EFFECT OF BYPASS FAT SUPPLEMENTATION ON PERFORMANCES IN CROSSBRED CATTLE DURING WINTER SEASON

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To study the effect of bypass fat supplementation on physiological, haemato-biochemical, behavioural parameters and milk production of crossbred cattle during winter (12 weeks), 12 crossbred dairy cattle, 4-5 years old, 423±5.9 kg average body weight and producing 12.5±0.3 kg/d of milk were randomly divided into two groups with six animals each group. Animals in the control group (T₁) were fed a basal diet while the animals in the treatment group (T₂) were fed the basal diet supplemented with a bypass fat @ 250 gm/animal/day. The mean of minimum temperature, maximum temperature, wind velocity and wind chill temperature (WCT) ranged from 9.9±0.5 to 17.9±0.8°C, 21.9±0.7 to 26.9±0.5°C, 2.4±0.4 to 4.1±0.5 km/h and 7.9±0.5 to 16.0±0.8°C, respectively. Supplementation of bypass fat significantly (P<0.05) increased the rectal temperature of T₂ (36.3±0.1°C; 38.3±0.1°C) compared with the T₁ (36.1±0.1°C; 37.8±0.1°C) at both 6:00 h and 14:00 h but did not significantly affect the respiration rate or pulse rate. The overall mean milk yield was higher (P<0.05) in T₂ (12.8±0.2 kg/d) than the T₁ (11.3±0.2 kg/d). Haemoglobin, packed cell volume, erythrocytic sedimentation rate, aspartate aminotransferase, alanine aminotransferase, superoxide dismutase, glutathione peroxidase, dry matter intake, water intake and rumination number did not differ significantly between the T₁ and T₂ groups. Thus, it is concluded that supplementation of bypass fat had beneficial effect on crossbred dairy cattle by maintaining the normal rectal temperature and preventing decline in milk production during winter.

Key words: Bypass fat, Crossbred cattle, Haemato-biochemical parameters, Milk production, Physiological parameters

Livestock are adversely affected by the detrimental effects of extreme weather leading to decreased production and reproduction efficiency (Sejian, 2013). The acceptable thermoneutral range varies with breed and production level. The crossbred cattle are more adapted to warm climate than cold climate (McManus *et al.*, 2014) and have a comfort zone of 18.3-23.7°C (Yasothai, 2014) while the zone of comfort for Indian cows is 10-26.7°C (Prasad and Neeraj, 2010).

Cold stress causes reduction in growth rate, feed conversion efficiency and milk secretion in lactating cows causing economic loss to the dairy farmers. Apart from lower critical temperature, cold stress is also described with the help of the Wind Chill Temperature (WCT) index (Angrecka and Herbut, 2015). WCT is the actual temperature felt by the animal (Agarwal and Upadhya, 2013) and it takes into account both air temperature and the effect of wind chill. When the ambient temperature is

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between the lower critical temperature (LCT) and the upper critical temperature (UCT) i.e., thermo-neutral zone, the animal has to invest only a minimum of energy in maintaining its body temperature (Silanikove, 2000). But, when the ambient temperature falls below the LCT, the animal is required to increasingly invest metabolic energy for heat production and the energy available for production diminishes. Unless additional food energy is provided to compensate for increased energy demand in cold environment, availability of metabolizable energy for productive process would be limited.

Feeding of bypass fat can enhance the energy density of the diet (Krishna Mohan and Reddy, 2009) to meet the energy requirement and alleviate problems of negative energy balance (Chalupa *et al.*, 1985). Supplementation of fat to grazing cows increased milk production by 4.5% (1.0 kg/d) compared to control cow (Schroeder *et al.*, 2004), increased body weight gain of pre weaned calves fed during mild winter (Litherland *et al.*, 2014) and also increased the body temperature of cattle exposed to cold conditions (Gaughan and Mader, 2009).

In Jammu the winter temperature occasionally fall below 4°C, possibly leading to cold stress in dairy cattle. Research reports on feeding of bypass fat to ameliorate the effect of cold stress are limited. Therefore, the present study was conducted to evaluate the effect of dietary bypass fat supplementation on physiological and haemato-biochemical parameters, dry matter intake, water intake, rumination number and milk production of crossbred dairy cattle during winter.

