STUDIES ON GROWTH, NUTRIENT UTILIZATION, IMMUNE MODULATION, AND ECONOMIC RETURN AT DIFFERENT LEVELS OF PROBIOTIC FEED SUPPLEMENTATION IN KANKREJ FEMALE CALVES

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ABSTRACT

Probiotics, a consortium of benefactor microbes, is administered to young ruminants to invigorate growth and protect gastrointestinal health from the risk of scours. Probiotics are safe alternatives to antibiotic feed additives, which bear the risk of drug resistance in livestock and their residual effect in livestock products. The present experiment was conducted with an objective to evaluate the combined effect of *Lactobacillus sporogenes* and *Saccharomyces cerevisiae* supplementation on growth, nutrient utilization, economic efficiency, and protection from gastroenteritis in Kankrej female calves. The experiment was conducted on eighteen Kankrej female calves averaged 78-120 kg in body weight and 135-240 days in age. The calves were divided into three batches of six calves in each group. They were subjected to three dietary treatments, *viz.,* T_1 (Basal concentrate mixture + mature pasture grass), T_2 (T_1 + probiotic @ 5 gm/day/calf), and T_3 (T_1 + probiotic @ 10 gm/day/calf). The probiotic contained *Lactobacillus sporogenes* (5×10^7 c.f.u. /g) and *Saccharomyces cerevisiae* (1.5×10^8 c.f.u. /g). The animals were under preliminary feeding schedule for 15 days, followed by 90 days of experimental feeding, and seven days of digestion trial. The parameters pertaining to body weight, average daily gain in weight, nutrient intake (gross and digestible), nutrient digestibility, nutrient conversion efficiency, recovery period from diarrhea, and economic return were studied. Probiotic supplementation resulted in significant ($P \leq 0.05$) improvement in body weight, average daily gain in body weight, and nutrient digestibility (DM, OM, and TDN) over T_1 controls, but the groups (T_2&T_3) were statistically at par ($P \geq 0.05$). The recovery period (days) from diarrhea in probiotic supplemented groups (T_2&T_3) were 56% reduced, compared to T_1 control (2.67±1.20) reflecting the immune modulation effects of probiotics. The feed costs (Rs/kg gain in body weight) in probiotic supplemented groups (T_2&T_3) were reduced by 10.2% and 10.5%, respectively, compared to T_1 control (48.16±0.85). It is concluded that supplementation of probiotics improved growth and nutrient utilization resulting in reduced feed cost (INR) per kg weight gain and reduced recovery period from diarrhea at both the levels of supplementation.

KEY WORDS

Economics, Growth, Kankrej calves, Nutrient digestibility, Probiotics

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INTRODUCTION

Probiotics, a consortium of benefactor microbes, particularly *Lactobacillus* bacteria and/or *Saccharomyces* yeast is administered to ruminants to invigorate growth and protect the gastrointestinal health of calves from the risk of scours. *Lactobacilli* help in diminishing the risk of pathogen colonization by installing a healthy intestinal microbiota, while yeast (*Saccharomyces cerevisiae*) is involved in stimulating the growth of cellulolytic bacteria that facilitate fibre digestion and improve dietary starch utilization in the rumen (Denev et al., 2007; Uyeno et al., 2015).

Antibiotics, commonly used as feed additives for promoting growth and preventing gut diseases like gastroenteritis in calves, by reducing pathogenic microbial load and modifying the gut microbiota, are prohibited now-a-days to avert drug resistance and proliferation of antibiotic-resistant bacteria of human significance (Barton, 2000; Mathew et al., 2007; Woolhouse and Ward, 2013).

