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Precision feeding approach affecting growth, nutrient utilization, feed conversion efficiency and economics of feeding weaned Murrah buffalo calves

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ABSTRACT

The biological value of protein affects the growth of pre-ruminant calves and most deficient (critical) amino acids are methionine and lysine, which have an important role to play in balancing of amino acids for efficient utilization of feed protein (CP). Planning was made to develop economical calf starter for weaned buffalo (*Bubalus bubalis*) calves. Equal-energy calf starters (CS) were prepared with variable protein and amino acid levels, CS1 for control group (26% CP) was made with natural feed ingredients only, while designer CSs for groups CS2 and CS3, had 2 levels of critical amino acids with reduced CP content (21 and 20%, respectively) and fed to 3 groups of 6 calves (age 30 to 45 days and 58.40 kg mean body weight) each for 3 months. Higher growth rate and savings on the cost of feed per kg weight gain was achieved without affecting the digestibility of organic nutrients.

Key words: Buffalo calves, Feed conversion efficiency, Lysine, Methionine, Nutrient digestibility, Precision feeding

India had the highest buffalo population (108.7 million, Department of Animal Husbandry, Dairying and Fisheries 2016–17) in the world. Among the buffalo keeper's activities, practice of the calf to suckle milk is disliked due to costlier rearing preposition and remains a cause of high rate of mortality among male buffalo calves (Shakya *et al*. 2017). However, rearing of calves at the age of 3–4 weeks on early weaning diets seems to be a potential approach. Advantages of this system include reducing feeding cost, less feeding labor and fewer diarrhoea and digestive problems. Deficiency of essential amino acids in early stages of growing phase have shown negative influence on the average daily gain (ADG) and indicated methionine as the primary limiting amino acid, while lysine as second (Zinn *et al*. 2007). Very limited research focused on estimating the requirement of two limiting amino acids with routinely available CS ingredients. Hence, the objective of the present study was to evaluate the optimum requirement of critical amino acids methionine and lysine on early growth-performance of buffalo calves.

MATERIALS AND METHODS

Animals selection and grouping: Before starting the experiment prior approval was obtained for conducting the experiment from the Institute level Animal Ethical Committee (IAEC). Buffalo calves were procured from the Institute's Animal Farm section. Weaned healthy male Murrah buffalo calves (18; around 30 to 45 days of age and 58.40 ± 3.35 kg body weights) were selected and divided equally into 3 groups of 6 each based on their body weight.

Housing and management: Murrah buffalo calves were housed in a well-ventilated, clean, and concrete-floored shed and fed individually. Strict management and hygiene practices were adopted throughout the experimental period. Clean drinking water was provided *ad lib.* twice a day at about 0900h and 1500 h.

Feeds and feeding: Calves were offered calf starter using maize and barley grain, wheat bran, deoiled groundnut cake, cottonseed cake and other supplements as per Table 1.

Calf starter @ 1.5% of the body weight of calves, was fed daily to each calf with 1 kg of available green fodder and *ad lib.* wheat straw. The amount of the concentrate mixture offered was regularly revised fortnightly as per changed body weights of calves. Feeding schedule was similar in all the 3 groups, except the calf starter. Experimental feeding was done for a period of 90 days.

Feed analysis: Calf starters were analysed for different chemical constituents after drying at 60°C and grinding to pass the 1mm screen in a Wiley mill using standard procedures (AOAC 2005 and Van Soest *et al.* 1991).

Body weight gain and digestion trial: Calves were weighed at starting of the experiment and thereafter, at the fortnightly interval (for 2 consecutive days) in the morning

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Table 1. Ingredient composition of different calf starters fed to weaned buffalo calves

Attribute	CS1	CS2	CS3
Maize (kg)	39	30	18
Barley (kg)	-	17.5	38
Wheat bran (kg)	11	11	11
Deoiled GNC (kg)	32	23.5	15
CSC (kg)	15	15	15
Mineral mixture (kg)	2	2	2
Vitamin A, D powder (g)	10	10	10
Salt (kg)	1	1	1
Lysine (g)	-	100	200
Methionine (g)	-	50	100
Cost of calf starter (₹/kg)	20.98	20.04	18.99

CS, Calf starter; GNC, groundnut cake.