MATERIALS AND METHODS

The study was carried out at the Division of Livestock Production and Management, Sher-e-Kashmir University of Agriculture Sciences and Technology, Jammu, India. The protocol of experiment was approved by the Committee for the Purpose of Control and Supervision of

Experiments on Animals (CPCSEA) (No. 862/GO/Re-SL/Bi-L/04). Twelve lactating crossbred cattle, in 3rd lactation, average body weight of 423±5.9 kg and producing 12.5±0.3 kg of milk per day were selected and divided into two groups (T₁ and T₂) consisting 6 animals in each group in a Randomised Block Design. The animals of T₁ group was fed only on basal diet and served as control animals while the animals of T₂ group were fed on basal diet supplemented with bypass fat @ 250 gm/animal/day. Bypass fat manufactured by Guru Anand Dev Veterinary and Animal Science University, Ludhiana was used for the experiment. It comprised of blend of calcium salt of rice bran fatty acids with vitamins. It has 84% bypass fat, 7-8% calcium, vitamin A, D₃, E, biotin, rumen protected niacin and rumen protected choline. Bypass fat was fed mixed with concentrate ration once a day in the evening. The study was conducted for a period of 12 weeks from December, 2017 to February, 2018 after an adaptation period of 2 weeks. All the animals were dewormed with broad spectrum anthelmintic before the beginning of the trial and maintained in a hygienic condition with uniform management practices throughout the experiment.

Housing and feeding management: Animals were housed in well-ventilated brick cemented house with cemented anti-slippery floor and gable roof type. The animals remained in the shed throughout the day and night. During extreme winter the windows were covered with curtains of plastic sheets. Animals were fed twice daily (early noon and evening) with chopped rice straw, wheat straw and green forages fed *ad lib* and concentrate mixture @ 5-6 kg/animal/day. The ingredients of concentrate mixture were crushed maize (40%), wheat bran (37%), groundnut cake (20%), mineral mixture (2%) and salt (1%). The feeding standard of NRC (2001) was followed. Proximate composition of feeds and fodders were done as per the methods of AOAC (1990) and presented in Table 1.

Table 1. Proximate composition of feed and fodder (% on DM basis)

Attributes %	Wheat straw	Rice straw	Green berseem	Green oat	Concentrate mixture	Attributes %	Wheat straw
Dry matter (fresh basis)	93.0	93.2	16.1	28.0	95.9	93.0	93.2
Crude protein	4.3	3.0	15.4	9.5	22.5	4.3	3.0
Crude fiber	39.9	37.9	26.3	24.4	7.7	39.9	37.9
Ether extract	0.7	0.9	2.6	2.7	3.5	0.7	0.9
Total ash	9.2	17.4	12.5	9.3	7.1	9.2	17.4
Acid insoluble ash	5.9	6.8	3.5	5.4	2.1	5.9	6.8
Nitrogen free extract	93.0	93.2	16.1	28.0	95.9	93.0	93.2

Microclimatic variables: Maximum and minimum temperature was recorded by using thermometer (Six's®) in degree Celsius (°C) at 06:00 h daily. Wind velocity was measured with the help of anemometer at 06:00 h daily and recorded as km/h. The WCT (°C) was calculated as per Tucker *et al.* (2007), by using the following equation:

$$\text{WCT index} = 13.2 + 0.6215 T_{\text{air}} - 13.17V^{0.16} + 0.3965 T_{\text{air}} V^{0.16}$$

Where, (T) is the temperature of the air and (V) is the velocity of wind.

Physiological parameters: Physiological variables viz., respiratory rate (RR; breaths/minute), pulse rate (beats/minute) and rectal temperature (°C; RT) of individual animals were recorded twice daily in the morning at 06:00 h and afternoon at 14:00 h.

Haemato-biochemical parameters: Blood samples (10 mL/animal) were collected at monthly interval from the jugular vein using two different anticoagulant coated vacutainers. Ethylene diamine-tetra-acetic acid containing blood was used for the estimation of haematological parameters viz., haemoglobin (Hb), packed cell volume (PCV) and erythrocytic sedimentation rate (ESR) by routine haematological methods. Plasma aspartate amino transferase (AST) and alanine amino transferase (ALT) activities were determined using automated biochemistry analyser. Erythrocyte lysate was prepared on the same day for the analysis of oxidative enzymes viz., glutathione peroxidase (GPx) by the method of Hafeman *et al.* (1974) and superoxide dismutase (SOD) using method of Marklund and Marklund (1974). Blood glucose level was estimated using digital glucometer (Dr. Morepen BG-03) at the time of blood collection.

