

## Microbial manipulation of rumen fermentation using *Saccharomyces cerevisiae* as probiotics

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The effect of oral feeding of yeast cell suspension (*Saccharomyces cerevisiae*) on feed intake, growth performance and nutrient utilization was evaluated in six calves of 15-weeks age. The animals were divided into two groups, control and experimental on the basis of body weight. All the calves were fed concentrate mixture and green grass *ad lib*. The yeast cell suspension was fed to calves in the experimental group @  $2 \times 10^9$  CFU/head/day for 105 days. The average daily live weight gain, dry matter, crude protein and crude fibre digestibility were found to be significantly higher ( $p < 0.05$ ) in the experimental group. The rumen bacteria and protozoa population were also found to be higher in the experimental group. The incidence of calf diarrhoea was reduced due to feeding of *S. cerevisiae* in the experimental group when compared to control. The results indicated that there are beneficial effects of oral feeding of yeast cell suspension in the growth performance of calves.

PROBIOTICS are the living organisms, which when supplemented are capable of improving the intake and utilization of nutrients, resulting in increase in the growth and milk yield of host animal<sup>1</sup>. Recently, the use of probiotics to increase the nutrient utilization and growth rate in cattle is gaining popularity. There are a number of studies which provide evidence indicating that live yeast cell can enhance digestive processes associated with micro-organisms in the gastrointestinal tract. Gastrointestinal infection is a serious problem, especially in new born calves. Dietary supplementation of lactic acid producing organisms can be used for prevention or treatment of intestinal disorders. Higher milk yield has been recorded in dairy cows. Increase in live weight gain in growing calves due to addition of live yeast culture in their diet<sup>2</sup>, improvement in dry matter intake<sup>3</sup>, nutrient digestibility<sup>4</sup> and feed conversion efficiency<sup>5</sup> have been reported but in some studies no beneficial effect was observed<sup>6</sup> due to inclusion of yeast culture. However, most of these reports were concerned with the evaluation of proprietary commercial products and inclusion in the feed might not give correct results depending on variation in experimental conditions. Hence, the present investigation was designed to evaluate the effect of oral feeding of *S. cerevisiae* on performance and nutrient utilization in calves under standard management and feeding practices.

Six calves of 15-weeks age were divided into two groups on the basis of body weight. The calves were maintained separately and fed individually. De-worming of all the calves was done before starting the experiment. The calves were fed with the concentrate mixture to fulfil the protein requirement. Grass and drinking water was provided *ad lib*.

*S. cerevisiae* pure culture was procured from the National Collection of Dairy Culture, NDRI, Karnal and maintained by sub-culturing in potato dextrose agar at intervals. Two ml of fresh culture containing  $2 \times 10^9$  C.F.U. of *S. cerevisiae* grown in yeast dextrose broth at  $25 \pm 1^\circ\text{C}$  for 24 h was drenched daily to each calf in the experimental group before feeding.

The dry matter (DM) content of concentrate mixture and grass offered and their residues was estimated daily. Similarly, chemical analysis of concentrate, mixture, grass and residues was done for DM, crude protein (CP), ether extract (EE) and crude fibre (CF) according to standard method<sup>7</sup>. All the calves were weighed at day 1 and thereafter at fortnightly intervals till the completion of the experiment. A digestibility trial was conducted during six days preceding the end of the experiment. A strict vigilance was kept to record the incidence of diarrhoea. Data were analysed statistically for interpretation<sup>8</sup>.

An *in vitro* experiment was conducted for studying the effect of *S. cerevisiae* inclusion in the experimental fermentation flask. The fermentation mixture contained strained rumen liquor (15 ml), concentrate mixture (01 g) and McDowel's buffer (25 ml). Two ml of sterile yeast dextrose broth was added in control and 2 ml of fresh yeast culture containing  $2 \times 10^9$  C.F.U. of live *S. cerevisiae* was added in the experimental flasks. All the fermentation flasks were incubated in a B.O.D orbital shaker (40 rpm) incubator at  $39^\circ\text{C}$  for 24 h in anaerobic conditions.

