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Research Article

Effect of Feeding Protected Protein on the Performance of The Body Weight and Physiological Reaction in Crossbred Heifers

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ABSTRACT

An experiment was conducted on 18 crossbred heifers, which were divided into 3 groups of 6 animals each and allotted to three dietary treatments. All the animals were provided wheat straw ad lib. + 5 kg green berseem. During treatment, T1 animals were given untreated GNC, whereas T2 and T3 FA were treated at 0.5 g FA/100 g CP and at 1.0 g FA/100 g CP, respectively, as a source of protein in the concentrate mixture was given. Effects of different dietary treatment groups on average daily DM, CP, DCP and TDN intake were found to be non-significant. The over-all maximum temperature in routine managements treatments was 34.88° C, which was recorded during the experimental period and the minimum temperature recorded was 17.14 oC. The average weekly relative humidity in the morning and evening ranged from 33.0 to 90.0% and 10.0 to 54.0%, respectively and the overall values ranged from 21.5 to 63.5%. The average RH was 30.77% higher in the morning as compared to the evening. Protected protein did not influence the morning and evening rectal temperature. The respiration rate of heifers was significantly ($P<0.05$) higher in T3 as compared to T1. There was a non-significant difference between T2 and T3 on one hand and T2 and T1 on the other. The morning pulse rate was significantly ($P<0.05$) influenced by the treatments. It may be inferred that feeding of formaldehyde -treated GNC increases the supply of essential amino acids without any adverse effect on rumen function, causing significant increase in the growth rate in crossbred heifers.

KEYWORDS: Crossbred Heifers, Growth, Formaldehyde, Berseem, Wheat Straw, Physiological Reaction.

INTRODUCTION

Crop residues, the major roughage feeds available in India, which include straws and stovers that are very inferior in quality, in term of palatability, digestibility and nutrient supply. Oil cakes are short in supply, due to the lower production of oil seeds in the country. Grains are mostly used for human consumption, though due to substantial increase in grain production lately, there areis some scope to divert at least the coarse grains for feeding animals. In India, we need to adopt the technology for feeding undergraded or protected proteins to increase animal productivity. The passive rumen manipulation aimed at reducing ruminal degradation of proteins, fats and starch, by allowing these nutrients to escape rumen as such, and then get digested and absorbed from the lower tract. This forms the basis for bypass nutrient technologies. The aim of these technologies is to increase the efficiency of protein and energy utilization in dairy animals, in order to fully exploit their potential for growth and milk production.

Feeding of formaldehyde treated oil meals generally increases the growth rate of animals. A significant increase in the growth rate was observed on feeding formaldehyde -treated groundnut cake and mustard cake to goat kids (Mudgal and Sengar, 1980; Gupta and Walli, 1987) crossbred calves (Kumar and Walli, 1994) and buffalo calves (Chatterjee and Walli, 2003). The growth rate could be 25-–30% more than the control group.

Atmospheric temperature and humidity are considerablye responsible for the variation in physiological reactions of animals and the reactions varies widely in different breeds and species. High ambient temperature and high

humidity invoke respiration and in turn body temperature to some extent. However, in homeotherms the panting, sweating and evaporative heat loss helps in dissipation of excessive heat gained to maintain the normal homeostasis of the animal. Beakley and Findlay (1955) studied the effect of the environmental temperature and humidity on rectal temperature of calves. They found that rectal temperature of animals rose with increasing environmental temperature and humidity. The animal with the highest normal rectal temperature at 15-–20°C of environmental temperature showed the least change in rectal temperature when exposed to high environmental temperature.

Several experiments on the feeding of groundnut cake to the calves and adult animals shows that their growth, nutrient utilization and health status were not affected adversely. Groundnut cake is also rich in some of the essential amino acids having higher content of lysine, methionine and sulphur- containing amino acids in comparison to other commonly used cakes. However, the major disadvantage in groundnut cake protein is its high degradability in rumen. Therefore, it may be worthwhile to feed this cake in the protected form to improve the utilization of its nutrients for growth and milk production. Formaldehyde has been found to be an efficient and a comparatively cheaper method to protect highly degradable protein sources in rumen. Scanty data are available on feeding of formaldehyde -treated groundnut cake to crossbred heifers. Hence,; the present study was planned to study the "effect of feeding protected protein on the performance of the body weight and physiology reaction in crossbred heifers".

