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RESEARCH ARTICLE

EFFECT OF SUPPLEMENTING TWO DIFFERENT COMMERCIAL STRAINS OF YEAST CULTURES ON RUMEN FERMENTATION, NUTRIENT DIGESTIBILITY AND BIO-CHEMICAL PROFILE IN KANKREJ COWS.

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Abstract

The present study was conducted to test efficacy of supplementing two commercial probiotics (*Saccharomyces cerevisiae*) Yea-Sacc[1026] (YC-1) of M/s. Alltech and Levucell SC-20 strain: CNCM I-1077 (YC-2) of M/s. Lallemand Animal Nutrition on the rumen fermentation, nutrient digestibility and bio-chemical profile in Kankrej animals. Based on the *in vitro* studies, optimum levels for incorporation of live yeast strains YC-1 and YC-2 in 50:50 concentrates: wheat straw based total mixed ration (TMR) were found to be 15 and 1.5 g/day, respectively. Fifteen animals were selected and divided into three equal groups of 5 in each, based on the body weight and age for allocating dietary treatments. The animals in group T_0 (control group) were fed 50:50 concentrates: wheat straw based TMR without yeast culture, to meet nutrient needs as per NRC (2001) standard, whereas, animals under T_1 and T_2 groups were fed TMR containing YC-1 and YC-2 @ 15 and 1.5 g/animal/day, respectively. After 40 days of experimental feeding, a digestibility trial for 7 days was conducted. Rumen liquor and blood samples were collected at the end of the experiment. The DM intake of experimental animals did not differ significantly ($P>0.05$). Ruminal pH, ammonia nitrogen, total nitrogen, TCA-N and total volatile fatty acids were within the normal range under the T_0, T_1 and T_2 groups, respectively, and differed significantly ($P<0.05$) from each other. However, non protein nitrogen in the SRL did not differ significantly from each other. There was significant ($P<0.05$) reduction in acetate and butyrate concentrations and increase in propionate concentration in T_1 and T_2 groups, as compared to T_0 group. Acetate to propionate (A:P) ratio was also decreased in the yeast supplemented groups, as compared to control. Animals receiving supplemental yeast cultures in T_1 and T_2 groups tended to have significantly ($P<0.05$) higher total anaerobic bacteria and cellulolytic bacteria concentrations in ruminal fluid than animals in T_0 group.

The serum glucose was significantly ($P<0.05$) higher in T_1 and T_2 groups, as compared to T_0 group. The average digestibility coefficients

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of nutrients for DM, OM, CP, CF, NDF, ADF, cellulose and hemi-cellulose were significantly ($P<0.05$) higher in treatment groups (T_1 and T_2) than the control (T_0), except those for EE and NFE. The serum enzymes aspartate amino-transferase (AST), alanine amino-transferase (ALT) and alkaline phosphatase (ALP) did not differ within groups. Yeast supplementation did not adversely influence red blood cells, PCV and white blood cells, except a significant ($P<0.05$) improvement in haemoglobin concentration. The results indicated that inclusion of live yeast culture in 50:50 concentrates: wheat straw based TMR resulted in improved rumen fermentation and digestibility of nutrients, without affecting bio-chemical profile in Kankrej cows.