Milk Yield: Milk yield from individual animals were recorded twice daily i.e. 06:00 h and 17:00 h by a weighing machine.

Dry matter intake, water intake and rumination number: Dry matter intake of the individual animal was recorded at monthly interval. The amounts of feed were weighed before offering and residue were collected on next morning. The feed intake was calculated (on dry matter basis) by subtracting the amount of residue left from the amount of total feed offered. Similarly the water intake was estimated by subtracting the amount of residue left from the amount of total water offered. Rumination number (number/5minute) was calculated by abdominal palpation method.

Statistical Analysis: Experimental data were analyzed by one way ANOVA as per the method described by Snedecor and Cochran (1994) using SPSS16.

RESULTS

Microclimatic variables: The mean of minimum temperature, wind velocity and wind chill temperature recorded at 6:00 h (Table 2) during the experiment ranged from 9.9 ± 0.5 to $17.9 \pm 0.8^\circ\text{C}$, 21.9 ± 0.7 to $26.9 \pm 0.5^\circ\text{C}$, 2.4 ± 0.4 to 4.1 ± 0.5 km/h and 7.9 ± 0.5 to $16.0 \pm 0.8^\circ\text{C}$. The mean WCT decreased to minimum in the 6th week of experiment then increased gradually.

Physiological parameters: The mean RT recorded at 06:00 h were sub normal in both T_1 and T_2 throughout the experiment and within the normal range at 14:00 h. Supplementation of

bypass fat significantly ($P<0.05$) increased overall mean RT in T_2 ($36.3\pm0.1^\circ\text{C}$, $38.3\pm0.1^\circ\text{C}$) compared with the T_1 ($36.1\pm0.1^\circ\text{C}$, $37.8\pm0.1^\circ\text{C}$) at both 6:00 and 14:00 h (Table 3). The overall mean RR (Table 3) was higher and the PR (Table 3) lower in T_2 over T_1 at both 6:00 h and 14:00 h but no significant differences were observed between T_1 and T_2 .

Haemato-biochemical parameters: The overall mean of Hb, PCV, and ESR in T_1 and T_2 (Table 4) did not show significant differences. Supplementation of bypass fat lowered the mean values of oxidative enzymes SOD and GPX, and, plasma AST and ALT (Table 4) but no significant difference between their mean were observed.

Blood glucose level (Table 4) was not significant.

Milk production: There was a trend of decrease in milk yield upto the mid of experiment and than an increasing trend was observed till the end of the experiment. Significantly ($P<0.05$) higher milk yield was observed in T_2 than T_1 group from 2nd week of the trial (Table 5). The overall mean milk production (Table 5) of T_2 (12.8 ± 0.2 kg/d) was also significantly higher ($P<0.05$) than T_1 (11.3 ± 0.2 kg/d).

Dry matter intake, water intake and rumination number: The dry matter intake, water intake and rumination number (Table 5) did not differ significantly.

Table 2. Micro climatic variables during the experimental period

Period	Week	Minimum temperature ($^\circ\text{C}$)	Maximum temperature ($^\circ\text{C}$)	Wind velocity (km/h)	WCT ($^\circ\text{C}$)
Dec	1	16.0 ± 0.7	26.0 ± 0.5	2.4 ± 0.4	14.8 ± 0.8
	2	15.4 ± 1.2	23.0 ± 1.0	4.1 ± 0.5	13.3 ± 1.4
	3	16.7 ± 0.5	25.1 ± 0.6	3.0 ± 0.3	15.2 ± 0.7
	4	14.7 ± 0.3	24.6 ± 0.7	2.9 ± 0.3	13.1 ± 0.3
Jan	5	12.1 ± 0.5	21.9 ± 0.7	2.6 ± 0.2	10.5 ± 0.6
	6	9.9 ± 0.5	22.7 ± 0.6	2.7 ± 0.3	7.9 ± 0.5
	7	10.3 ± 0.8	24.9 ± 0.6	2.5 ± 0.3	8.6 ± 0.8
	8	11.7 ± 0.4	23.1 ± 0.8	3.1 ± 0.3	9.7 ± 0.4
Feb	9	13.7 ± 0.6	23.9 ± 0.7	2.9 ± 0.2	11.9 ± 0.8
	10	13.1 ± 0.3	25.9 ± 0.3	2.8 ± 0.3	11.4 ± 0.3
	11	16.3 ± 0.9	24.0 ± 0.6	3.4 ± 0.5	14.7 ± 0.8
	12	17.9 ± 0.8	26.9 ± 0.5	3.0 ± 0.5	16.0 ± 0.8

