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ORIGINAL ARTICLE

The Effect of Feeding Bypass Fat and Yeast (*Saccharomyces cerevisiae*) Supplemented Total Mixed Ration on Feed Intake, Digestibility, Growth Performance and Feed Conversion Efficiency in Weaner Surti Kids

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Abstract

The present study was conducted to evaluate the effect of supplementing bypass fat and commercial yeast culture (*Saccharomyces cerevisiae*) on feed intake, digestibility, growth performance and feed conversion efficiency in weaner Surti kids. Twenty four Surti kids were divided into four equal groups of six animals in each group based on age and body weight. The kids were fed TMR with no bypass fat and yeast (T_1); TMR with 2% yeast (T_2); TMR with 2% bypass fat (T_3) and TMR with a combination of 2% each of yeast and bypass fat (T_4) following Completely Randomized Design. A digestion trial of 5 d duration was conducted after 60 days of experimental feeding to assess the digestibility of nutrients. The dry matter intake of experimental kids did not differ significantly (P>0.05). The average digestibility coefficients of nutrients for dry matter (DM), organic matter (OM), crude protein (CP), ether extract (EE), crude fibre (CF), neutral detergent fibre (NDF), acid detergent fibre (ADF) and hemi-cellulose were significantly (P<0.01) higher in T_2 and T_4 groups. The average daily gain in treatment groups differed significantly (P<0.01) from each other. The feed conversion efficiency for dry matter, crude protein, digestible crude protein (DCP) and total digestible nutrient (TDN) was better (P<0.01) in T_2 and T_4 group as compared to T_1 and T_3 group. It is concluded that inclusion of live yeast (*Saccharomyces cerevisae*) and bypass fat at 2% each in TMR (60: 40 concentrate roughage) for weaner Surti kids resulted in better growth, digestibility of nutrients and feed conversion efficiency with 6.66% less feed cost as compared to control group.

Keywords: Bypass fat, Digestibility, Feed conversion efficiency, Growth performance, *Saccharomyces cerevisiae*, Surti kids.

1. Introduction

Goats occupy a significant niche in the rural economy of India. With their inherent qualities of early maturity, ability to thrive even under harsh environment, low capital investment etc. This small ruminant acts as an insurance against crop failure and provides alternative source of livelihood to the farmers all the year round (Selvam and Safiullah, 2002). These animals mostly thrive on grazing of natural grass as well as browsing on shrubs and tree leaves. These feed resources are characterised by low digestibility, low ME and low CP besides poor availability of minerals and vitamins. Moreover, the grazing lands are fast dwindling due to ever growing human population. To address these issues, it is pertinent to formulate total mixed ration (TMR) for intensively managed goats. Total mixed ration, is a practice of weighing and blending all feedstuffs into a nutritionally balanced ration, which provides adequate nourishment to meet the needs of animals to help them achieve maximum performance.

In 1989, Fuller defined the probiotic as "a live microbial feed supplement which beneficially affects the host animals by improving its intestinal microbial balance." A stricter and modern definition was given by Schrezenmeir and De Vrese (2001) who defined probiotics as ‘a preparation of or a product containing viable, defined microorganism in sufficient numbers, which alter the microflora (by implantation or colonization) in a compartment of the host and by that exert beneficial health effects in this host’. Later on US Food and Drug Administration (US-FDA) in 1989 used the term “Direct Fed Microbials (DFM)”. The DFM have been a main focus as a replacement for antibiotics and these DFMs are generally recognized as safe. Among them, yeast *Saccharomyces cerevisiae* is the most common product currently supplemented to ruminant animal diets.

Yeast supplementation in the diet caused a significantly higher digestibility of nutrients and increased production of carboxymethylcellulase activity in the rumen (Maurya *et al.,* 1993; Garg, 2008). Feeding of *Saccharomyces cerevisae* for the improvement in digestibility and production of the animals was demonstrated by Kamra *et al.* (1996), Prahalada *et al.* (2002) and Garg (2008). Body weight and feed conversion ratio increased significantly.

Feeding of inert or bypass fat is a means of rendering fats insoluble in the rumen, which reduces the negative nutrient digestion. The problem of negative energy balance can be easily overcome by feeding protected/bypass lipids to ruminants. By protecting the lipids, these are protected from ruminal hydrolysis and bio-hydrogenation, so that the fats are digested and absorbed in the lower GI tract. Therefore, keeping this in view, the present experiment was carried out to evaluate feed intake, digestibility, growth performance and feed conversion efficiency in weaner Surti kids.