The mode of action and dose standardization of probiotics are sparse in published literature, and are far from perfection, portraying variable results (Denev et al., 2007). The results of specific research projects, pertaining to the effect of *Saccharomyces cerevisiae* yeast (Singh et al., 1998; Kamra et al., 2002) and *Lactobacillus acidophilus* bacteria (Ramaswami et al., 2005), on growth, feed intake, feed conversion efficiency, and digestibility of nutrients in crossbred (*Bos taurus* x *Bos indicus*) calves failed to project significant ($P \leq 0.05$) improvement over the control, so also the response of bacterial probiotic (*Bacillus subtilis*) and yeast culture combination on growth in Holstein calves (Laborde, 2008).

However, Raval et al. (2013) have reported that supplementation of probiotics containing *Saccharomyces cerevisiae* (1.5×10^8 c.f.u./g) and *Lactobacillus sporogenes* (5×10^7 c.f.u./g) combination @ 15g/d, resulted in significant improvement ($P \leq 0.05$) in DM intake, intake of nutrients (CP and TDN), digestibility of DM and EE, and increase in Fat% and 4% FCM in lactating Kankrej cows, while economic return as percent of feed cost compared to the control was non-significant ($P \geq 0.05$).

The present experiment was conducted with an objective to evaluate the combined effect of *Lactobacillus sporogenes* and *Saccharomyces cerevisiae* supplementation on growth, nutrient utilization, economic return, and gastrointestinal health status in female calves of Kankrej breed.

MATERIALS AND METHODS

Experimental animals: The study was conducted on eighteen growing Kankrej female calves averaged 78-120 kg in body weight and 135-240 days in age, maintained at Livestock Research Station, Sardarkrushinagar Dantiwada Agricultural University, Sardar-krushinagar, Gujarat, during January – April, 2008.

Experimental Protocol: The animals were randomly divided into three experimental groups, based on three ration schedules, *viz.*, T_1 (Basal concentrate mixture + mature pasture grass), T_2 (T_1 + probiotic @ 5 gm/day/calf), and T_3 (T_1 + probiotic @ 10 gm/day/calf). The probiotic contained *Saccharomyces cerevisiae* (1.5 x 10^8 c.f.u. / g) and *Lactobacillus sporogenes* (5 x 10^7 c.f.u. /g).

Feeding Schedule: The animals were under preliminary feeding schedule for 15 days, followed by 90 days of experimental feeding, and seven days of digestion trial. The animals were individually fed as per ICAR feeding standards (ICAR, 1998).

Proximate composition: The samples of feeds, fodders, and faces were analyzed for proximate constituents (Table-1) by the method of AOAC (1999).

Performance analysis: Body weight and measurements (Heart girth, Height at withers, and Body length) were recorded in the morning before feeding and watering. Feed intake was determined on the basis of total feed offered minus feed left over. Nutrient intake with respect to DM, CP, DCP and TDN were worked out, and feed conversion efficiencies in terms of intake of DM, CP, and TDN per kg weight gain (gross and metabolic) were estimated. The recovery periods from diarrhea in the probiotic supplemented and control groups were recorded.

Table-1. Proximate composition (% of DM except DM) of feed offered to Kankrej female calves. (n=18)

Parameters	Concentrate mixture	Mature Pasture Grass
Dry matter (DM)	92.00	92.48
Crude protein (CP)	21.50	02.70
Ether extract (EE)	04.19	02.52
Crude fibre (CF)	09.80	37.42
Nitrogen free extract (NFE)	55.51	48.56
Total Ash	09.00	08.80

Table-2. Body weights, average daily gain in weight, and increase in body measurements of Kankrej female calves in different probiotic treated groups during the experimental period. (n=18)

Parameters	T_1 (Control)	T_2 (Probiotic-5g)	T_3 (Probiotic-10g)	P value
Initial Body Weight (kg)	97.66±6.11	97.33±7.7	97.66±25.78	0.824
Final Body Weight (kg)*	134.67^b±6.24	140.69^a±7.72	141.66^a±8.08	0.004
Av. daily gain in wt. (g/d)*	370^b±8.33	430^a±11.94	440^a±18.25	0.005
Increase in Heart Girth (cm)	12.50±1.37	13.00±1.26	13.83±1.16	0.220
Increase in Height (cm)	12.00±1.41	13.16±0.98	13.50±1.22	0.116
Increase in Body Length (cm)	8.66±0.81	9.16±0.40	9.33±0.51	0.174

Note: *Significant ($P \leq 0.05$). Means with different superscripts in a row differ significantly.