Data pertaining to the effect of *S. cerevisiae* feeding on the population of bacteria and protozoa are presented in the Table 1. It was observed that the total count of

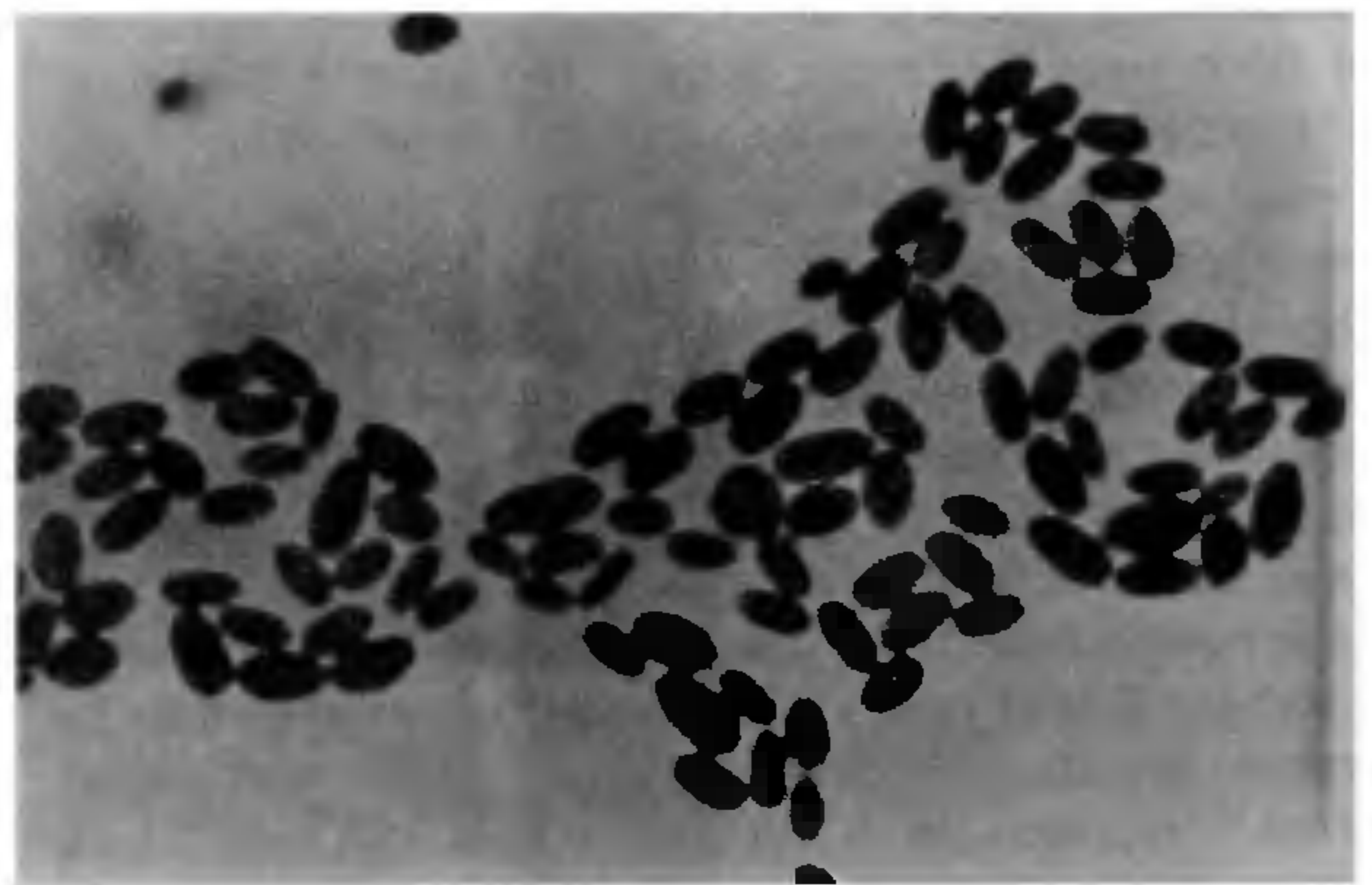


Figure 1. *Saccharomyces cerevisiae* (NCDC-50),  $\times 500$ . Plan-apo-objective.

\*For correspondence.