Table 2. Chemical composition of different calf starters (%, on dry matter basis) fed to weaned buffalo calves

Nutrient	CS1	CS2	CS3
Dry matter	87.64	88.64	88.71
Organic matter	93.43	91.94	92.99
Ether extract	2.80	2.65	2.75
Crude protein*	25.81	21.32	20.44
		(21.17±0.15)	(20.14±0.30)
Nitrogen free extract	53.00	54.91	59.52
Crude fibre	11.82	13.06	10.28
Total ash	6.57	8.06	7.01
Acid insoluble ash	2.17	2.84	2.25
Neutral detergent fibre	29.36	37.23	43.22
Acid detergent fibre	19.82	16.52	20.19

*Crude protein content includes contribution from amino acids supplements; CS, calf starter.

Table 3. Growth performance (kg) and feed efficiency in weaned buffalo calves fed different calf starters

Attribute	CS1	CS2	CS3	SEM	p-value
Initial body weight	59.6	59.8	58.4	3.35	0.986
Day 15	62.8	63.0	61.8	3.27	0.989
Day 30	64.5	64.6	64.7	3.38	1.000
Day 45	67.4	69.4	68.4	3.64	0.979
Day 60	71.6	72.9	72.4	3.99	0.992
Day 75	74.8	77.4	77.0	4.36	0.971
Day 90 /Final body weight	79.6	82.0	82.4	4.62	0.970
Total weight gain	20.0	22.2	24.0	2.05	0.757
Average daily weight gain (g)	222.22	246.67	266.66	22.81	0.757
Average daily feed intake (g)	1748	1658	1622	53.42	0.543
Feed Efficiency (Feed intake/ Weight gain)	7.87	6.72	6.08	0.78	0.186

CS, Calf starter; CS1 was based on natural feed ingredients, while low protein CS were supplemented with low (CS2) and high (CS3) levels of methionine and lysine.

before offering feed and water throughout the experimental period to assess their growth rate. A 6-day digestion trial was conducted before the termination of experimental feeding following standard procedures (Sastry *et al.* 1999).

Statistical analysis: Data generated in the experiment were analyzed statistically using SPSS (version 16). The comparison was made following General Linear Model with tuckey HSD.

RESULTS AND DISCUSSION

Ingredient and chemical composition of calf starters: Three different calf starters were prepared using maize and barley as major grain sources, wheat bran as a major by-product and groundnut cake and cottonseed cake as protein sources. Details regarding each ingredient are mentioned in Table 1. The chemical composition of 3 different calf starters, CS1, CS2, and CS3 is presented in Table 2. In CS2 and CS3, protein content reduced due to a reduction in the amount of groundnut cake in these 2 groups, while incorporating with critical amino acids methionine and lysine at 2 different levels, as mentioned in Table 2.

Body weight gain and feed efficiency: Total weight gain in calves during an experimental period of 90 days remained comparable among groups (Table 3).

An improvement in average daily gain (ADG) of about 11 and 20% in CS2 and CS3 fed group was observed as compared to control (CS1), though remained statistically comparable (P=0.757). Due to higher ADG in CS2 and CS3 groups, but comparable dry matter intake (P=0.543), feed efficiency remained lower in the treatment groups as compared to control, although, statistically comparable (P=0.186).