2. Materials and Methods

2.1 Experimental Site

The present study was conducted in two phases at Animal Nutrition farm of Animal Nutrition Research Station, Anand Agricultural University, Anand, 388 001, Gujarat, India.

2.2 Phase I and II

In vitro studies were conducted to arrive at the optimum level of incorporation yeast (*Saccharomyces cerevisiae*) and bypass fat in *jowar* hay based total mixed ration (TMR). On the basis of the results of *in vitro* fermentation of TMR incorporated yeast (*Saccharomyces cerevisiae*) and bypass fat at different levels used as substrate, the optimum level of each was selected, for *in vivo* study.

2.3 Feeds, Feeding and Housing Management

Twenty four Surti kids were divided into four equal groups of six animals in each group based on age and body weight. The kids were fed TMR with no bypass fat and yeast (T_1); TMR with 2% yeast (T_2); TMR with 2% bypass fat (T_3) and TMR with a combination of 2% each of yeast and bypass fat (T_4). All the experimental kids were fed TMR in pallet form with or without probiotics and bypass fat to meet their nutrients needs as per ICAR (1998) standard. Individual feeding of all the kids were followed. The experimental kids were let loose for exercise for two hours in the morning and one hour in the afternoon under controlled conditions during which they had free access to fresh, wholesome drinking water. De-worming of all the kids were carried out using broad spectrum anthelmintic before initiation of the experiment.

2.4 Body Measurements

The body weight and measurements viz., height at withers, body length and heart girth were recorded at fortnightly intervals. The body length was taken from point of shoulder to pin bone. The height was recorded at point of wither while the heart girth was measured taking the circumference from behind the hump and behind the brisket. All the measures were taken by keeping the animals on flat platform in normal position.

2.5 Digestibility Study

Digestion trial of 5 d duration was conducted after 60 days of experimental feeding to determine digestibility of nutrients. During digestion trial, feed, refusals and faecal samples of individual animals were collected daily, composited and stored for analysis. The feed intake and faecal outgo were recorded.

2.6 Chemical Analysis

The composite dried feed, refusals and faeces were pooled, ground to pass through a 1 mm screen and subjected for chemical analysis (AOAC, 2005) for fibre fractions as per (Van Soest *et al*., 1991).

2.7 Statistical Analysis

The data generated during the experiment were subjected to one way analysis of variance as per the methods of Snedecor and Cochran (1994), and treatment means were tested by applying Tukey's test by using SPSS software package, version 13 (SPSS, Chicago, IL, USA).

3. Results and Discussion

3.1 Chemical Composition of Total Mixed Rations

The proximate composition and fibre fractions (NDF and ADF) of all the four TMRs offered to experimental Surti kids is presented in Table 1. The TMR-T_1, TMR-T_2, TMR-T_3 and TMR-T_4 contained 10.64, 10.52, 10.62 and 10.48% crude protein, 2.80, 2.93, 3.27 and 3.32% ether extract, 49.18, 50.17, 48.93 and 49.55% NDF, respectively. Bypass fat contained, 87.96% ether extract, 12.04% total ash and 9.30% calcium, respectively.

3.2 Feed Intake and Digestibility of Nutrients

The dry matter, crude protein, digestible crude protein and total digestible nutrient intake (g/kg $W^{0.75}$) of experimental kids was similar (P>0.05) during experimental period (Table 2). This is corroborated by the findings of Giger-Reverdin *et al*. (2004) for dairy goats and Haddad and Goussous (2005) for growing Awassi lambs. Contrary to this, Harikrishna *et al*. (2013) and Salem *et al*. (2000) reported sheep diets supplemented with yeast significantly improved voluntary feed intake. The findings of present study are

Table 1: Chemical composition of total mixed rations (% on DM basis)

Sl. No.	Parameter	T_1 Group	T_2 Group	T_3 Group	T_4 Group	Bypass Fat*
1.	Crude protein (%)	10.64	10.52	10.62	10.48	
2.	Ether extract (%)	2.80	2.93	3.27	3.32	87.96
3.	Crude fibre (%)	20.41	21.25	20.88	19.89	
4.	Nitrogen free extact (%)	55.81	54.35	55.12	54.70	
5.	Total ash (%)	10.34	10.94	10.11	11.61	12.04
6.	Organic matter (%)	89.66	89.06	89.89	88.39	
7.	NDF (%)	49.18	50.17	48.93	49.55	
8.	ADF (%)	31.03	32.43	30.82	31.28	
9.	Hemi-cellulose (%)	18.15	17.74	18.11	18.27	
10.	Calcium (%)	0.75	0.74	0.87	0.82	9.30
11.	Phosphorus (%)	0.58	0.60	0.63	0.59	