MATERIALS AND METHODS

Experimental animals and rations

Crossbred heifers (18) were randomly divided into 3 groups of 6 animals each in completely randomised randomized design (CRD) on the basis of nearness in their 63 to –104 kg body weight and 8 to –15 months of age. All the animals were provided with wheat straw (Triticum aestivum) ad lib. + 5kg green berseem (Trifoliun alexandrinum. During treatment, the T1 animal were was given untreated GNC, while in treatment T2 and T3 FA treated at 0.5 g FA per 100 g CP treated 1.0 g FA per 100 C P, respectively, as a source of protein in the concentrate mixture. The concentrate mixtures wereprepared by using untreated or treated groundnut cake, barley, wheat bran, mineral mixture and common salt as per the details given in Table 1. The TDN values of concentrate mixture were calculated using the values of ingredients as compiled by Arora (1997). All the heifers were fed as per their requirements (Ranjhan, 1998). The experiment was continued for 150 days. In addition, a digestion trial of 7 days duration was conducted at the end of the experiment to determine the nutritive value (DCP and TDN) of rations. Clean and fresh water was provided to all the animals daily. All other management practices were similar in all the treatment groups. All the animals were fed individually during the entire experimental period. The Data of feed intake wereas recorded for two 2 consecutive days at fortnightly intervals. The samples of feed and residues were analysed for proximate principles (AOAC, 1995).

Table 1.: Ingredients of concentrate mixtures and chemical composition of feeds

Attributes	Concentrate mixtures			Berseem	Wheat straw
	T_1 (control)	T_2 (0.5% FA treated GNC)	T_3 (1.0% FA treated GNC)		
GNC	30	30	30		
Barley	33	33	33		
Wheat bran	35	35	35		
Mineral mixture	1	1	1		
Common salt	1	1	1		
Dry matter (DM)	90.95	90.58	90.05	17.88	90.20
Organic matter (OM)	93.37	93.33	93.35	86.82	89.15
Crude protein (CP)	19.64	19.59	19.62	15.12	3.38
Crude fibre (CF)	8.25	8.17	8.14	24.96	32.90
Ether extract (EE)	4.63	4.60	4.56	2.20	1.14
Nitrogen free e xtract (NFE)	60.85	60.97	61.03	44.54	51.73
Total Ash (TA)	6.63	6.67	6.65	13.18	10.85

Body weight

Body weight (kg) of heifers was recorded at the beginning of the experiment and thereafter at fortnightly intervals during the experimental period. The weight was recorded in the morning between 08.00 AM to 09.00 AM before providing water and feed to the animals. These weights were used for computation of ration as well as to study the body weight changes of animals.

Physiological reaction

Meteorological observations like maximum, minimum, dry and wet bulb temperatures of heifers were recorded daily at 08.00 AM and 3.00 PM during the experiments. The relative humidity was calculated from dry and wet bulb thermometer reading using the hygrometric tables (Indian Meteorological Department, Pune). Rectal temperature, respiring rate and pulse rate of heifers were recorded at 09.00 AM and 2.30 PM at fortnightly intervals during the experimental period. The rectal temperature (^{o}C) was recorded by inserting the clinical thermometer in to the rectum and by touching the bulb of the thermometer with the mucosa of rectum for one minute. The respiration rate was recorded by counting the movement of the right flank (counts per minute) of the experimental animals. The pulse rate was measured by palpating the coxccygieal artery (Bhatnagar and Chaudhary, 1960).

Statistical analysis:

The Data were statistically analysed (Snedecor and Cochran, 1980). Treatment means were tested by the critical difference test.

RESULTS AND DISCUSSION

Chemical composition of feeds and fodders

The chemical composition of feeds and fodders (on DM basis) fed to the growing crossbred heifers has been presented in Table 1. The average crude protein content in berseem (Trifolium alexandrinum) and wheat straw (Triticum aestivum) was 15.12 and 3.38% , respectively. The crude protein content of concentrate mixtures T1, T2 and T3 was 19.64, 19.59 and 19.62% respectively. The mean dry matter in berseem and wheat straw was 17.88 and 90.20%, respectively. The dry matter (DM) content of concentrate mixture T1, T2 and T3 was 90.95, 90.58 and 90.05%, respectively. The proximate composition of ingredients used to formulate experimental rations was in general agreement towith the figures given by Arora (1997). The chemical composition of green berseem and wheat straw used in the present study was similar to that reported by Sen and Ray (1971), Arora (1997) and ICAR (1998). The chemical composition of the three concentrates was similar, because all the ingredients were the same and were used in the same proportion in the three concentrate mixtures. Concentrate mixture given to groups T2 and T3 had FA -treated GNC, whereas concentrate mixture given to group T1 has untreated GNC. Treatment of GNC with formaldehyde at 0.5 g/100 g CP (T2) and at 1.0 g /100 g CP did not cause any change in proximate principles to the GNC.