**Table 1.** Response of ruminal microbial population to yeast culture supplementation

Microbes	Condition	Total counts ( $\times 10^9$ /ml)	
		Control group	Exp. group
Bacteria	<i>in vitro</i>	$0.42 \times 10^9$	$1.22 \times 10^9$
	<i>in vivo</i>	$5.75 \times 10^9$	$8.45 \times 10^9$
Protozoa	<i>in vitro</i>	$0.15 \times 10^5$	$0.45 \times 10^5$
	<i>in vivo</i>	$3.15 \times 10^5$	$6.75 \times 10^5$

**Table 2.** Effect of *S. cerevisiae* feeding on growth, intake of feed and incidence of diarrhoea

Parameter	Control	Experiment
Initial body weight (kg)	$26.23 \pm 0.62$	$25.83 \pm 0.44$
Final body weight (kg)	$66.67 \pm 1.01$	$71.33 \pm 0.65$
Total gain (kg)	40.43	45.50
Average daily gain (g/day)	385	433*
Total DMI (kg)	71.4	76.65
DMI/d (kg)	$0.68 \pm 0.80$	$0.73 \pm 0.15$
DMI/kg gain (kg)	1.76	1.68
Average days in diarrhoea	$7.5 \pm 2.2$	$2.5 \pm 1.1$

\*Significant difference ( $p < 0.05$ ).

bacteria and protozoa was significantly ( $p < 0.05$ ) increased in the experimental group due to inclusion of *S. cerevisiae* than the control group, both in *in vitro* and *in vivo*. A similar trend was also observed by other workers<sup>9,10</sup>.

After 105 days of experimental feeding, the yeast group attained higher ( $p < 0.05$ ) body weight when compared to calves in the control group. Yeast supplementation stimulated the growth rate of the calves (Table 2). Higher growth rate in calves due to feeding live yeast was reported earlier<sup>4,5</sup>. The organism is a rich source of vitamins, enzymes, nutrients and other important co-factors. This could probably stimulate the growth of key rumen microbes. Reduction in ammonia concentration<sup>9,11</sup> in rumen liquor was not as a result of reduced protein degradation or deamination<sup>2</sup> but because of increased utilization by micro-organisms in the rumen which could also be responsible for enhanced microbial population. The increased microbial population, including the yeast introduced, on subsequent passage through lower digestive tract get degraded, becoming a potential source of amino acids for absorption and further utilization in body building processes, thus making a significant increase in growth and yield. The DM intake during supplementation period was significantly higher ( $p < 0.05$ ) than in the control. However, the lower DM intake/kg gain in supplemented group clearly indicated the higher efficiency of feed utilization by yeast-fed group over control. The findings are well supported by the results of other workers<sup>4,12</sup>.

The results of digestibility of nutrients (Table 3) showed that yeast feeding resulted in significantly ( $p < 0.05$ ) higher digestibility of DM, CP and CF. The increase in live weight gain in yeast-fed calves can be explained on the basis of higher DM, CP and CF

**Table 3.** Effect of *S. cerevisiae* feeding on nutrient digestibility (%).

Parameter	Control	Experiment
Dry matter	$56.25 \pm 0.45$	$69.22 \pm 0.22^*$
Crude protein	$62.55 \pm 0.75$	$68.55 \pm 0.25^*$
Ether extract	$66.77 \pm 0.78$	$68.78 \pm 1.25$
Crude fibre	$51.25 \pm 0.56$	$58.75 \pm 0.34^*$
Nitrogen free extract	$68.22 \pm 0.89$	$70.55 \pm 0.26$

\*Significant difference ( $p < 0.05$ ).

digestibility because of enzymes and other co-factors produced by *S. cerevisiae* and better feed conversion efficiency. Also, it was observed that feeding *S. cerevisiae* reduced the occurrence of diarrhoea in experimental calves when compared with the control group. This could be related to low and high net body weight gain in control and experimental calves respectively. There are reports of significant increase in digestibility of CP and CF and reduced incidence of calf diarrhoea<sup>13,14</sup>.

The present results indicated that oral feeding of *S. cerevisiae* to calves resulted in higher growth performance, better nutrient digestibility and also reduced the incidence of calf diarrhoea. No adverse biological consequences have been recorded after regular oral feeding of *S. cerevisiae* in the animals. As probiotic feeding in animals and man is a proven technology worldwide, the present study is of tremendous practical relevance. However, further studies are in progress to understand the mechanism of action, dietary and other factors involved.

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