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Growth and Feed Conversion Efficiency as Influenced by High Plan of Nutrition in Crossbred Heifers

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A B S T R A C T

Study was planned to evaluate effect of high plan of nutrition on feed intake, growth, feed efficiency and cost of feeding in crossbred heifers (50% Holstein Friesian and 50% Kankrej inheritance). Twenty four crossbred heifers divided in two equal groups having similar body weight and age for twelve period of fifteen days. Heifers were fed concentrate, hybrid napier (Coimbture-3) and sorghum hay to meet nutrient requirement in control and 5-10% higher nutrients in treatment group. Average daily intake of dry matter (DM), total digestible nutrients (TDN), crude protein (CP), ether extract (EE), crude fibre (CF), and nitrogen free extract (NFE) was higher ($p<0.01$) by 0.46, 0.43, 0.23, 0.04, 0.06 and 0.18 kg/day of heifers in high plan of nutrition. The per cent and metabolic body weight basis intake of total digestible nutrients and crude protein was also higher ($p<0.01$). Feeding of high plan of nutrition resulted in 137.53 g/day higher growth rate and 6.03 cm higher heart girth ($p<0.001$) whereas body length and wither height were only numerically ($p>0.05$) improved. Feed conversion efficiency in terms of DM (18.55 vs. 11.39 kg/kg gain) and TDN (10.99 vs. 7.04 kg/kg gain) were improved ($P<0.05$) in treatment groups, suggesting that the nutrient dense diet, efficiently converted to live weight gain. Cost of feeding (59.50 vs. 83.11 Rs./day) was higher ($p<0.001$) and cost of weight gain (176.90 vs. 142.21 Rs./kg weight gain) was lower ($p<0.05$) in high plan group of heifers. In conclusion, feeding high plan of nutrition (6% higher than requirement) results upward manipulation of growth rate with higher nutrients intake, improve feed efficiency and economical (lower) cost of feeding per unit weight gain in crossbred heifers.

Introduction

Accelerated growth rate of dairy heifers is key to early puberty, breeding, and milk production (Gardner *et al.*, 1988) in Holstein dairy breeds. Body growth rate of Holstein heifers must be greater than 800 g/d and less than 1000 g/d (Kertz *et al.*, 1987) for economic and efficient production and reproduction. The higher energy and protein

intake from 2 to 8 wk of age increased parenchymal mass as DNA and RNA in mammary glands of heifer calves without increasing deposition of fat, but increasing energy and protein intake from 8 to 14 weeks of age had no effect on mammary gland development (Brown *et al.,* 2005) as later on pre-pubertal higher energy diet resulted in more fat deposition in mammary tissue which prevent growth of paranchymal mass, and ultimately reduces milk production of cows (Lohakare *et al.,* 2012; Weller *et al.,* 2016). The predicted difference in milk yield per kg of average daily gain was 850 liter of milk for the first lactation, and remained significant for the second and third lactation in Holstein cows.

Average body growth rate reported during year 2016, 2017 and 2018 was 471.76 g/d in crossbred calves having 50% Holstein and 50% Kankrej inheritance (Anonymous, 2019). Relationship of the growth rate with reproduction and milk production data in crossbred heifers having 50% Holstein and 50% Kankrej inheritance is may be rare or not available in literature. The target of feeding is to fulfil nutrient requirement of dairy heifers for desire growth or milk production performances in a cost effective manner. Among all production inputs, feeding alone covers more than 60% hence; improving the utilization efficiency of nutrients in ruminant diet is of special concern. Moreover, this will also help to resolve the environmental impact of animal wastes through lower excretion of nitrogenous end product (Carter and Kim, 2013).

With above facts in mind the study was planned to upward manipulate growth and to improve feed efficiency by higher plan of nutrition in crossbred dairy heifer for six months to evaluate extent of growth rate in crossbred heifers having 50% Holstein and 50% Kankrej inheritance.