Table 2: Effect of feeding bypass fat and yeast (*Saccharomyces cerevisiae*) on nutrient intake and diet digestibility in weaner Surti kids

Attributes	Groups#				P value
	T_1	T_2	T_3	T_4	
Nutrient Intake g/kg $W^{0.75}$					
Dry matter	84.12±1.37	84.13±1.32	84.95±1.82	83.00±1.24	0.608
Crude protein	8.95±0.15	8.74±0.14	9.02±0.19	8.70±0.13	0.400
Digestible crude protein	6.18±0.12	6.10±0.10	6.30±0.15	6.16±0.09	0.681
Total digestible nutrients	51.70±0.82	51.99±0.95	53.04±1.04	52.42±0.76	0.740
Digestibility of nutrients (%)					
Dry matter**	62.24^{a}±0.37	63.90^{bc}±0.31	62.82^{ab}±0.23	64.52^{c}±0.36	0.001
Organic matter**	65.70^{a}±0.38	67.28^{b}±0.32	65.82^{a}±0.23	67.80^{b}±0.36	0.001
Crude protein*	67.37^{a}±0.56	68.34^{ab}±0.22	68.14^{ab}±0.30	68.83^{b}±0.23	0.059
Ether extract**	71.05^{a}±0.42	70.90^{a}±0.30	75.68^{b}±0.21	77.67^{c}±0.25	0.001
Crude fibre**	63.27^{a}±0.25	66.79^{b}±0.44	62.96^{a}±0.16	67.89^{b}±0.23	0.001
Nitrogen free extract	65.99±0.68	67.06±0.54	65.99±0.35	66.95±0.53	0.335
Neutral detergent fibre**	56.69^{a}±0.39	60.17^{b}±0.23	57.70^{a}±0.21	60.24^{b}±0.22	0.001
Acid detergent fibre**	49.65^{ab}±0.45	51.57^{c}±0.23	48.87^{a}±0.05	50.50^{bc}±0.33	0.001
Hemi-cellulose **	68.37^{a}±0.98	75.73^{c}±0.65	72.46^{b}±0.65	76.70^{c}±0.36	0.001
Nutrient density (%)					
DCP	7.34±0.06	7.34±0.02	7.42±0.02	7.42±0.02	0.242
TDN**	61.46^{a}±0.34	62.54^{ab}±0.29	62.45^{ab}±0.21	63.17^{b}±0.32	0.005

*The parameters mark as * (P<0.05) and ** (P<0.01) differ significantly.*
#T_1: Control, T_2: Yeast, T_3: Bypass fat and T_4: combination of bypass fat and yeast group

similar to Manso *et al.* (2006), Salinas *et al*. (2006), Abdelrahman (2010) and Abdelrahman (2012) who did not find any difference in the DMI of growing lambs on diets supplemented with or without bypass fat.

The average digestibility coefficients of nutrients in T_1, T_2, T_3 and T_4 groups for DM, OM, CP, EE, CF, NDF, ADF and hemi-cellulose were significantly (P<0.01) higher in groups supplemented with *Saccharomyces cerevisiae* alone (T_2) and in combination with bypass fat (T_4) group. But the treatment groups did not differ with respect to digestibility coefficient of NFE. Chaudhary *et al.* (2008) observed improvement in EE digestibility on account of feeding yeast culture. However, Paengkoum and Yong (2009), Ismaiel *et al*. (2010), Hillal *et al.* (2011) and Sawsan *et al*. (2012) did not find any influence of inclusion of *Saccharomyces cerevisiae* on EE digestibility.

The increase in EE digestibility when bypass fat is added to the diet is consistent with the findings of Bayourthe *et al*. (1994), Alexander *et al*. (2002), Ramana Reddy *et al*. (2003), Haddad and Younis (2004) and Manso *et al*. (2006). These authors suggested that EE digestibility increases because the added fat is characterized by greater digestibility and availability. In the present study, the diet supplemented with bypass fat alone (T_3) or in combination with yeast (T_4) had significantly (P<0.01) higher ether extract digestibility on account of higher EE content in these TMR compared to either control or T_2 group.