Microclimate

The data on average maximum and minimum temperature and relative humidity are presented in Table 2. The over all maximum temperature in routine management treatment was 34.88 ^{o}C as recorded during the experimental period and the minimum temperature was recorded as 17.14 ^{o}C. The average weekly relative humidity in the morning and evening ranged from 33.0 to 90.0% and 10.0 to 54.0% , respectively, and the overall values ranged from 21.5 to 63.5%. The average RH was 30.77% higher in the morning as compared to the evening. This wide gap in relative humidity was due to frequent water supply and washing of heifers in the morning and the high micturation rate of heifers during nights.

Table 2: Average weekly meteorological data during experimental period in heifers

Weeks	Temperature (°C)			Relative humidity (%)		
	Maximum	Minimum	Average	Morning	Evening	Average
I	27.71±0.58	8.86±0.26	18.28	69	54	61.5
II	25.14±0.37	9.14±0.37	17.14	71	45	58
III	25.57±0.41	8.79±0.26	17.18	84	41	62.5
IV	26.07±0.21	8.93±0.28	17.50	75	29	52
V	22.59±0.53	13.26±1.69	17.92	90	37	63.5
VI	29.83±2.22	19.51±0.88	24.67	77	32	54.5
VII	28.6±1.73	12.77±2.46	20.68	68	28	48
VIII	28.14±1.68	18.93±0.57	23.53	62	34	48
IX	31.17±1.15	21.07±0.36	26.12	60	27	43.5
X	33.57±0.79	24.00±0.92	28.78	54	15	34.5
XI	37.37±1.03	22.73±0.61	30.05	39	17	28
XII	36.21±0.65	25.46±1.33	30.83	45	16	30.5
XIII	33.4±1.40	26.57±0.71	29.98	58	13	35.5
XIV	35.03±1.50	25.71±0.87	30.37	51	15	33
XV	37.71±0.71	25.29±0.88	31.50	36	20	28
XVI	38.74±0.82	23.43±2.00	31.08	39	14	26.5
XVII	39.14±0.49	26.07±1.37	32.60	35	12	23.5
XVIII	39.17±0.71	28.14±0.62	33.65	33	10	21.5
XIX	40.46±0.54	28.70±0.22	34.58	34	13	23.5
XX	41.43±0.97	28.33±0.63	34.88	37	16	26.5
XXI	39.43±0.31	25.00±0.53	32.21	35	18	26.5
Average	**33.17±2.94**	**20.51±3.58**	**26.83±3.17**	**54.86±9.14**	**24.09±6.21**	**39.48±7.28**

Voluntary intake

Average dry matter intake, crude protein intake, digestible crude protein intake, total digestible nutrient intake and water intake under different treatments are depicted in Table 4

The average daily DMI (kg) at fortnightly intervals has been shown in Table 3 and presented graphically in Figure 1.

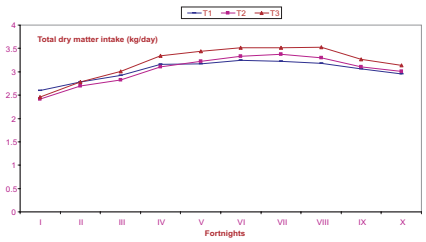

Fig. 1 Average daily dry matter intake (kg/day) at fortnightly intervals of crossbred heifers under different treatments

Table 3.: Average daily dry matter intake (kg) at fortnightly intervals of crossbred heifers under different treatments