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Introduction:-

The Kankrej is one of the largest and heaviest Indian breeds of cattle and are prized as powerful draft animals and are moderate milk producers. In Asia, they are more created in the Western and Northern India (Joshi and Phillips, 1953). Guzerat cattle breed is also developed in Brazil from Kankrej cattle imported from India. In United States, this race with Nellore and Gir, are three major Indian breeds that have had the most important impact on American cattle breeding. Moreover, Kankrej is the most important zebu breed for the formation of American Brahman cattle (Mason, 1996). They show the usual advantages of Zebu cattle in the tropical and semi-tropical environment, good heat tolerance and pest resistance (Garg et al., 2012). The use of yeast cultures to improve production efficiency and the underlying mechanisms for such improvement have attracted increasing attention during recent years (Williams and Newbold, 1990). Yeast cells are known to be a rich source of vitamins, enzymes and some unidentified cofactors that are helpful in increasing microbial activity in the rumen (Dawson et al., 1990 and Williams et al., 1991); hence, yeast culture supplementation has been shown to improve the growth rate (Panda et al., 1995) and feed conversion efficiency (Mir and Mir, 1994). Several workers (Williams, 1989; Williams et al., 1991; Singh et al., 1998 and Lila et al., 2004) have reported that dietary yeast culture supplements produce a range of effects in the rumen including increased pH, increased ruminal concentration of volatile fatty acids and acetate: propionate ratio (Alshaikh et al., 2002), decreased methane production and increased total number of microorganisms and cellulolytic bacteria, others have demonstrated no effect of yeast culture supplementation on ruminal pH, ammonia-N and VFA patterns (Adams et al., 1995; Robinson and Garrett, 1999 and Chaudhary et al., 2008). The objectives of the following study were to examine the effect of supplementing yeast culture from two different commercial sources on the rumen fermentation, nutrient digestibility and bio-chemical profile in Kankrej cows.

Subjects and methods:-

All experimental procedures were approved by the Institutional Animal Ethics Committee (IAEC) of the Faculty of Veterinary and Animal Science, Anand Agricultural University, Anand, Gujarat, India and were carried out by experienced technical experts.

Selection, feeding and management of experimental animals:-

Based on the results of *in vitro* studies, probiotic strains YC-1026 and YC-1077 were incorporated @ 15 and 1.5g/day, respectively in TMR, to study the effect of supplementing these strains of probiotics on ruminal fermentation, digestibility of nutrients and bio-chemical profile in Kankrej cows. The feeding trial was conducted for 40 days (excluding 10 days pre-experimental feeding) at Animal Nutrition Research Station farm. Fifteen Kankrej cows were divided into three equal groups of five animals in each group, based on age and body weight: i.e. T_0 (Control) group with no probioics, T_1 group (YC-1026) and T_2 group (YC-1077). Animals in control group were fed TMR without probiotics and those in experimental groups were fed TMR formulated with probiotics level selected on the basis of results of *in vitro* studies. All the animals were fed TMR with or without probiotics to meet their nutrients requirement per NRC (2001) standard. Individual feeding of all the animals was followed. The animals 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 animals were carried out using broad spectrum anthelmintic before initiation of the experiment.

Digestion trial:-
After 40 days of experimental feeding, a digestion trial for 7 days was conducted to determine digestibility of the nutrients. A proper record of feed consumed, refusal and feces voided by each cow was maintained during the trial period. The chemical analysis of preserved samples of TMR, leftover and feces were carried out as per AOAC (1995) methods, neutral detergent fibre (NDF) and acid detergent fibre (ADF) were determined as per Van Soest et al. (1991) for calculation of digestibility coefficients.

Rumen pH:-
About 250 ml of rumen liquor was collected from each animal, using a stomach tube and employing suction (Lane et al., 1968). The rumen liquor was immediately brought to the laboratory and strained through four layers of cheese cloth. The pH of SRL was determined immediately after collection using portable digital pH meter.

Nitrogen fractions and total volatile fatty acids:-
The samples of SRL were analyzed for ammonia-N (Pearson and Smith, 1943) and total-N by Kjeldahl's method. Soluble-N in supernatant of SRL after centrifuging was estimated by Kjeldahl's method and non protein-nitrogen estimated by Trichloro-acetic acid precipitation of SRL and estimating the N content of supernatant by Kjeldahl's method. The concentration of total VFA was determined in SRL by the steam distillation method (Barnett and Reid, 1957), using Markham micro-distillation apparatus.