Klemesrud *et al.* (2000) also reported nonsignificant (P<0.10) improvement in weight gain due to the feeding of rumen-protected lysine and methionine in steers. Likewise, Khan and Azim (2000) in their study on weaning buffalo calves weighing 42 kg (40–45 kg) fed either solvent extracted cottonseed meal based diet or the same diet supplemented with 0.67% lysine and 0.07% methionine and reported nonsignificant improvement in daily weight gains (0.510 vs 0.478 kg/day). Our results are in contrast with those of prior researchers who obtained a higher live weight gain in heifers on rumen-protected lysine and methionine supplementation (Bindel *et al.* 2000, Gajera *et al.* 2013, Gami *et al.* 2015). Improvements in feed efficiency were reported by Hussein and Berger (1995) in Holstein steers on fortification of the ration with rumen-protected lysine and methionine. The higher biological value of CS2 and CS3 in the present experiment is also indicative of possible reasons for having a higher weight gain on those diets as compared to CS1 inspite of having lower protein content.

Similar to present observations, Huang *et al.* (2015) when fed growing Sika deer with either crude protein appropriate (16.63%) diet or deficient diet (13.77%) supplemented with 2 levels of lysine and methionine and also reported no effect on average daily gain and feed efficiency. Sai *et al.* (2016) also reported a nonsignificant improvement in body weight gain (15.8%) and feed efficiency (12.5%) when rumen-protected lysine and

methionine was fed to Karan Fries calves as compared to control. In a recent study also Torrentera *et al.* (2017) reported no effect on dry matter intake as well as average daily gain in Holstein steer calves due to supplementation of lysine and methionine in a 56-day study.

Digestibility of nutrients: Digestibility of different nutrients remained comparable (P>0.05, Fig. 1) among groups. Although figures of digestibility of nitrogen free extractives (NFE), crude fiber (CF) as well as NDF and ADF, remained numerically higher in the group fed high amounts of critical amino acids (CS2) as compared to rest two groups.

Digestibility of most of the nutrients except NDF remained lower in CS2 fed group as compared to control (CS1). Similar to present findings supplementation of cottonseed meal with lysine and methionine did not (P>0.05) increase the digestibility of dry matter and crude protein in the early weaning cow calves diets at 5th and 9th week of age (Khan *et al.* 2002). Sai *et al.* (2016) reported that digestibility of CP was higher in rumen-protected lysine and methionine fed Karan Fries calves as compared to control, while digestibility of dry matter (DM), organic matter (OM), ether extract (EE), NDF and ADF remained comparable. Gami *et al.* (2015) did not find any effect on CP digestibility when rumen-protected lysine and methionine were supplemented to a diet with 12% CP compared to 14% CP. The results were in agreement with those of Sun *et al.* (2007) who reported that supplementing methionine and lysine did not affect N metabolism and whole tract N digestibility in growing goats.

A meta-analysis reported increased feed intake due to increased dietary protein intake (Lee *et al.* 2012a, 2012b). In contrast, Yang *et al.* (2014) observed similar trends with low CP diet. In the present study, apparent reduction in nutrient digestibility, particularly fiber was suggestive that rumen function was modified due to rumen degradable protein and ammonia deficiency (Allen 2000). Therefore, our data suggested that nutrient digestibility decreased as a consequence of decreased CP. Tomkins and McMeniman (2006) reported that the apparent digestibility of DM, OM and CP decreased when the CP of the diet decreased, which presumably depressed the availability of amino acids and energy. Yang *et al.* (2014) also reported a similar response to protein digestibility when deer were fed with pelleted diets varying in CP content.