Materials and Methods

Experimental heifers were cared as per guidelines of Institute Animal Ethics Committee of College of Veterinary Science and Animal Husbandry, Anand Agricultural University, Anand. Twenty four crossbred heifers were divided in two equal groups having similar body weight (148.83±10.14 vs. 148.10±11.46 kg) and age (297.25±29.84 vs. 296.17±28.27 days). Experiment was carried out for twelve periods of fifteen days (180 days), where all heifers were fed individually to meet nutrients requirements (NRC, 2001) and enhanced plan of nutrition. Control group of heifers fed Concentrate pellet (1.5 kg/day/head), Sorghum hay and Hybrid Napier (Coimbture-3) to meet requirements, whereas treatment group of heifers fed Concentrate mesh (2.0 kg/day/head), Sorghum hay and Hybrid Napier (Coimbture-3) to have 5-10% higher nutrients than requirement. All heifers were fed to acclimatize for fifteen days before start of experiments. All heifers were let loose three hours (8:00 to 11:00) for exercise during which they have free access to clean and wholesome drinking water. Water was also offered during afternoon hours (14:00 to 16:00).

Body weight of heifers was taken on platform weighing balance at fifteen days intervals in morning before feeding and watering. Average growth rate was taken at fifteen days intervals. Heart girth, body length and height at wither (cm) was also taken at fifteen day intervals in morning before feeding and watering.

Feed conversion efficiency in terms of dry matter, crude protein and total digestible nutrients was calculated as dry mater, crude protein and total digestible nutrients (kg) required gaining kilogram body weight. Cost of feeding was calculated based on purchasing price of concentrate and sorghum hay. Price of green fodder produce at fodder farm was taken

as selling price fixed by university. The data on intake, growth, feed efficiency and cost of feeding were analyzed as two way variance (Snedecor and Cochran, 1994).

Results and Discussion

Composition of feed and fodder are given in Table 1. An intake of nutrients were sufficient to meet requirements as per NRC (2001) in control group of heifers (T1) whereas heifers of high plan of nutrients (T2) group were 6 per cent higher than requirement.

Dry matter and nutrients intake

Average daily intake of dry matter and nutrients (Table 2) were significantly ($p<0.001$) higher except crude fibre (CF) which were higher ($p<0.05$). An intake of dry matter (DM), total digestible nutrients (TDN), crude protein (CP), ether extract (EE), crude fibre (CF), and nitrogen free extract (NFE) was higher ($p<0.01$) by 0.46, 0.43, 0.23, 0.04, 0.06 and 0.18 kg/day, respectively in heifers of high plan of nutrition in comparison to control group. This significant higher intake of dry matter and nutrients to heifers was may be due *ad. libitum* feeding of dry sorghum and associative effect of higher feeding of concentrate on sorghum hay. The per cent intake of dry mater was non-significant ($p>0.05$) between treatments, whereas percent intake of total digestible nutrients and crude protein was higher ($p<0.01$) in high plan group in comparison to control group of heifers. Same trend was observed for intake on metabolic body weight. These findings correlate with Barua *et al* (2008) who reported higher dry matter and nutrient intake with high levels of protein in Red Chittagong heifers. Similarly Akhter *et al* (2017) reported improvement in intake of crude protein, digestible crude protein and energy intake of crossbred (Indigenous x 50% Holstein Friesian) bull calves on feeding dense (protein and energy) diet whereas dry matter intake was without effect. Zhang *et al* (2017) reported similar value of dry matter intake (6.3 kg/day) of Holstein heifers on feeding iso-caloric diet with low, medium and high protein diet (10.2, 11.9, and 13.5%, respectively) and difference amongst treatments were non-significant due to restricted feeding.

Growth rate

The data on growth rate was presented in Table 3. The final body weight of heifers on high plan of nutrition was 32.28 kg higher than heifers of control group, whereas total gain was higher by 33.01 kg. Average body weight was significantly ($p<0.001$) higher on account of high plan of nutrition. Feeding on high plan of nutrition resulted in 137.53 g/day higher growth rate ($p<0.001$) and 6.03 cm higher heart girth ($p<0.001$) whereas, body length and height at wither were only numerically ($p>0.05$) improved. Period effect on all parameters except growth rate was also significant ($p<0.001$). An interaction of treatment and period was significant only for average body weight ($p<0.01$) and height at wither ($p<0.001$).