Fractions of total VFAs:-
Volatile fatty acids were estimated using Nucon-5765 gas chromatograph equipped with a double flame ionization detector as per the method described by Barnett and Reid (1957). The glass column (6 ft length and 1.8 mm diameter) packed with Chromosorb 101 was used for the estimation of VFAs. The gas flows for nitrogen, hydrogen and air were 30, 30 and 320 ml/min, respectively. Temperature of injector oven, column oven and detector was 270^{o}C, 172^{o}C and 270^{o}C, respectively. Samples were prepared by adding 0.2 ml of 25% meta-phosphoric acid per ml of SRL, allowing it to stand for 2 h followed by centrifugation at 4000 rpm for 5 min. Supernatant was used for estimation of VFA. Standard VFA mixture was prepared by mixing stock solutions (each of 25 mg/ml concentration) of standard VFAs and water in following amounts: acetic acid 1.68 ml; propionic acid 0.48 ml; butyric acid 0.24 ml; isobutyric acid 0.12 ml; valeric acid 0.12 ml; isovaleric acid 0.12 ml; distilled water 7.24 ml to obtain final concentration of acetic acid 7.0; propionic acid 1.62; butyric acid 0.68; isobutyric acid 0.34; valeric acid 0.29 and isovaleric acid 0.29 mM/100 ml. The mixture was stored in deep freeze until further analysis.

Total bacterial counts in the SRL:-
Total anaerobic bacteria count was determined on roll tubes, using complete carbohydrate agar prepared with energy-depleted ruminal fluid (Allison et al., 1979) and counted after 5 d of incubation at 37°C. Cellulolytic bacteria were enumerated using the most probable numbers procedure in cellulose broth after 14 d of incubation at 37°C (Bryant et al., 1958).

Haemato-biochemical parameters:-
At the end of experimental feeding, blood samples from all animals were collected in 10 ml vacuunette tubes early in the morning before feeding from jugular vein, taking all aseptic precautions, for estimation of different haemato-biochemical constituents. A set of tubes was allowed for clotting for separation of serum. The serum concentrations of total protein, albumin, globulin and glucose, alanine aminotransferase (ALT/SGPT), aspartate aminotransferase (AST/SGOT) and alkaline phosphatase (AKP) were estimated using Semi Automatic Analyzer for clinical chemistry test (Model 3000 EVOLUION) of Coral Clinical Systems. The commercial diagnostic kits for analysis were procured from CREST Bio-Systems Ltd., Goa, India. Another set of blood samples was used to measure haemoglobin, packed cell volume, red blood cells and white blood cells, using Automatic Hematology Analyzer (Model PE 6000).

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), with the help of SPSS package programme (SPSS 9.00 software for Windows, SPSS Inc., Chicago, IL).

Results and discussion:-

The chemical composition and fiber fractions (NDF, ADF), cellulose and hemi-cellulose of wheat straw based total mixed ration offered to experimental animals are summarized in Table 1. It was within the normal range.

Table 1:- Chemical composition of TMRs offered (% on DM basis) to animals

Parameter	T_0 Group (Control)	T_1 Group (YC-1026)	T_2 Group (YC-1077)
Moisture (%)	15.20	16.30	15.40
Crude protein (%)	11.39	11.76	11.61
Ether extract (%)	2.31	2.38	2.30
Crude fibre (%)	25.92	26.93	26.36
NFE (%)	45.54	44.78	45.62
Total ash (%)	15.04	14.15	14.11
OM (%)	84.96	85.85	85.89
Acid insoluble ash (%)	8.62	7.96	7.92
NDF (%)	67.43	67.59	66.96
ADF (%)	38.77	36.25	38.39
Cellulose (%)	26.80	26.10	26.34
Hemi-cellulose (%)	33.84	32.93	32.45
Calcium (%)	0.49	0.46	0.47
Phosphorus (%)	0.70	0.60	0.58

