RESEARCH ARTICLE

Optimization of Age at Maturity in Surti Buffalo Heifers with Dietary Supplementation of Bypass Protein and Bypass Fat

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Abstract

Surti buffaloes heifers reared under ideal feeding and managemental practices achieve puberty, sexual maturity and first calving at the optimum desired age and body weight. In growing heifers during first parity, requirement of high plane of nutrition is obvious to meet the demands of body growth of dam, growth of fetus, and galactopoetic functions. This study was aimed to find out the effect of feeding bypass protein and bypass fat right from the age of puberty up to the age of first successful conception, *i.e.* maturity in Surti buffalo heifers. Sixteen Surti buffalo heifers were allotted in four equal groups (n=4 in each group), *viz*., Control (T-1) fed basal diet following ICAR nutrient requirements, T-2 basal diet + 30 % protein of concentrate mixture replaced with formaldehyde treated guar meal (FTGM), T-3 basal diet + 100 gm bypass fat (BF), and T-4 basal diet + 30 % protein of concentrate mixture replaced with FTGM + 100 gm of BF. All the treatment diets were isonitrogenous. The results revealed that there was beneficial effect of feeding by pass protein and bypass fat along with routine feeding management on growth of heifers in terms of the body wt. gain and reduced age at first conception (maturity) and thereby age at first calving (AFC). AFC reduced to 37.25, 37.87 and 33.37 months, respectively, in T_2, T_3 and T_4 groups respectively; compared to 43.75 months in Control group. Further, the net benefit over control, in the group of heifers fed with FTGM alone and FTGM plus BF groups were 22.90 % and 16.40 % respectively.

Key words: Age at first calving, Bypass fat, Formaldehyde treated guar meal, Maturity, Surti buffalo.

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Introduction

On the basis of our past research data on Surti buffaloes under ideal feeding and managemental practices; age of puberty achieved in heifers was 18-20 months and age at maturity 24-26 months. However, age at first calving reported was 36-42 months, *i.e.* in growing heifers during first parity; requirement of high plane of nutrition is obvious to meet with the demands of body growth of dam, growth of fetus, and galactopoetic functions. Khan and Husain (2007) observed that age at puberty, maturity and first calving in dairy animal has definite relation with body measurement (length, height and heart girth) and body weight gain. Feeding of bypass protein may help to provide the required supply of amino acids to growing animals (Vahora *et al.,* 2012). Gajera *et al.* (2013) also found beneficial effect of bypass protein and bypass fat feeding on body weight gain and reduce cost of feeding per kg live weight gain in Jaffarabadi buffalo heifers. Bharadwaj *et al.* (2000) reported positive impact of feeding bypass nutrients on growth and nutrient utilization of buffalo calves, leading to early age at puberty and maturity. Therefore, present study was planned to evaluate the effect of feeding bypass protein and bypass fat right from the age of puberty up to the age of first successful conception, *i.e.* maturity, and its economics in Surti buffalo heifers.

Materials and Methods

The present experiment was conducted at Surti buffalo farm of RBR Unit of Anand Agricultural University, Anand, Gujarat, India. Total 16 Surti buffalo (*Bubalus bubalis*) heifers of identical age (18-21 months) and body weight (200 kg) were distributed in to four treatment groups (4 heifers/group) for this study. The treatment groups were T1 (Control): basal diet, T2: basal diet + 30% protein of concentrate mixture replaced with protein of formaldehyde treated guar meal (FTGM), T3: basal diet + 100 g bypass fat (BF), and T4: basal diet + 30% protein of concentrate mixture replaced with protein of FTGM + 100 g BF. The basal diet was formulated for nutrient requirements as per ICAR (2013) feeding standard. All the supplemented diets were made isonitrogenous in composition.

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On a daily basis, the voluntary feed intake was recorded, based on voluntary feed intake and composition of feed ingredients, the DM intake and nutrient intake were derived for each heifer in a particular treatment group. At the biweekly interval, body weight (BW) was taken on weighing balance for heifers of all the groups in the morning before feeding. The average daily b.wt. gain, biweekly b.wt. gain, and cumulative b.wt. gain were worked out accordingly. Feed conversion ratio (FCR) was calculated based on BW gain (kg), DM intake (kg), and nutrient intake [CP(g), DCP(g), TDN(kg)] of heifers. The age of sexual maturity (in months) was noted when the heifers shown the first signs of heat (estrus). The economics of feeding was worked out by daily body weight gain and daily feed intake of each animal under all the treatment groups considering the actual price of feed components. The cost-benefit relationship was derived by comparing the outcome of the cost of feeding per kilogram gain in the control group. The data generated were analysed statistically using a statistical package for the social sciences (SPSS, version, 2010).