Table 3: Physiological parameters of experimental crossbred cattle

Attributes	Time	Group	December-January	January-February	February-March	Overall mean
Respiration rate (per minute)	6:00 h	T_1	21.5 ± 0.6	19.7 ± 0.4	22.5 ± 0.5	21.7 ± 0.6
		T_2	21.8 ± 0.5	20.2 ± 0.5	23.8 ± 0.5	22.1 ± 0.5
	14:00 h	T_1	27.0 ± 0.7	25.3 ± 0.5	27.6 ± 0.7	26.8 ± 0.4
		T_2	27.2 ± 0.8	25.9 ± 0.7	27.8 ± 0.6	27.1 ± 0.4
Pulse rate (beats/minute)	6:00 h	T_1	62.3 ± 0.7	62.9 ± 0.7	61.0 ± 0.6	62.3 ± 0.4
		T_2	62.5 ± 0.7	62.9 ± 0.6	61.0 ± 0.6	61.9 ± 0.3
	14:00 h	T_1	70.8 ± 0.6	71.9 ± 0.7	71.3 ± 0.7	71.3 ± 0.2
		T_2	70.6 ± 0.6	71.6 ± 0.8	70.8 ± 0.8	70.9 ± 0.2
Rectal temperature ($^\circ\text{C}$)	6:00 h	T_1	36.2 ± 0.1	35.6 ± 0.1^a	36.4 ± 0.1^a	36.1 ± 0.1^a
		T_2	36.4 ± 0.2	35.9 ± 0.4^b	36.9 ± 0.4^b	36.3 ± 0.1^b
	14:00 h	T_1	37.9 ± 0.2	37.6 ± 0.2^a	37.9 ± 0.2^a	37.8 ± 0.1^a
		T_2	38.2 ± 0.2	38.1 ± 0.2^b	38.4 ± 0.1^b	38.3 ± 0.1^b

Values with different superscript differ significantly ($P<0.05$) between the rows

Table 4. Haemato-biochemical parameters of experimental crossbred cattle

Attributes	Groups	December	January	February	March	Overall
Haemoglobin (g/dL)	T ₁	10.6±0.3	10.7±0.4	11.3±0.3	11.3±0.2	10.9±0.2
	T ₂	10.6±0.2	10.8±0.4	11.3±0.2	11.4±0.2	10.9±0.2
Packed cell volume (%)	T ₁	31.7±0.5	32.3±0.9	32.5±0.9	32.8±0.5	31.9±0.4
	T ₂	31.7±0.4	32.3±0.5	32.6±0.7	32.8±0.5	32.0±0.4
Erythrocyte sedimentation rate (mm/24 h)	T ₁	2.9±0.2	3.0±0.3	3.3±0.2	3.1±0.2	3.0±0.1
	T ₂	3.0±0.3	3.1±0.3	3.3±0.3	3.2±0.3	3.1±0.1
Aspartate amino transferase (IU/L)	T ₁	94.4±1.2	90.6±1.3	87.9±0.6	85.2±0.7	90.9±2.1
	T ₂	94.4±1.3	90.5±1.1	87.8±0.7	85.2±0.9	90.9±1.9
Alanine amino transferase (IU/L)	T ₁	32.2±0.5	34.1±0.8	35.3±1.6	37.1±0.9	33.6±0.9
	T ₂	32.3±0.6	34.2±0.9	35.4±1.1	37.3±0.7	33.7±0.8
Superoxide dismutase (U/mg of protein)	T ₁	16.0±2.5	15.5±1.7	19.1±2.5	19.4±2.5	17.2±1.2
	T ₂	16.2±2.1	15.6±1.7	19.2±2.2	19.4±2.5	17.4±1.1
Glutathione peroxidase (U/mL)	T ₁	3.5±0.6	2.5±0.8	5.0±0.4	5.7±0.5	4.3±0.3
	T ₂	4.4±0.9	2.7±0.5	5.3±0.8	5.8±0.7	4.6±0.4
Glucose (mg/dL)	T ₁	68.3±0.8	69.2±0.7	69.8±0.6	69.3±0.8	68.8±0.4
	T ₂	68.5±0.8	69.3±0.5	70.0±0.6	69.5±0.4	69.0±0.4