Effect of supplementing yeast culture on dry matter intake:-

The average dry matter intake of animals in T_0, T_1 and T_2 groups was 8.82±0.53, 8.64±0.50 and 8.88±0.63 kg/day and when expressed as kg/100kg body weight was 3.00±0.03, 2.96±0.05 and 3.01±0.09 and the same in terms of g/kg $W^{0.75}$ was recorded as 124.12±1.51, 122.12±1.51 and 124.29±3.58 (Table 2). The DM intake of experimental animals did not differ significantly (P>0.05). The results of the present study are in agreement with the reports of Pandey and Agrawal (2001b), Isik et al. (2004), Chaudhary et al. (2008), Francia et al. (2008), Hucko et al. (2009) and Hossain et al. (2012). However, Grieve (1979), Mutsvangwa (1992), Malik and Sharma (1998), Reddy and Bhima (2003), Kumar and Reddy (2004) and Laborde (2008) reported significantly higher DMI in group of animals supplemented with YC.

Table 2:- Average dry matter intake of experimental animals during digestion trial

Attributes	Treatments		
	T_0	T_1	T_2
Average DMI (kg/day)	8.82±0.53	8.64±0.50	8.88±0.63
DMI (kg/100 kg BW)	3.00±0.03	2.96±0.05	3.01±0.09
DMI (g/kg $W^{0.75}$)	124.12±1.51	122.19±1.01	124.29±3.58

Schingoethe et al. (2004) recorded that the dry mater intake of cows was unaffected by the treatment with yeast culture @ 60 g/day, when supplied through feed. Phondba et al. (2009) also reported the DM intake in crossbred cows was not affected by supplementing probiotic feed supplement @ 10 g/head/day and @ 20 g/head/day, as top dressing over concentrate mixture. Zhang et al. (2000) also recorded 1.8% (0.36 kg) lower dry matter intake in a group, which was supplemented with *Saccharomyces cerevisiae* @ 10/cow/day than the control cows. In agreement with that, some studies with lactating animals found no response in dry matter intake (Arambel and Kent, 1990; Piva et al., 1993; Wohlt et al., 1998; Soder and Holden, 1999; Bagheri et al., 2009 and Ondarza et al., 2011). Harrison et al. (1988) explained this situation such that the addition of yeast cultures to the diets of lactating cows increased total concentrations of cellulolytic bacteria in the rumen, but this increase may have not affected total fiber digestion or dry matter intake. This result is contrary to that of Desnoyers et al. (2009), Williams et al. (1991), Wohlt et al. (1991), Dawson and Tricarico (2002) and Stella et al. (2007), who reported that yeast supplementation increased DM intake of experimental cows.

Effect of YC supplementation on rumen parameters:-

Average values for ruminal pH, total nitrogen, ammonia nitrogen, non protein nitrogen, TCA-N and total volatile fatty acid of experimental animals during different hours of post feeding are summarized in Table 3.

Ruminal pH:-

The average pH in SRL of T_0, T_1 and T_2 groups was 6.40, 6.50 and 6.52, respectively, and were statistically significant between treatments (Table 3). The pH of SRL decreased up to 4th h of post feeding, again increased at 6th h post feeding indicating that the pH of SRL during periods differed significantly (P<0.05). Pandey and Agrawal (2001a), Chaudhary et al. (2008) and Thrune et al. (2009) found increase in ruminal pH significantly (P<0.05) in yeast supplemented group. However, Panda et al. (1999), Rao et al (2001), Laborde (2008**),** Tripathi et al. (2008), Lascano and Heinrichs (2009), Hucko et al. (2009) found no differences among treatment groups in rumianl pH on yeast supplementation. It is likely that the yeast strain's positive effects on rumen pH were due to inhibiting the growth of lactate-producing bacteria while stimulating the growth of lactate-utilizing bacteria, thus leading to an overall decrease in lactate accumulation. Live yeast has been shown to increase rumen pH in a number of studies with varying levels of starch in the diets. Guedes et al. (2008) found that live yeast reduced rumen pH variation and increased average rumen pH from 6.41 to 6.55 in non-acidotic cows.