Results and Discussion

The findings on mean (±SE) values of different parameters studied are presented in Table 1 and 2. From the data available, it seems that there is beneficial effect of feeding by pass protein and bypass fat on growth of heifers in terms of the body weight gain compared to control heifers. The age of maturity in T2, T3 and T4 groups reduced numerically, over the T1 group, but did not differ statistically. The age of maturity and age at first calving were significantly reduced amongst the supplemented groups, *viz.,* T4, T2 and T3, respectively. The T4 group revealed lowest age of maturity in buffalo heifers (23.25±0.25 months). The weight at puberty did not differ significantly, however, the weight at maturity and at first calving were highest ($p<0.05$) in T4 group followed by T2 and T3 groups (Table 1).

Regarding growth performance, final body weight, total body weight gain and gain per day were highest ($p<0.05$) in T4 groups followed by T2 group (Table 1 and 2). Sexual maturity in dairy heifers is determined by the body weight rather than the age of the heifer (Gupta *et al*., 2016; Paul *et al.,* 2020). Under-feeding and imbalanced feed composition is the leading cause of poor growth rate in field conditions and thus delays maturity (Gupta *et al.,* 2016). Feeding of by-pass protein in the heifer's diet, an essential nutrient for growth and development is provided in terms of the amino acids, which are the building blocks for the body and reproduction (Promkot *et al.,* 2007). Plasma or serum proteins are closely related to tissue proteins and are recorded to be essential for the development of endocrine glands, such as pituitary and sex organs (Tiwari *et al*., 2018). Feeding of bypass proteins also leads to better digestibility of dry matter, organic matter, and crude protein in ruminants. It is directed to various macro-micro minerals and bypass fat that positively affect steroidogenesis and follicular growth, and promote early symptoms of ovulatory estrus (Dhami *et al*., 2019).

Table 1: Age and body weight at puberty, maturity and first calving of Surti buffalo heifers in relation to feeding regimens (n=4 each)

	Treatment groups			
Treatment/ Observations	**T_1 Control**	**T_2 C+FTGM**	**T_3 C+BF**	**T_4 C+FTGM+BF**
Age at puberty (months)	20.00 ± 2.12	21.00±2.79	18.50±1.32	19.00±0.64
Age at maturity (months)	34.00^{c}±2.41	27.05^{b}±2.22	27.37^{b}±2.77	23.25^{a}±0.25
Age at first calving (months)	43.75^{c}±2.46	37.25^{b}±2.42	37.87^{b}±0.96	33.37^{a}±0.23
Wt. at puberty (kg)	200.00±1.62	200.88±1.67	199.00±2.65	204.00±2.48
Wt. at maturity (kg)	301.25^{c}±4.19	315.63^{b}±3.46	312.69^{b}±3.04	335.75^{a}±2.95
Wt. at first calving (kg)	370.00^{c}±5.40	397.25^{a}±9.75	385.00^{b}±4.56	402.50^{a}±22.79

Means with different superscripts a,b,c within the row differ significantly at $P<0.05$ level.

Table 2: Advantages of feeding regimens: Reduction in age at maturity and first calving, and increase in body weight and weight gain per day (n=4 each)

Performance / Parameters	**Control**	**Control *Vs.* FTGM**	**Control *Vs.* BF**	**Control *Vs.* FTGM+BF**
Puberty to Maturity				
Age Difference (months)	14.00±1.60	6.06±1.75	8.88±0.92	4.08±0.45
Weight Difference (kg)	101.25±3.94	114.75±2.65	113.69±4.28	131.75±2.17
Difference of Wt. Gain /Day (gm)	375.00±14.59	425.00±9.81	421.06±15.86	487.97±8.05
Maturity to First calving (Gestation period)				
Age Difference (Gestation, months)	10.00±0.80	10.19±0.84	10.50±0.88	10.30±0.82
Weight Difference (kg)	68.75±2.80	81.62±2.40	72.31±3.60	66.75±1.90
Difference of Wt. Gain /Day (gm)	229.16±11.30	266.99±8.40	229.55±12.20	216.00±8.10

Table 3: Performance of Surti buffalo heifers under different feeding protocols (control *Vs.,* FTGM, BF and FTGM+BF)