Fortnights	Treatments		
	T_1	T_2	T_3
I	2.60±0.26	2.42±0.15	2.46±0.32
II	2.78±0.27	2.70±0.25	2.78±0.30
III	2.92±0.34	2.83±0.32	3.01±0.37
IV	3.16±0.41	3.10±0.38	3.34±0.46
V	3.17±0.30	3.22±0.40	3.44±3.52
VI	3.24±0.30	3.33±0.45	3.52±0.48
VII	3.22±0.32	3.38±0.46	3.51±0.52
VIII	3.18±0.39	3.30±0.57	3.53±0.52
XI	3.06±0.40	3.11±0.53	3.27±0.51
X	2.95±0.43	3.01±0.46	3.14±0.44
Mean	**3.03±0.32**	**3.04±0.39**	**3.20±0.43**

Table 4.: Average daily dry matter intake, crude protein intake (CPI), digestible crude protein intake (DCPI), total digestible nutrient intake (TDNI) and water intake (WI) of crossbred heifers during the experimental period

Attributes	Treatments			
	T_1	T_2	T_3	CD at 5 %
Daily DMI (kg)	3.03±0.32	3.04±0.39	3.20±0.43	NS
DMI per 100 kg B.wt. (kg)	2.52±0.04	2.48±0.05	2.49±0.04	NS
DMI per $W^{0.75}$ (g)	83.28±1.72	82.39±1.60	83.68±2.15	NS
CPI per day (g)	510.94±49.56	495.91±53.27	510.85±54.19	NS
CPI per 100 kg B.wt. (g)	425.24^{a}±10.99	405.75^{ab}±16.88	398.99^{b}±20.82	20.58
CPI per $W^{0.75}$ (g)	14.06^{a}±0.21	13.47^{b}±0.13	13.40^{b}±0.40	0.34
DCPI per day (g)	300.72±30.38	293.34±33.83	302.97±29.85	NS
DCPI per 100 kg B.wt. (g)	250.26±8.63	239.87±10.65	236.90±14.38	NS
DCPI per $W^{0.75}$ (g)	8.28±0.24	7.96±0.21	7.95±0.27	NS
TDNI per day (kg)	1.67±0.19	1.72±0.26	1.81±0.27	NS
TDNI per 100 kg B.wt. (kg)	1.39±0.05	1.40±0.05	1.41±0.04	NS
TDNI per $W^{0.75}$ (g)	45.94±2.00	46.66±2.30	47.29±2.18	NS
Voluntary WI (L)	18.08^{b}±1.55	18.32^{b}±1.47	21.53^{a}±2.83	2.52
WI through feeds (L)	4.34±0.03	4.35±0.04	4.37±0.04	NS
Total WI (L)	22.42^{b}±1.57	22.67^{b}±1.49	25.91^{a}±2.85	2.54
VWI/kg DMI (L)	5.99±0.44	6.09±0.74	6.78±0.88	NS
Total WI/kg DMI (L)	7.44±0.54	7.54±0.89	8.17±0.98	NS

Means of a particular row bearing different superscripts differed significantly (P<0.05) among themselves

The average daily DMI in T1, T2 and T3 was 3.03 ± 0.32, 3.04 ± 0.39 and 3.20 ± 0.43 kg, respectively (Table 4). Non-significant differences were observed in T1, T2 and T3 groups. The DMI of T1, T2 and T3 at 2.52 ± 0.04, 2.48 ± 0.05 and 2.49 ± 0.04 kg per 100 kg body weight was similar to that reported by Mojumdar et al. (1999) and Chatterjee and Walli (2003b). The reasons for non-significant differences in DMI are probably on account of isocaloric and isonitrogenous rations provided to the heifers in different treatment groups. With increase in age, the body weight of heifers also increased resulting in the increase of the dry matter intake.

The crude protein intake of heifers under different treatment groups was non-significant, in respect of CPI (g/d). The present results are in agreement with the findings of Chetterjee (1998) and Singal (2001). While CP intake per 100 kg body weight and per kg metabolic body size were significantly (P<0.05) higher in the present study, which were similar to Singal (2001).); the average daily DCP intake (g/d, per 100 kg body weight as well as per kg metabolic body size) of heifers during experimental period was non-significantly influenced by a different level of protected protein in the ration (Table 4). Similar results were observed by Srivastava and Mudgal (1987) and Ravikumar et al. (2004). Average daily TDN intake as well as TDN intake per 100 kg body weight and per kg metabolic body size was unaffected by treatment groups (Table 4). The results of the present study are comparative with the reports of Bharadwaj et al. (2000) and Mehta and Srivastava (2001).