This growth rate was higher than growth rate (471.76 g/d) reported during last three year (2016, 2017 and 2018) at same experimental farm (Anonymous, 2019) where crossbred calves were fed in group. Akhter *et al* (2017) reported linear improvement in growth rate (0.043 to 0.422 kg/d), and heart girth (0.06 to 0.18 cm/d), with increase in diet density (protein and energy) of crossbred (Indigenous x 50% Holstein Friesian) bull calves whereas improvement in body length and wither height were non-significant. Similarly, Gardner *et al* (1988) reported that Holstein heifers fed higher energy during early growth reached breeding size (340 kg) earlier than heifers fed a higher forage to grain ratio (11.3 vs. 12.8 mo

of age) and higher (p<.001) daily gains from birth to 340 kg (0.89 vs. o.78 kg). Average ages at first calving also improved by feeding high energy diet. Even, feeding high quality forages to the control heifers, resulted in an improvement in age at first calving over the average herd. This report was similar in finding on growth rate of crossbred heifers where growth rate was improved even in control group of heifers. Again crossbred calves fed total mixed ration with 50% concentrate + 50% wheat straw, and 50% concentrate + 25% wheat straw + 25% groundnut straw resulted in 564.44, and 675.56 g/day growth, respectively at same experimental farm (Anonymous, 2018); growth rate value and effect of intervention was similar to this finding.

Same finding was reported by Chaudhari (2018) on half replacement of wheat straw with pigeon pea straw in crossbred calves. Zhang *et al* (2017) had also reported higher growth rate (g/d) 955.2 and 970.3 on feeding iso-caloric diet with medium, and high protein diet (11.9 and 13.5%, respectively) in comparison to growth rate (799.9) low protein diet (10.2%) in Holstein heifers.

Feed conversion efficiency and economics

Feed conversion efficiency in terms of DM (kg/kg gain) and TDN (kg/kg gain) were improved (P<0.05) in T_2 groups, these results suggest that the nutrient dense feed efficiently converted in live weight gain as compared to control group (Table 4). Present findings go with Barua *et al* (2008) who reported significant (P<0.05) boost in feed conversion efficiency among the dietary groups supplementing higher level of protein that was @ 15, 20 and 25 % CP over the control group. Similarly, Akhter *et al* (2017) reported improved dry matter conversion efficiency (58.53 to 10.00), protein conversion efficiency (4.39 to 0.92) and energetic efficiency (404.65 to 65.91 MJ MEI/kg body weight gain) on feeing nutrient dens (protein and energy) diet in crossbred (Indigenous x 50% Holstein Friesian) bull calves. In contrary to modern research, Previous works of Umunna *et al* (1980) revealed that increase in protein levels after a certain level declined the feed conversion and Greathouse *et al* (1974) reported higher rate of feed conversion due to rising of protein level without concurrent rising of energy value of diet.

Table.1 Composition of feed and fodder offered to heifers

Parameters (On DM basis)	Feed/Fodder			
	Concentrate pellet	Concentrate mesh	Green Hybrid Napier (Coimbture-3)	Sorghum hay
Crude Protein %	19.66	27.13	9.53	6.16
Ether Extract %	3.41	4.91	1.56	2.11
Crude Fibre %	13.39	13.11	28.65	35.70
Nitrogen Free Extract %	49.45	46.84	45.72	46.91
Total Digestible Nutrients %	75.00	80.00	55.00	55.00
Ash%	14.09	8.01	14.54	9.12
Silica%	4.16	2.59	4.35	4.15
Calcium %	2.25	1.56	1.43	1.09

Table.2 Dry matter and nutrients intake of crossbred heifers

Character	Treatment		P Value		
	T1 (Control)	T2 (High Plan)	T	P	TXP
Intake (kg/day)					
Dry Matter	6.23±0.07	6.69±0.08 (+0.45)	0.000	0.000	0.037
Total Digestible Nutrients	3.69±0.04	4.12±0.05 (+0.43)	0.000	0.000	0.040
Crude Protein	0.64±0.01	0.87±0.01 (+0.22)	0.000	0.000	0.048
Ether Extract	0.14±0.00	0.18±0.00 (+0.04)	0.000	0.000	0.049
Crude Fibre	1.76±0.02	1.82±0.03 (+0.05)	0.049	0.000	0.028
Nitrogen Free Extract	2.93±0.03	3.11±0.04 (+0.18)	0.000	0.000	0.037
Per cent intake (kg/day)					
Dry Matter	2.97±0.02	2.93±0.03 (-0.05)	0.125	0.000	0.001
Total Digestible Nutrients	1.77±0.01	1.81±0.02 (+0.05)	0.023	0.000	0.000
Crude Protein	0.83±0.01	0.79±0.01 (-0.05)	0.000	0.000	0.007
Intake on metabolic body weight (g)					
Dry Matter	112.60±0.60	112.97±0.67 (+0.37)	0.644	0.000	0.003
Total Digestible Nutrients	66.86±0.36	69.90±0.45 (+3.04)	0.000	0.000	0.000
Crude Protein	1.17±0.01	1.49±0.01 (+0.31)	0.000	0.000	0.000