Ismaiel *et al*. (2010), Hillal *et al*. (2011), Sawsan *et al*. (2012) and Harikrishna *et al*. (2013) also observed improvement in crude fibre digestibility when the animals were supplemented with *Saccharomyces cerevisiae*. The results indicated that, yeast inclusion might have exerted selective stimulatory effect on specific rumen bacteria responsible for fibre degradation and microbial protein synthesis in kids (Erasmus, 1992; Rossi *et al.*, 1995). Higher CF digestibility in the T_2 and T_4 diet might be due to inclusion of yeast, which might have shown a complementary effect by providing a favorable rumen environment for stimulating cellulolytic and hemicellulolytic bacteria. The results of current study were consistent with findings of Salem *et al.* (2000; 2002); Mahender *et al.* (2006), who reported significant improvement in CF digestibility in lambs due to supplementation of yeast. However, Khotsakdee *et al.* (2010) did not influence digestibility of CF significantly in goats supplemented with tallow rich ration fortified with yeast.

The average DCP content of (7.34 to 7.42 %) was statistically similar in all the groups. But the TDN content of the T_4 group (63.17 ± 0.32) was significantly ($P<0.01$) higher than T_1 (61.46 ± 0.34), T_2 (62.54 ± 0.29) and T_3 (62.45 ± 0.21) groups which did not differ from each other.

3.3 Growth Performance

The initial body weights of animals in all the treatment groups were statistically similar. With respect to final body weight, the yeast supplemented alone (T_2) and a combination of yeast and bypass fat (T_4) group recorded the highest body weight compared to either T_1 or T_3 group that did not differ from each other. The average daily gain was 63.74 ± 0.54, 80.22 ± 0.38, 67.43 ± 0.68 and 88.50 ± 0.26 g in T_1, T_2, T_3 and T_4 groups. The treatment groups differed significantly ($P<0.01$) from each other. The highest gain was in T_4 followed by T_2, T_3 and T_1 groups (Table 3). Haddad and Goussous (2005) reported an improvement in average body weight and average daily gain with 3 g/d of YC supplementation to growing Awassi lambs. The kids supplemented with *Saccharomyces cerevisiae* also had higher average daily gain (Jinturkar *et al*., 2009; Jayabal *et al.*, 2008; Adangale *et al*., 2011; Yadav and Khan, 2012). In contrast, Atasoglu *et al*. (2010), Doto *et al.* (2011), reported that yeast supplementation didn't affect the average daily gain of kids and growing lambs, respectively. The highest daily gain observed in the group supplemented with both yeast and bypass fat could find support from the work of Han *et al*. (2008) who reported the average daily gain to significantly increase due to probiotics and combination of probiotics and bypass fat ($P<0.05$) supplementation. The improvement in live weight gain on account of bypass fat supplementation was observed by Daniel *et al*. (2010) and Abdelrahman (2012). In contrast, (Haddad and Younis, 2004; Salinas *et al*., 2006; Seabrook *et al*., 2011) reported no advantages of using protected fat in the diets for lambs.

The increase in the body measurements *viz.* increase in body length, height and heart girth of kids in T_1, T_2, T_3 and T_4 groups, was numerically higher in T_4 kids. However, the treatment groups did not differ ($P>0.05$) from each other (Table 3). Laborde (2008) did not find any influence of feeding yeast culture to growing calves on their body measurements. Similarly, Jayabal *et al.* (2008) and Kochewad *et al*. (2009) found no increase in body length, height and heart girth of yeast supplemented kids. The improvement in length, chest girth and belly girth of kids was reported by Adangale *et al*. (2011) due to yeast supplementation.

3.4 Feed Conversion Efficiency (FCE)

The intake (kg/kg gain) of kids during experimental period in terms of DM (9.39 ± 0.18, 7.68 ± 0.19, 9.02 ± 0.17 and 7.02 ± 0.13); CP (1.50 ± 0.03, 1.21 ± 0.03, 1.44 ± 0.03 and 1.10 ± 0.02) and DCP (0.69±0.02, 0.56±0.01, 0.67±0.01 and 0.52±0.01) were significantly ($P<0.01$) lower in treatment groups T_2, T_3 and T_4 than the control (T_1) group, indicating better conversion efficiency. However, conversion efficiency of TDN (kg/kg gain) in T_2 (4.80 ± 0.12) and T_4 (4.44 ± 0.08) group was better ($P<0.01$) than T_1 (5.77 ± 0.12) and T_3, (5.63 ± 0.12) groups which did not differ from each other. The overall improvement in feed conversion efficiency observed in T_2, T_3 and T_4 groups in the present study may be due to better growth rate in kids in these groups compared to control group. These results are corroborated by the findings of Abdelrahman and Hunaiti (2007), Ding *et al*. (2008), Jinturkar *et al*. (2009), Paengkoum and Yong (2009), and Ismaiel *et al*. (2010) on account of yeast supplementation in the diet of growing lambs. However, supplementation of yeast had no significant effects on conversion of DM, TDN and DCP to body weight gain in growing lambs (Nagah, 2002; El-Ashry *et al*., 2003; Hillal *et al*., 2011). Better conversion efficiency in bypass fat supplemented compared to control group observed in the present study is in agreement with findings of Manso *et al*. (2006) and Seabrook *et al*. (2011) who reported better FCR in lambs fed bypass fat supplement. In contrast, other authors (Haddad and Younis, 2004; Salinas *et al*., 2006; Abdelrahman, 2010; Abdelrahman, 2012) did not observe improvement in feed conversion ratios in lambs fed bypass fat.