Water intake

The present results revealed that on feeding different levels of protected protein (GNC) in the ration, heifers of T3 groups consumed a higher amount of voluntary and total water intake(21.53 ± 2.83 and 25.91 ± 2.85 litres) as compared to T2 (18.32 ± 1.47 and 22.67 ± 1.49 litres) and T1 groups (18.08 ± 1.55 and 22.42 ± 1.57 litres) fed group, respectively (Table 4). Similar results were reported by Bharadwaj (1996). Similarly, the differences in voluntary water intake per kg DMI (5.99, 6.09 and 6.78 litre) and total water intake per kg DMI (7.44, 7.54 and 8.17 litre) were non-significant among the treatments. These results are in close agreement with the finding of Singh (1995) and Singal (2001). The water requirements of animals depend upon the kind of feed, the climatic conditions and the nature of protected protein.

Body weight

Average body weights of crossbred heifers under different treatments haves been presented in Table 5. The Data taken at fortnightly intervals under different treatments are depicted in Table 6 and are graphically represented in Figure 2.

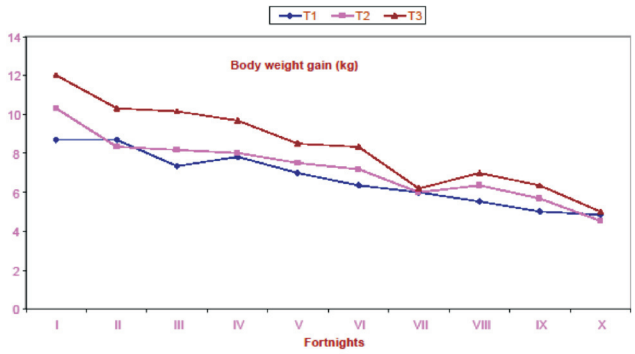

Fig. II Average fortnightly body weight gain (kg) in crossbred heifers, under different treatments

The total body weight gain as well as average daily weight gain was significantly (P<0.01) higher in T3 (83.50 ± 4.50 kg and 556.67 ± 28.18 g) as compared to T2 (72.00 ± 5.02 kg and 480.17 ± 33.55 g) and T1 (67.17 ± 2.71 kg and 447.83 ± 17.99 g) treatments. The present results (Table 5) indicates that all the animals under different treatments received sufficient nutrients as per their requirement for maintenance and growth. The results of the present experiment are in agreement towith the findings of Mehta and Srivastava (2001), Chatterjee and Walli (2003b). However, the present results are contradictory to the finding of Sampath et al. (1996) who did not observe any significant difference in body weight change in animals, which were supplied with a different level of protected protein in the diets.

Table 5.: Mean body weight changes in crossbred heifers

Treatments	Initial body wt. (kg)	Final body wt. (kg)	Mid body wt. (kg)	Total gain in 150 days (kg)	B.wt. gain/ day (g)
T1	86.83±14.96	154.00±13.34	120.42±14.11	67.17^{b}±2.71	447.83^{b}±17.99
T2	86.83±17.24	158.83±19.09	122.83±18.02	72.00^{b}±5.02	480.17^{b}±33.55
T3	87.00±18.03	170.50±20.15	128.75±19.00	83.50^{a}±4.50	556.67^{a}±28.18
CD at 5 %	NS	NS	NS	5.04	33.65

Values in a particular column bearing different superscripts differed significantly (P<0.05) among themselves

Table 6.: Average fortnights body weight gain (kg) in crossbred heifers under different treatments

Fortnights	Treatments		
	T_1	T_2	T_3
I	8.67±1.37	10.33±2.94	12.00±1.09
II	8.67±1.86	8.33±1.03	10.33±1.51
III	7.33±1.37	8.16±1.72	10.17±1.33
IV	7.83±2.23	8.00±0.63	9.67±1.03
V	7.00±2.09	7.50±0.84	8.50±1.05
VI	6.33±1.03	7.17±1.17	8.33±0.82
VII	6.00±1.41	6.00±1.09	6.17±1.33
VIII	5.50±0.84	6.33±1.21	7.00±1.67
IX	5.00±0.89	5.67±1.36	6.33±1.86
X	4.84±1.94	4.51±0.55	5.00±1.26

Physiological reactions

The average rectal temperature, respiration and pulse rate of each group of heifers has been depicted in Table 7. The average rectal temperature, respiration and pulse rate of each group of heifers has been depicted in Table 7, which indicates that the protected protein did not influence the morning and evening rectal temperature. The present results confirm the observation already made by others (Balakrishnan and Nagarcenkar, 1988 and Kumar and Gupta, 1991).