	Treatment Groups						
Particulars	**T1 (Control)**	**T2 (FTGM)**	**T3 (BF)**	**T4 (FTGM+BF)**	**SEm**	**CD (0.05)**	**CV%**
Body weight change and Growth rates							
Initial Body Wt. (kg)	200.00±1.62	200.88±1.67	199.00±2.65	204.00±2.48	2.03	NS	2.26
Final Body Wt. (kg)	301.25^{c}±4.19	315.63^{b}±3.46	312.69^{b}±3.04	335.75^{a}±2.95	4.42	13.77	3.14
Total Gain (kg/270 days)	101.25^{c}±3.94	114.75^{b}±2.65	113.69^{b}±4.28	131.75^{a}±2.17	3.39	10.59	6.66
Gain /Day (g)	375.0^{c}±14.59	425.0^{b}±9.81	421.06^{b}±15.86	487.97^{a}±8.05	12.58	39.21	6.66
Feed and Nutrient intakes							
DMI (kg)	7.41±0.03	7.08±0.04	7.51±0.02	7.50±0.03	0.08	NS	3.11
CPI (g)	620.62±3.47	541.26±4.31	633.12±2.69	578.40±3.04	18.21	NS	6.85
DCPI (kg)	422.02^{b}±2.36	405.95^{c}±3.01	430.52^{b}±1.83	445.37^{a}±2.35	5.28	16.46	2.78
TDNI (kg)	4.54^{c}±0.02	4.63^{b}±0.02	4.73^{b}±0.01	4.96^{a}±.02	0.04	0.13	2.62
Feed conversion efficiency							
DMI (kg intake/kg gain)	19.76^{c}±0.66	16.66^{a}±0.23	17.84^{b}±0.55	15.37^{a}±0.20	0.55	1.71	8.76
CPI (kg intake/kg gain)	1.66^{c}±0.07	1.28^{a}±0.02	1.51^{b}±0.05	1.19^{a}±0.01	0.07	0.24	12.32
DCPI (kg intake/ kg gain)	1.13^{c}±0.04	0.96^{a}±0.01	1.03^{b}±0.03	0.91^{a}±0.01	0.03	0.11	7.90
TDNI (kg intake/kg gain)	12.10^{c}±0.39	10.89^{a}±0.15	11.23^{b}±0.34	10.16^{a}±0.13	0.26	0.82	6.67
Economics of Feeding							
Total feed cost (Rs./270 days)	20806.42 ±64.30^{c}	18161.47 ±74.49^{d}	24623.02 ±58.00^{a}	22636.58 ±65.89^{b}	65.30	711.00	10.65
Feed cost (Rs./day)	77.07^{c}±0.23	67.26^{d}±0.27	91.20^{a}±0.21	83.84^{b}±0.24	2.09	7.70	10.63
Feed cost (Rs. /kg gain)	205.53^{d}±4.78	158.26^{c}±1.54	216.60^{a}±4.60	171..81^{b}±1.54	7.23	26.18	15.40
Net benefit over control (Rs./ kg gain)	-	47.27 (22.99%)	(-)11.07	33.72 (16.40%)		-	-

*Means with different superscripts a,b,c,d within the row differ significantly at P<0.05.

Performance of Surti buffalo heifers (in terms of feed intake, body weight gain, feed conversion efficiency and feed economics) under different feeding protocols (control *Vs.*, FTGM, BF and FTGM+BF) are depicted in Table 3. The dry matter intake (DMI) was unaffected with dietary supplementation. The crude protein intake (CPI) did not differ significantly; however, the digestible crude protein (DCPI) intake was higher (445.37±2.35 kg) in T4 group and lowest in T2 group. The feed conversion efficiency for DMI, CPI, DCPI and TDNI was better (p<0.05) in T2 and T4 groups. Price of green and dry fodder was considered as per the University rate as dairy farmers mostly use their own green and dry fodder.

Protein fermentation in the rumen prior to enzymatic digestion in the lower tract leads to reduced protein utilization efficiency (Singh *et al.,* 2019). With bypass proteins, the protein availability increased and led to better growth and development. Similar increased in body weight and body weight gain at puberty, maturity and calving were reported on supplementation of bypass protein and bypass fat in heifers (Kumar *et al*., 2018; 2022; Parmar *et al*., 2023). Vahora *et al.* (2012) and Gajera *et al.* (2013) also found beneficial effect of bypass protein and bypass fat feeding on body weight gain and reduce cost of feeding per kg live weight gain in calves.

At the same time age at first conception (maturity) and age at first calving (AFC) were reduced to 23.25 and 33.37 months, respectively. Feeding of bypass protein and bypass protein plus fat from the age of puberty in Surti buffalo heifers in present study lead improvement in weight gain, which results in early onset of maturity and AFC, which economically benefited up to Rs. 47.27 and 33.72 for per kg weight gain in heifers fed with bypass protein and bypass protein plus bypass fat groups, respectively, to the livestock owners.

Conclusion

The study clearly revealed that feeding high plane of nutrition (feeding by pass protein and bypass fat) over routine feeding, significantly (P<0.05) increased weight gain and reduced age at puberty, maturity (23 months) and first calving (33 months), which is ultimately economically beneficial to the farmers to get more calf crop and early onset of milk yield. Further, the net benefit over control (for kg body wt gain) was Rs. 47.27 in heifers fed with bypass protein group. Hence, dairy farmers are recommended to feed bypass protein (30% of total protein requirement) concentrate to Surti buffalo heifers starting from the age of puberty to improve daily weigh gain

(13.30%) and reduce the age at maturity (20.4%), first calving (14.8%), as well as feed cost per each kg in weight gain (23%).

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