Table-3. Nutrient and digestible nutrient intakes in Kankrej female calves in different probiotic treated groups. (n=18)

Parameters	T_1 (Control)	T_2 (Probiotic-5g)	T_3 (Probiotic-10g)	P value
Water intake (L/d)	7.41 ± 0.41	7.27 ± 0.39	7.85 ± 0.24	0.824
DM intake (kg/d)	3.21±0.77	3.44±0.96	3.55±1.11	0.826
DM intake (g/kg $W^{0.75}$)	94.22±8.58	98.19±12.19	99.59±15.50	0.744
CP intake (g/d)	439.24±97.30	471.17±125.77	483.38±147.34	0.822
CP intake (g/kg $W^{0.75}$)	12.93±1.03	13.50±1.56	13.53±2.00	0.765
DCP intake (g/d)	300.22±64.44	337.47±85.51	360.78±114.16	0.519
DCP intake (g/kg $W^{0.75}$)	8.87±1.02	9.65±1.06	10.08±1.63	0.279
TDN intake (kg/d)	1.88±0.45	1.97±0.59	2.08±0.65	0.838
TDN intake (g/kg$W^{0.75}$)	55.40±5.19	56.64±9.25	58.37±9.17	0.818

Table-4. Nutrient digestibility coefficients (%) of various nutrients in Kankrej female calves in different probiotic treated groups during digestibility trial. (n=18)

Parameters	T_1 (Control)	T_2 (Probiotic-5g)	T_3 (Probiotic-10g)	P value
Dry matter*	56.27^b ± 3.19	60.98^a ± 2.34	61.46^a ± 5.1	0.05
Organic matter*	57.44^b ± 1.63	62.08^a ± 2.18	62.13^a ± 1.66	0.01
Crude Protein	68.50 ± 2.74	71.85 ± 2.56	74.40 ± 1.75	0.12
Crude Fibre	49.99 ± 9.06	52.23 ± 7.2	57.72 ± 3.69	0.83
Ether Extract	69.32 ± 3.09	70.44 ± 5.29	71.23 ± 7.38	0.18
Nitrogen Free Extract*	56.29^b± 2.66	61.92^a ± 2.72	64.71^a± 4.95	0.03

Note: *Significant ($P \leq 0.05$). Means with different superscripts in a row differ significantly.

Table-5. Nutrient conversion efficiency (NCE) of various nutrients, recovery from diarrhoea, and feed cost for kg gain in body weight in Kankrej female calves in different probiotic treated groups. (n=18)

Parameters	T_1 (Control)	T_2 (Probiotic-5g)	T_3 (Probiotic-10g)	P value
DM (kg/kg wt. gain)	7.57±2.14	6.79±2.55	7.38±2.94	0.652
CP (g/kg wt. gain)	1.05±2.22	0.98± 2.68	0.98±3.89	0.825
DCP (g/kg wt. gain)	0.72±1.46	0.70±1.88	0.73±2.05	0.652
TDN (kg/kg wt. gain.)	4.55±1.03	4.13±1.27	4.38±1.72	0.745
Recovery from diarrhoea (d)	2.67±1.20	1.17±0.74	1.17±0.74	0.436
Feed cost (Rs./kg wt. gain)	48.16±0.85	43.25±0.59	43.09±0.35	0.547

Economics: The total feed cost and feed cost per kg gain in body weight were estimated on the basis of the cost of feed consumed.

Statistics: The data were analysed by standard statistical techniques (Snedecor and Cochran, 1989).

