contained higher amount of these minerals than *B. decumbens*.

Resumption of postpartum ovarian activity

The effect of energy levels on postpartum interval to resumption of ovarian activity and proportion of cows resuming ovarian activity within 60 days postpartum is shown in *Table 3*. Cows in the high and medium energy groups had a shorter postpartum interval to resumption of ovarian activity than the low energy group but the difference was not significant (p >0.05). The

Table 4. Effects of energy levels on body condition score

	Energy levels			
	High	Medium	Low	LSD
Area around tail head				
Prepartum	3.44a	3.71a	3.40a	0.13
Postpartum: Week 1	3.56a	3.50a	3.50a	0.16
Week 2	3.42a	3.60a	3.32a	0.14
Week 3	3.61a	3.60a	3.32a	0.13
Area around pin bone				
Prepartum	4.00a	3.42b	4.04a	0.09
Postpartum: Week 1	4.00a	3.62b	3.68ab	0.12
Week 2	3.42a	3.40a	3.32a	0.17
Week 3	3.53a	3.40a	3.32a	0.17

LSD = Least significant difference for the means
Values with different letter in the same row are significantly different (p <0.05)
[1]Body Condition Score was based on grading values of 0 to 5, with 0 the lowest and 5 the highest grades

proportion of cows resumed ovarian activity within 60 days postpartum was markedly higher in the high energy group compared with the low energy group. However, the difference was also not significant. More than half of the cows in the low energy group resumed ovarian activity at beyond 60 days postpartum.

Postpartum conception and calving interval

Both postpartum interval to conception and calving interval in cows on high and medium energy groups were shorter *(p <0.05)* than in cows on low energy diet *(Table 3)*. Postpartum interval was shortest in cows on medium energy diet although not significantly different from that of cows on high energy diet. The results indicated that higher energy concentrates (13.0 and 11.0 Mcal/kg) produced better postpartum reproductive performance in KK cows. Similar results were reported by Zimmerman et al. (1961), Wiltbank et al. (1965) and Davis et al. (1977) who found that reduced energy intake would severely restrict postpartum reproductive performance in cattle, whereas protein restriction would have minimal effect. In the present experiment, all concentrate feeds were isonitrogenous and it was assumed that protein had minimal or no effect on the differences in reproductive performance. About similar trend with lower prepartum energy level was reported by Dunn et al. (1969) that prepartum energy deficiency reduces postpartum reproduction in beef cows.

Body condition score

The concept of body condition scoring as a management aid in beef cattle production has been widely accepted, and it is a good indicator of body energy reserves (Wagner et al. 1988). There was a reduction in body condition scores in cows in all treatments after calving but they showed recovery in the third week postpartum *(Table 4)*. This was in agreement with that of Morrison et al. (1999) who explained that pregnant cows tend to buffer the adverse effects of low plane of nutrition on their developing foetuses by utilizing body reserves resulting in body condition loss.

On the average, cows in high energy group showed relatively higher pre- and postpartum body scores (tail head and pin bone) than cows in the other two groups. However, there was no significant difference between treatments in the tail head pre- and postpartum body score values. But body condition scores at pin bone pre and postpartum (week 1) for the high and low energy groups were significantly higher

(p <0.05) than the medium energy group. The reason for low energy group being better than the medium energy group in body condition scores at pin bone was not known. However, as seen from the pre- and postpartum body condition scores and the postpartum interval to conception and inter-calving interval, there was a tendency for the KK cows to improve in their reproductive performance with increasing ME level in the diet. Body condition scores at calving and at breeding were the most accurate predictors of pregnancy in first-calf cows (DeRouen et al. 1994) and also the most important factors affecting subsequent net calf-crop in mature beef cows (Selk et al. 1988; Morrison et al. 1999).

Conclusion

Higher level of energy had a significant effect on the reproductive performance of KK cows managed under semi-intensive system. On the average the reproductive performance of cows in Concentrates A and B was comparatively better than cows in Concentrate C as shown in their shorter postpartum conception and calving interval. Results on body condition scoring showed that cows in all treatments reduced body scores after calving but all showed improvement in week 3 postpartum. The pre- and postpartum body scores of cows in Concentrate A were relatively higher than cows in Concentrates B and C. However, there was no significant difference between treatments in the pre- and postpartum scores of tail head. But, pre- and postpartum (week 1) scores of pin bone for Concentrates A and C were significantly higher (p <0.05) than Concentrate B. The results on pre- and postpartum body condition scores and the earlier results on postpartum conception and calving interval indicated that there was a tendency for the KK cows to improve their reproductive performance with increasing ME level in the diet. *Plate 1* shows a breeding herd of KK cows with a few crossbred calves grazing on *B. decumbens*.

KK cows and crossbred calves grazing on ***Brachiaria decumbens***

Acknowledgement

The authors would like to extend their thanks to Mr Yunos Ismail of MARDI Station, Serdang for the preparation of the concentrate feeds, the EAEC for providing the kits for progesterone analysis, the MINT, Bangi for the use of hormone laboratory for progesterone analysis and the supporting staff in the Beef Cattle Nutrition Unit, MARDI Station, Kluang for their assistance in data recording and maintenance of the experimental animals.