The average respiration rate (counts/minute) in the morning was 24.78 ± 2.12, 26.73 ± 1.53 and 27.98 ± 2.32 counts per minute in T1, T2 and T3, respectively. The respiration rate of heifers was significantly ($P<0.05$) higher in T3 as compared to T1. There was a non-significant difference between T2 and T3 on one hand and T2 and T1 on the other. A similar trend was also observed by Singal (2001), in which protected protein was fed in growing Murrah buffalo heifers. The respiration rate in the T3 group was higher, which might be due to an increase in the temperature and relative humidity (Venugopal et al., 1987).

The pulse rate per minute was also recorded in the morning and evening, given in Table 7, which revealed that the morning pulse rate was significantly ($P<0.05$) influenced by the treatments. The present results are close in agreement with the finding of Singal (2001). Razdan et al. (1968) also observed the change in air temperature, which was found to be the major cause for variation in the pulse rate.

From the results obtained in this study, it is concluded that there is a beneficial effect of feeding FA -treated GNC (1.0 g FA per 100 CP) as such or untreated GNC to crossbred heifers, in terms of increasing their growth rate. The increase in growth rate might be due to the increased supply of amino acids from treated GNC and a better balance of protein and energy for optimum tissue protein synthesis. Formaldehyde treatment of groundnut cake may protect its first limiting amino acids like methionine and lysine in cake, which alone could result in better growth performance. It may be inferred that feeding of formaldehyde- treated GNC increased the post ruminal supply of UDP and consequently the supply of essential amino acids, without any adverse effect on rumen function, causing significant increase in the growth rate in crossbred heifers. There were no significant differences among the treatments in the morning and evening rectal temperature. The average respiration rate was significantly ($P<0.01$) higher in T3 and T2 as compared to T1 groups. However, the morning pulse rate was significantly ($P<0.05$) affected, but the evening and the average pulse rate were not affected by treatment.

Table 7:. Average daily rectal temperature (°C), respiration and pulse rate of crossbred heifers during the experimental period

Parameters	Treatments			
	T_1	T_2	T_3	CD at 5%
Rectal temperature (°C)				
Morning	38.72±0.16	38.76±0.20	38.77±0.31	NS
Evening	38.93±0.22	38.96±0.23	38.98±0.32	NS
Average	38.83±0.16	38.86±0.17	38.88±0.30	NS
Respiration rate/minute				
Morning	24.78^{b}±2.12	26.73^{ab}±1.53	27.98^{a}±2.32	2.48
Evening	30.52^{b}±1.33	32.72^{ab}±2.20	33.90^{a}±2.27	2.43
Average	27.65^{b}±1.38	29.73^{a}±1.38	30.94^{a}±1.95	1.96
Pulse rate/minute				
Morning	61.13^{b}±0.52	61.25^{b}±0.67	62.42^{a}±1.19	1.04
Evening	67.15±2.30	67.98±3.29	68.48±2.58	NS
Average	64.14±1.32	64.62±1.57	65.45±1.53	NS

Values in a particular row bearing different superscripts differed significantly ($P<0.05$) among themselves

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REFERENCES

AOAC 1995. Official methods of Analysis analysis (16th edn.), Association association of official Analytical analytical Chemistschemists, Washington, D.C.

Arora, S.P. 1997. Feeding of dairy cattle and buffaloes. I.C.A.R., New Delhi.

Balakrishnan, M. and Nagarcenkar, R. 1988. Effect of cooling by splashing water, wallowing and mud plaster on buffaloes during summer. Proc. II World Buffalo Congress, New Delhi, India, p. 317.

Beakley, W.R. and Findlay, J.D. 1955. The effect of environmental temperature and humidity on rectal temperature of calves. *J. Agric. Sci.* **45** : 339-–352.

Bharadwaj, A. 1996. Effect of sources of dietary protected protein on lactational performance and rumen metabolic profile in buffaloes. Ph.D. thesis, CCS Haryana Agric. Univ., Hisar, India.

Bharadwaj, A. Sengupta, B.P. and Sethi, R.K. 2000. Effect of feeding rumen protected and unprotected protein on nutrients intake and reproductive performance of lactating buffaloes. *Indian J. Anim. Sci.* **70** (4) : 428-–430.