RESULTS AND DISCUSSION

Body weights and Measurements: Body weights and measurements depicted in Table-2, have indicated that the final body weights (kg) of the calves in probiotic treated T_2 (140.69±7.72) and T_3 (141.66±8.08) groups were significantly ($P \leq 0.05$) higher than the T_1 control (134.67±6.24). The average daily gain (g/day) of the calves in probiotic treated T_2 (430±11.94) and T_3 (440±18.25) groups were also significantly ($P \leq 0.05$) higher than the T_1 control (370±8.33). However, the probiotic treated groups were statistically at par ($P \geq 0.05$) with each other.

The increases in body measurements (Heart Girth, Height, and Length) during the experimental period were higher in probiotic supplemented T_2 and T_3 groups than in T_1 control, but the differences were non-significant ($P \geq 0.05$).

The study indicated positive influence of probiotics on growth characteristics. This might be due to the positive influence of probiotics in invigorating the metabolic activity of gut microflora, leading to better digestion and absorption of nutrients. This supports the reports of Gilliland et al. (1980), Van Soest (1994), and Timmerman et al. (2005) on body weights and gain in bodyweights due to supplementation of probiotics in calves.

Nutrient Intake

The intake of water, and gross and metabolic intakes of dry matter (DM), and crude protein (CP) are depicted in Table-3.

Water intake: Water intake (liters/day) in the probiotic treated T_2 (7.27±0.39) and T_3 (7.85±0.24) groups were statistically at par ($P \geq 0.05$) with T_1 control (7.41±0.41).

Dry matter intake (DMI): DMI intake (kg/d) in the probiotic treated T_2 (3.44±0.96) and T_3 (3.55±1.11) groups were higher than the T_1 control (3.21±0.77), but were statistically at par with each other ($P \geq 0.05$). DMI intake per unit metabolic body weight (g/kg $W^{0.75}$) per day in the probiotic treated T_2 (98.19±12.19) and T_3 (99.59±15.50) groups were higher than the T_1 control (94.22±8.58), but were statistically at par with each other ($P \geq 0.05$).

Crude protein intake (CPI): CPI intake (g/d) in the probiotic treated T_2 (471.17±125.77) and T_3 (483.38±147.34) groups were higher than the T_1 control (439.24±97.30), but were statistically at par with each other ($P \geq 0.05$). CPI intake per unit metabolic body weight (g/kg $W^{0.75}$) per day in the probiotic treated T_2 (13.50±1.56) and T_3 (13.53±2.00) groups were higher than the T_1 control (12.93±1.03), but were statistically at par with each other ($P \geq 0.05$).

Digestible Nutrient Intake

Digestible nutrient intakes (gross and metabolic) depicted in Table-3 have indicated that DCP (g/d) in the probiotic treated T_2 (337.47 ± 85.51) and T_3 (360.78±144.16) groups were higher than the T_1 control (300.22±64.44), but were statistically at par with each other ($P \geq 0.05$). DCP intake per unit metabolic body weight (g/kg $W^{0.75}$) per day in the probiotic treated T_2 (9.65±1.06) and T_3 (10.08±1.63) groups were higher than the T_1 control (8.87±1.02), but were statistically at par with each other ($P \geq 0.05$).

TDN intake (kg/d) in the probiotic treated T_2 (1.97±0.59) and T_3 (2.08±0.65) groups were higher than the T_1 control (1.88±0.45), but were statistically at par with each other ($P \geq 0.05$). TDN intake per unit metabolic body weight (g/kg $W^{0.75}$) per day in the probiotic treated T_2 (56.64±9.25) and T_3 (58.37±9.17) groups were higher than the T_1 control (55.40±5.19), but were statistically at par with each other ($P \geq 0.05$). Our results conformed to the report of Sievert and Shaver (1993) in lactating dairy cows, while it differed from the report of Raval et al. (2013), who found significant improvement in DM intake ($P \leq 0.01$), and intake of nutrients, *viz.,* CP ($P \leq 0.01$) and TDN ($P \leq 0.05$).