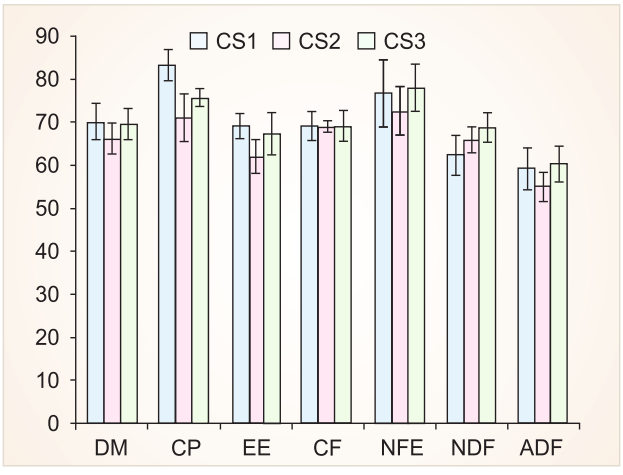

Fig. 1. Digestibility coefficients (%) of organic nutrients in weaned buffalo calves fed different calf starters. CS, Calf starter; DM, dry matter; CP, crude protein; EE, ether extract; CF, crude fibre; NFE, nitrogen-free extract; NDF, neutral detergent fibre; ADF, acid detergent fibre.

Similar to present findings, Khan and Azim (2000) in their study on weaning buffalo calves weighing 42 kg (40–45 kg) fed either solvent extracted cottonseed meal based diet or the same diet supplemented with 0.67% lysine and 0.07% methionine and reported comparable dry matter intake as well as digestibility in 2 groups. Huang *et al.* (2015) when fed growing Sika deer with either crude protein appropriate (16.63%) diet or deficient diet (13.77%) supplemented with 2 levels of lysine and methionine and reported no effect on digestibility of CP, NDF and ADF, while digestibility of dry matter was lower in the group fed low levels of 2 amino acids as compared to control or high levels of two amino acids.

Economics: Cost of calf starters, green fodder, and wheat straw, with details of benefits from intervention, appeared during the complete period of study (90 days) are presented in Table 4. Owing to the lower cost of calf starter and wheat straw intake in amino acid supplemented groups, cost saving was achieved at the rate of about 15 and 25% in buffalo calves fed CS2 and CS3, respectively, as compared to control group (CS1).

Table 4. Cost of feed and benefits of intervention (throughout the study) using different calf starters

Attribute	CS1		CS2		CS3	
	Amount (kg)	Cost (₹)	Amount (kg)	Cost (₹)	Amount (kg)	Cost (₹)
Concentrate consumed per day	1.07	22.45	1.06	21.24	1.06	20.13
Wheat straw consumed per day	0.65	2.83	0.56	2.4	0.52	2.21
Green fodder consumed per day	1.00	3.00	1.00	3.00	1.00	3.00
The total cost incurred per day		28.28		26.64		25.34
Saving on feed cost per day*		-		1.64		2.94
Weight gain per day (g)	222		247		267	
Cost of feed per kg weight gain		127.39		107.85		94.91
Cost saving/kg weight gain*		-		19.54		32.48
% cost saving/kg weight gain*		-		15.34		25.50

CS, Calf starter; CS1 was based on natural feed ingredients, while low protein CS were supplemented with low (CS2) and high (CS3) levels of methionine and lysine; *saving as compared to control group.

CS2 and CS3 fed group showed improvement in the form of economic terms and similar type of findings were also reported by Khan *et al.* (2002) when used lysine and methionine supplementation on a cottonseed meal based diet in cattle calves (₹ 17.92 vs 19.19). Khan and Azim (2000) also reported that feeding of these amino acids supplemented cottonseed meal to buffalo calves gave beneficial results. Sai *et al.* (2016) also reported a reduction in feed cost (₹ 71.77 vs 74.09) for each kg weight gain in rumen-protected lysine and methionine fed Karan Fries calves as compared to control. Zinn *et al.* (2007) conducted studies on Holstein steer calves (114±8 kg) and evaluated the effects of phase feeding metabolizable amino acids (MAA) on growth performance. They concluded that methionine and lysine appear to be the most limiting amino acids during the first feeding phase (56 days).

On the basis of the present findings, it may be concluded that precision feeding in buffalo calves is possible by using most critical amino acids methionine and lysine with beneficial effects on growth performance (11 and 20%) and the economics of feeding (15.34 and 25.50%) without affecting digestibility of nutrients adversely and due to lesser intake of wheat straw the approach will be environment friendly too.

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