Table.3 Body weight and growth of crossbred heifers

Character	Treatment		P Value		
	T1 (Control)	T2 (High Plan)	T	P	TXP
Body weight Initial (kg)	148.83±10.14	148.10±11.46	NS	--	--
Body weight Final (kg)	277.95±8.67	310.23±13.65 (+32.28)			
Gain in body weight kg	+ 129.12	+ 162.13 (+33.01)			
Av. Body weight (kg)	213.32±3.42	235.49±4.41 (+22.17)	0.000	0.000	0.007
Growth rate g/day	538.02±19.23	675.56±24.22 (+137.53)	0.000	0.992	0.999
Heart Girth cm	139.73±0.85	145.76±1.06 (+6.03)	0.000	0.000	0.077
Body length cm	123.01±0.81	124.80±0.83 (+1.79)	0.071	0.000	0.135
Height at Wither cm	115.45±0.62	116.26±064 (+0.82)	0.234	0.000	0.000

Table.4 Feed conversion efficiency and cost of feeding of crossbred heifers

Character	Treatment		P Value		
	T1 (Control)	T2 (High Plan)	T	P	TXP
Feed Conversion Efficiency					
Dry matter kg/kg weight gain	18.55±1.81	11.39±1.38 (-7.15)	0.002	0.040	0.805
Crude Protein kg/kg weight gain	1.91±0.19	1.49±0.17 (-0.43)	0.088	0.059	0.798
Total Digestible Nutrients kg/kg weight gain	10.99±1.07	7.04±0.84 (-3.96)	0.004	0.044	0.804
Cost of feeding					
Daily cost of feeding Rs./day	59.50±0.61	83.11±0.75 (+23.62)	0.000	0.000	0.049
Cost of feeding Rs./kg weight gain	176.90±17.27	142.21±16.64 (-34.70)	0.015	0.045	0.789

Daily feed cost (Rs./day) was higher ($p<0.001$) and feed cost for weight gain was lower ($p<0.05$) in high plan group of heifers in comparison to control group. Heifers in high plan of nutrition found to be more economically efficient. This finding is in accordance with report of Chaudhari (2018); who indicated reduced ($p<0.05$) cost of feeding (85.85 Vs. 114.85 Rs./kg gain) on replacement of total mixed ration (50% concentrate + 50% wheat straw) with total mixed ration (50% concentrate + 25% wheat straw + 25% pigeon pea straw; *Cajanus cajan*) in crossbred calves having 50% Holstein Friesian and 50% Kankrej inheritance.

The feeding of high plan of nutrition (6% higher) to crossbred heifers resulted in significant higher intake of dry matter, total digestible nutrients, crude protein, ether extract, crude fibre and nitrogen free extract. An intake of total digestible nutrients and crude protein was also significantly higher on per cent and metabolic weight basis.

Growth rate and heart girth were also significantly higher. Feed efficiency in terms of dry matter and total digestible nutrients (kg/kg gain) and cost of weight gain (Rs./kg gain) was improved significantly whereas, daily feed cost (Rs./day) was significant higher under high plan of nutrition. In conclusion, feeding high plan of nutrition (6% higher than requirement) results upward manipulation of growth rate with higher nutrients intake, improve feed efficiency and economical (lower) cost of feeding per unit weight gain in crossbred heifers.

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Author's contribution

SSV and LPM: conceptualized, designed and supervised the study; LPM and HKK: executed the research study and revision of manuscript; SKK and PYG: analyzed data analysis, preparation of manuscript, and revised manuscript.

Conflict of Interest

Author declare no conflict of interest

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