References

AOAC (1980). *Official Methods of Analysis* (13th ed.). Washington, DC: Association of Official Analytical Chemists

ARC (1981). *The Nutrient Requirement of Livestock: Technical Review.* 2nd ed. Agricultural Research Council. Slough: Common wealth Agricultural Bureaux

Bellows, R.A. and Short, R.E. (1978). Effects of pre-calving feed level on birth weight, calving difficulty and subsequent fertility *J. Anim. Sci. 44:* 1522

Davis, D., Schalles, R.R., Kiracofe, G.H. and Good, D.L. (1977). Influence of winter nutrition on beef cow reproduction. *J. Anim. Sci. 56:* 430

DeRouen, S.M. Franke, D.E., Morrison , D.G., Wyatt, W.E., Coombs, D.E., White, T.W., Humes P.E. and Greene B.B. (1994). Prepartum body condition and weight influences on reproductive performance of first-calf beef cows. *J. Anim. Sci. 72:* 1119–25

Dunn, T.G., Ingalls, J.E., Zimmerman, D.R. and Wiltbank, J.N. (1969). Reproductive performance of 3-year old Hereford and Angus heifers as influenced by pre- and post-

calving energy intake. *J. Anim. Sci. 29:* 719
Morrison, D.G., Spitzer, J.C. and Perkins, J.L. (1999). Influence of prepartum body condition change on reproduction in multiparous beef cows calving in moderate body condition. *J. Anim. Sci. 77:* 1048–54
Richards, M.W., Wetterman, R.P. and Schoenemann, H.M. (1989). Nutritional anestrus in beef cows: body weight change, body condition luteinizing hormone in serum and ovarian activity. *J. Anim. Sci. 67:* 1520–6
SAS (1985). *SAS User's Guide: Statistics,* Version 5 ed. 956 p. Cary, NC: SAS Inst. Inc.
Selk, G.E., Wettermann, R.P., Lusby, K.S., Oltjen, J.W., Mobley, S.C., Rasby, R.J. and Garmendia, J.C. (1988). Relationship among weight change, body condition and reproductive performance of range beef cows. *J. Anim. Sci. 66:* 3153–9
Wagner, J.J., Lusby, K.S., Oltjen, J.W., Rakestraw, J., Wettemaun, R.P. and Walters, L.E. (1988). Carcass composition in mature Hereford cows: Estimation and effect on daily ME requirement during winter. *J. Anim. Sci. 66:* 603–12
Williams, R.J. (1980). Effect of energy and protein restriction on postpartum reproductive performance in beef heifers. M. Sc. Thesis. University of Idaho, Moscow
Wiltbank, J.N., Bond, J., Warwick, E.J. Davis, R.E., Cook, A.C., Reynolds, W.L. and Hazen, M.W. (1965). Influence of total feed and protein intake on reproductive performance of the beef female through second calving. *USDA Bulletin No. 1314:* 1
Zimmerman, D.R., Clanton, D.C. and Matsushima, J.K. (1961). Postpartum reproductive performance in beef heifers as affected by protein and energy intake during gestation. *J. Anim. Sci. 20:* 57 (Abstr.)

Abstrak

Kesan tahap kandungan tenaga di dalam makanan lembu induk (semasa bunting akhir sehingga 4 bulan laktasi) terhadap prestasi pembiakan induk telah dikaji. Sebanyak 70 ekor induk baka Kedah-Kelantan (KK) telah dibiakkan dengan penjantan baka Charolais-KK (CK) dan kemudian dibahagikan kepada tiga kumpulan semasa bunting akhir. Setiap kumpulan diberi makanan tambahan yang mengandungi tenaga yang berbeza selain meragut rumput *Brachiaria decumbens* setiap hari. Konsentrat telah diberi berasaskan 40% daripada keperluan bahan kering harian. Kandungan tenaga metabolisme (ME) bagi setiap konsentrat ialah 13.0 Mcal/kg (Konsentrat A), 11.0 Mcal/kg (Konsentrat B) dan 9.0 Mcal/kg (Konsentrat C). Tempoh pemberian konsentrat bermula dari peringkat akhir bunting sehingga 4 bulan laktasi dan induk dikembalikan ke kumpulan pembiakan masing-masing setelah penyapihan. Data prestasi pembiakan direkodkan dalam tempoh uji kaji selama 3 tahun.

Prestasi Konsentrat A dan B adalah lebih baik ($p \leq 0.05$) daripada Konsentrat C dari segi sela kelahiran dan konsepsi lepas beranak. Sela kelahiran (hari) dan konsepsi lepas beranak (hari) bagi Konsentrat A , B dan C masing-masing ialah 396.7 dan 126.7; 375.3 dan 105.5; dan 436.2 dan 166.2. Data keadaan badan lembu selepas beranak pula menurun dalam semua kumpulan tetapi pulih semula selepas 3 minggu melahirkan anak. Namun pada keseluruhannya Konsentrat A menunjukkan keadaan badan sebelum dan selepas beranak yang lebih baik daripada Konsentrat B dan C. Kajian ini menunjukkan pemberian makanan tambahan mengandungi tenaga metabolisme sebanyak 13.0 Mcal/kg kepada induk lembu semasa akhir bunting hingga 4 bulan laktasi dalam sistem separa intensif rumput *Brachiaria decumbens* telah meningkatkan prestasi pembiakan lembu induk KK.

Accepted for publication on 14 September 2004