Bhatnagar, D.S. and Chaudhary, N.C. 1960. Influence of climate on the physiological reactions in Murrah buffalo calves. *Indian Vet. J.* **37** : 404-–408.

Chatterjee, A. 1998. Ruminal and post-ruminal digestibility of formaldehyde treated mustard cake protein and its effect on growth and milk production in Murrah buffaloes. Ph.D. Thesis submitted to NDRI, Karnal.

Chatterjee, A. and Walli, T.K. 2003. Economics of feeding formaldehyde treated mustard cake as bypass protein to growing buffalo calves. *Indian. J. Dairy Sci.* **56** (4) : 241-–244.

Gupta, H.K. and Walli, T.K. 1987. Influence of feeding formaldehyde -treated GN cake and its partial replacement with urea on growth and feed utilization in crossbred kids. *Indian J. Anim. Nutr.* **4** (2) : 94-–99.

ICAR. 1998. Nutrient requirements of livestock and poultry. Handbook by S.K. Ranjhan (2nd revised edn.).

Kumar, D. and Gupta, L.R. 1991. Effect of some summer managemental practices on the growth, physiological and biochemical responses of buffalo calves. *Indian J. Anim. Prod. Mgmt.* **7** (2) : 98-–101.

Kumar, V. and Walli, T.K. 1994. Effect of feeding urea treated wheat straw supplemented with HCHO treated groundnut cake on growth performance of crossbred calves. *Indian J. Anim. Nutr.* **11** (1) : 29-–33.

Mehta, M.K. and Srivastava, A. 2001. Effect of feeding formaldehyde treated barley on nutrient utilization and growth rate in crossbred calves. *Indian J. Anim. Nutr.* **18** (4) : 320-–324.

Mojumdar, A.B., Mahanta, S.K. and Panchauri, V.C. 1999. Performance of female calves fed sorghum silage and concentrate mixture containing formaldehyde treated groundnut cake. *Indian J. Anim. Nutr.* **16** (4) : 336-–340.

Mudgal, V.D. and Sengar, S.S. 1980. Effect of feeding protected and unprotected protein on growth and body composition of goats. *J. Nucl. Agric. Biol.* **9** : 19.

Ranjhan, S.K. 1998. Nutrient requirement of livestock and poultry. Published by . I.C.A.R., New Delhi-3, (2nd revised edn.).

Ravikumar, M., Tiwari, D.P. and Anil Kumar. 2004. Performance of lactating crossbred cows fed different levels of undegradeable dietary protein and plane of nutrition. XI Animal Nutrition Conf., J.N.K.V.V., Jabalpur (M.P.), 5-–7 Jan., 2004, pp. 67.

Razdan, M.N., Bhosrekar, M.R. and Ray, S.N. 1968. Physiological behaviour of Tharparker cattle under different environments II. Physiological reactions and zone of thermoneutrality. *Indian J. Dairy Sci.* **21** : 82.

Sampath, K.T., Prasad, C.S., Sundareshan, K. and Subba Rao, A. 1996. Effect of feeding two levels of undegradable dietary protein (UDP) on growth and nutrient utilization in crossbred female calves. *Indian J. Anim. Nutr.* **13** (1) : 1-–6.

Sen, K.C. and Ray, S.M. 1971. Nutritive value of Indian cattle. Feeds and the feeding of animals. 6th edn. ICAR, Delhi.

Singal, J.S. 2001. Effect of feeding bypass protein and improved managemental practices on growth performance of Murrah buffalo heifers. Ph.D. Thesis Submitted to CCS HAU, Hisar (Haryana), India.

Singh, J. 1995. Influence of enhanced feeding and modified management on growth performance of female buffalo calves. Ph.D. Thesis, CCS Haryana Agric. Univ., Hisar, India.

Snedecor, G.W. and Cochran, W.G. 1980. Statistical methods. 7th Edn. Iowa State University Press, Ames, Iowa.

Srivastava, A. and Mudgal, V.D. 1987. Effect of feeding protected fat to lactating buffaloes on the digestibility of nutrients. *Indian Vet. J.* **64** (1) : 579-–584.

Venugopal, G., Singh, K. and Bhattacharya, N.K. 1987. Cardinal physiological responses in zebu crosses having different levels of Brown Swiss inheritance in Kerela. *Indian Vet. J.* **64** : 388-–394.