Table 5. Milk production (kg/d) of experimental crossbred cattle

Treatments	December-January	January - February	February - March	Overall mean
T ₁	12.0±0.4 ^a	9.2±0.5 ^a	11.9±0.3 ^a	11.3±0.2 ^a
T ₂	13.3±0.5 ^b	10.5±0.6 ^b	14.4±0.4 ^b	12.8±0.2 ^b

Values with different superscript differ significantly (P<0.05) between the rows

DISCUSSION

Microclimatic variables: During the experimental period the WCT was 7.9±0.5 to 16.0±0.8°C which was below the comfort zone of the crossbred dairy cattle as reported by Yasothai (2014). This result indicates stress in the animals during the period of experiment.

Physiological parameters: The increase or decrease in RT is an adaptive response of the animal to maintain homeothermy (Sabuncuoglu, 2004). Subnormal RT recorded in both T₁ and T₂ at 6:00 h indicated stress in experimental animals. Supplementation of bypass fat significantly (P<0.05) increased overall mean RT in T₂ over T₁ at both 6:00 and 14:00 h. Higher RT in dietary fat supplemented group over the control group was also reported by Gaughan and

Mader (2009) and Moallem *et al.* (2010). Cho *et al.* (2014) also reported that high energy diet increased rectal temperature in cattle. The increase (P<0.05) in RT of T₂ might be due higher energy density by bypass fat (NRC, 2001). Higher RR and lower PR were observed in T₂ over T₁ at both 6:00 h and 14:00 h. But there was no significant difference between the mean values which indicated that supplementation of bypass fat has no significant effect on respiration rate and pulse rate.

Haemato-biochemical parameters: Supplementation of bypass fat did not exert any effect on haematological profile (Table 4). This was in agreement with Savsani *et al.* (2013). This revealed that supplementation of bypass fat did not exert any effect on haematological

Table 6. Dry matter intake (kg/d), water intake (L) and rumination number of experimental crossbred cattle

Attributes	Group	December	January	February	March	Overall
Dry matter intake	T ₁	12.8±0.6	13.2±0.8	13.4±0.5	12.5±0.6	12.2±0.3
	T ₂	13.3±0.5	13.3±0.6	13.6±0.3	13.3±0.9	13.3±0.3
Water Intake	T ₁	46.2±1.6	47.1±1.3	46.3±1.4	45.5±1.4	46.2±0.6
	T ₂	46.6±1.5	47.3±1.3	46.8±1.9	45.9±1.7	46.6±0.7
Rumination number (number/5 min)	T ₁	8.7±0.5	9.2±0.5	8.8±0.3	8.5±0.7	8.6±0.3
	T ₂	8.8±0.5	9.5±0.8	9.2±0.4	8.8±0.8	8.9±0.3

profile. Supplementation of bypass fat had no significant effect on SOD, GPX, AST and ALT. Blood glucose level observed between bypass fat treated group and the control group was not significant. This finding is similar to the report of Ranjan *et al.* (2009). Contrary, significantly higher blood glucose level was reported by Waghmare *et al.* (2016) in bypass fat treated group.

Milk production: The trend of milk production corresponded with the WCT. The decrease in milk production might be due the fact that more energy is diverted for maintaining body temperature and less energy was available for milk production. Reduction in milk yield due to cold stress was also reported by Angrecka and Herbut (2015). Significant increase in milk yield by dietary supplementation of bypass fat is in accordance to the findings of Gowda *et al.* (2013) and Wadhwa *et al.* (2012) which may be attributed to the improved energy status due

to supplementation of bypass fat as stated by Naik *et al.* (2009).

Dry matter intake, water intake and rumination number: The dry matter intake, water intake and rumination number (Table 6) did not significantly differ. No significant effect in dry matter intake in bypass fat treated group is in accordance to Mudgal *et al.* (2012).

On the basis of the above observation, it is concluded that supplementation of dietary bypass fat at 250 g per day to lactating crossbred cattle increases the rectal temperature and the milk production and therefore can alleviate the negative effect of cold stress during winter.

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