Nutrient Digestibility: The nutrient digestibility coefficient (NDC) of nutrients (%) depicted in Table-4 have indicated that NDC of dry matter intake in the probiotic treated T_2 (60.98±2.34) and T_3 (61.46±5.1) groups were significantly ($P \leq 0.05$) higher than the T_1 control (56.27±3.19), but were statistically at par ($P \geq 0.05$) with each other.

The NDC of organic matter digestibility (%) in the probiotic treated T_2 (62.08±2.18) and T_3 (62.13±1.66) groups were significantly ($P \leq 0.05$) higher than the T_1 control (57.44±1.63), but were statistically at par ($P \geq 0.05$) with each other.

The NDC of nitrogen free extract (%) in the probiotic treated T_2 (61.92±2.72) and T_3 (64.7±4.95) groups were significantly ($P \leq 0.05$) higher than the T_1 control (56.29±2.66), but were statistically at par ($P \geq 0.05$) with each other.

The present findings on DMI corroborate with Raval et al. (2013), while Singh et al. (1998) and Kamra et al. (2002) did not find significant effect of probiotics (yeast cell suspension) on feed intake and nutrient utilization in crossbred calves.

Nutrient Conversion Efficiency (NCE): The NCE (kg of nutrient/kg weight gain) for DM, CP, DCP and TDN are shown in Table-5. The NCE for T_1, T_2, and T_3, respectively, in terms of dry matter intake (7.57±2.14, 6.79±2.55, and 7.38±2.94), crude protein intake (1.05±2.22, 0.98±2.68, and 0.98±3.89), digestible crude protein intake (0.72±1.46, 0.70±1.88, and 0.73±2.05), and total digestible nutrients intake (4.55±1.03, 4.13±1.27, and 4.38±1.72) were statistically at par with each other ($P \geq 0.05$). Our results were similar to the findings of Orr et al. (1988), Fuller (1989), and Cruywagen et al. (1996), but did not agree with Prahalada et al. (2001), who reported better feed conversion efficiency in crossbred calves administered with *Sacchromyces cerevisiae* and *Lactobacillus acidophilus* combination.

Recovery from Diarrhea:

The recovery period of diarrhea (days) depicted in Table-5 in probiotic supplemented T2&T3 groups (1.17±0.74) were less than in T_1 control (2.67±1.20).

It could be due to fact that probiotics produce many kinds of metabolites which arrest the growth and multiplication of many pathogenic bacteria like *E. coli*, *Salmonella* spp, *Staphylococcus aureus* (Hem et al., 2003).

Probiotics are also known to promote barrier effect of the intestine in the young new born animals, thus enhancing disease resistance (Kelly, 1998), thereby reducing metabolic and environmental stresses. The feeding of lactic acid bacteria has shown to reduce incidence of diarrhoea and the number of days on which positive symptoms of diarrhoea were observed in the animals (Das et al., 2001).

Probiotics have the ability to shape the immune system by their physiological action in the intestines. Upon colonising in the gut, they trigger an immune response because the intestinal cells can produce a series of immunoregulatory molecules when stimulated by bacteria (Corcionivoschi et al., 2010).

Economics of probiotic feeding: The feeding of probiotics to animals proved to be beneficial (Table-5). Cost (INR)/kg weight gain in probiotic supplemented T_2 (43.25±0.59) and T_3 (43.09±0.35) groups were 10.2% and 10.5% less respectively over T_1 control (48.16±0.85). Increased ADG coupled with low DMI in probiotic supplemented calves was suggestive of better feed utilization resulting in decrease in cost per kg live weight gain.

Prahalada et al. (2001) have reported that feed conversion efficiency was significantly higher ($P<0.05$) in probiotic supplemented crossbred calves as compared to the control, while Raval et al. (2013) did not find significant return of feed cost in lactating Kankrej cows.

CONCLUSION

Our study indicated that supplementation of probiotics improved growth and nutrient utilization resulting in reduced feed cost (INR) per kg gain in body weight and reduced recovery period from diarrhea at both the levels of supplementation.

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