3.5 Cost of Feeding

The cumulative feed cost (Rs/head/120 days) in T_1, T_2, T_3 and T_4 was 1093.88 ± 27.72, 1327.56 ± 35.48, 1132.14 ± 24.77 and 1425.64 ± 27.86, respectively. The cumulative feed cost was significantly ($P<0.01$) higher in T_2 andT_4 groups, as compared to T_1 and T_3 group -

Table 3: Effect of feeding bypass fat and yeast (*Saccharomyces cerevisiae*) on growth performance, feed efficiency and cost of feeding in weaner Surti kids

Attributes	Groups#				P value
	T_1	T_2	T_3	T_4	
Growth performance					
Initial BW (kg)	10.31±0.61	10.31±0.62	10.28±0.54	10.30±0.56	0.234
Final BW** (kg)	17.96±0.67	19.93±0.65	18.37±0.59	20.92±0.58	0.001
Total gain** (kg)	7.65±0.06	9.63±0.05	8.09±0.08	10.62±0.03	0.001
Average daily gain (g/d)	63.74±0.54	80.22±0.38	67.43±0.68	88.50±0.26	0.001
Increase in length (cm)	10.00±0.82	10.83±1.08	9.67±0.67	12.00±0.82	0.252
Increase in height (cm)	15.00±0.58	16.67±0.67	14.17±1.19	16.33±1.20	0.248
Increase in girth (cm)	15.33±0.67	16.83±0.75	15.67±0.49	17.33±1.09	0.251
Feed efficiency (kg/kg gain)					
Dry matter **	9.39±0.18	7.68±0.19	9.02±0.17	7.02±0.13	0.001
Crude protein**	1.50±0.03	1.21±0.03	1.44±0.03	1.10±0.02	0.001
Digestible Crude protein**	0.69±0.02	0.56±0.01	0.67±0.01	0.52±0.01	0.001
Total digestible nutrients**	5.77±0.12	4.80±0.12	5.63±0.12	4.44±0.08	0.001
Cost of feeding** (Rs/head/120days)	1093.88±27.72	1327.56±35.48	1132.14±24.77	1425.64±27.86	0.001
Cost of feeding ** (Rs/kg) gain	142.43±2.66	137.16 ±3.51	139.32±2.59	133.54±2.46	0.001

*The parameters mark as ** (P<0.01) differ significantly.*
#T_1: Control, T_2: Yeast , T_3: Bypass fat and T_4: combination of bypass fat and yeast group

(Table 3).

The feed cost in terms of Rs/kg gain (Table 3) in T_1, T_2, T_3 and T_4 groups was Rs. 142.43 ± 2.66, 137.16 ± 3.51, 139.32 ± 2.59 and 133.54 ± 2.46, respectively, which was lowest (P<0.01) in T_4 group followed by T_2 and T_3 group, while the control group recorded the highest cost. The feed cost in T_2 group was statistically similar to that in T_3 and T_4 groups, whereas, group T_3 and T_1 did not differ from each other. Thus, the feed cost was statistically similar in groups supplemented with *Saccharomyces cerevisiae* alone or in combination with bypass fat and was lower than other groups.

Malik and Sharma (1998), Kumar and Reddy (2004) and Ismaiel *et al*. (2010) reported that feed cost/kg BW gain was significantly (P<0.05) lower in rations with yeast culture as compared with corresponding rations without yeast culture in crossbreed calves and lambs, respectively. Dietary supplementation of protected fat reduced feed costs/kg BW gain by 4.43- 9.95% in lambs (Daniel *et al*., 2010).

4. Conclusion

It is concluded that inclusion of live yeast (*Saccharomyces cerevisiae*) alone or in combination of bypass fat in 60: 40 concentrates: jowar hay based TMR for Surti kids resulted in improved digestibility of nutrients and feed conversion efficiency, without affecting dry matter intake and increment in the daily feed cost. Thus supplementation of probiotic (*Saccharomyces cerevisiae*) and bypass fat at 2 % each in the TMR for weaner Surti kids was found to be advantageous in improving growth performance.

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