Table 3:- Average ruminal pH, NH_3-N, total-N, NPN, TCA precipitable-N and TVFA in different treatment groups

Treatment	Hours post-feeding					
	0	**2**	**4**	**6**	**8**	**Avg.**
Ruminal pH						
T_0	6.72± 1.23	6.32 ± 0.81	6.25 ± 0.42	6.31 ± 0.11	6.40 ± 0.33	**6.40[a]**
T_1	6.72± 0.06	6.41 ± 0.06	6.35 ± 0.11	6.46 ± 0.05	6.55 ± 0.05	**6.50[b]**
T_2	6.81 ± 0.07	6.81 ± 0.07	6.45 ± 0.10	6.48 ± 0.04	6.56 ± 0.04	**6.52[b]**
Ammonia – N (mg/dl SRL)						
T_0	7.22 ± 0.44	15.79 ± 0.49	20.27 ± 1.28	13.60±1.08	7.46±1.17	**12.87[b]**
T_1	6.49 ± 0.31	14.06 ± 0.94	15.18 ± 2.66	10.96±2.05	4.83±0.38	**10.30[a]**
T_2	6.81 ± 0.81	14.34 ± 0.94	16.64 ± 1.84	12.40±1.33	5.42±0.63	**11.12[a]**
Total Nitrogen (mg/dl SRL)						
T_0	71.96±4.40	110.04±6.36	97.16±8.86	93.52±7.51	91.56±3.33	**92.85[a]**
T_1	80.92±6.44	117.60±4.75	124.60±7.26	115.64±8.06	103.04±9.19	**108.36[b]**
T_2	82.60±7.08	126.84±7.60	127.40±3.86	110.04±6.02	110.88±8.06	**111.55[b]**
Non Protein Nitrogen (mg/dl SRL)						
T_0	26.32±1.22	26.60 ± 2.12	31.36 ± 3.56	26.32±1.74	33.60±5.63	**28.78**
T_1	25.76±0.84	27.72 ± 1.74	35.56 ± 1.44	31.64±3.05	36.12±1.72	**31.36**
T_2	27.72±1.49	28.84 ± 1.96	32.48 ± 2.10	32.48±2.56	36.12±1.03	**31.53**
TCA Precipitable Nitrogen (mg/dl SRL)						
T_0	45.92±5.43	83.44 ± 4.98	65.80 ± 8.91	67.20±6.84	57.90±7.31	**54.67[a]**
T_1	55.16±6.49	89.88 ± 4.86	89.04 ± 8.22	84.00±7.73	66.92±11.81	**64.64[b]**
T_2	54.88±8.06	98.00 ± 8.62	94.92 ± 5.86	77.56±6.02	74.76±7.19	**66.82[b]**
Total Volatile Fatty Acids (mM/ml SRL)						
T_0	7.83±5.14	9.39 ± 5.17	11.94 ± 5.25	10.74±5.03	9.72±5.03	**9.92[a]**
T_1	10.23±4.12	15.39 ± 7.79	17.97 ± 7.68	13.17±6.61	11.52±5.12	**13.65[b]**
T_2	10.08±4.04	16.68 ± 6.32	18.93 ± 6.21	13.95±2.60	10.53±5.69	**14.03[b]**

[ab]Means with different superscripts in columns for a parameter differ significantly (P<0.05)

Ammonia nitrogen:-

The average ammonia nitrogen in SRL in T_0, T_1 and T_2 groups was 12.87, 10.30 and 11.12 mg/dl, respectively. The treatment differed significantly (P<0.05) from each other in this respect. Also, the concentration of ammonia nitrogen differed significantly during different periods. The control group T_0 recorded significantly (P<0.05) higher ammonia nitrogen than T_1 group. The animals under T_2 group had an intermediate position between T_0 and T_1 groups. Ammonia nitrogen levels attained peak at 4 h post feeding and then declined afterwards up to 8 h post feeding with the same pattern in all treatment groups. NH_3-N was depressed significantly (P<0.05) due to supplementation of live yeast in T_1 and T_2 groups. In present study, the yeast supplementation in animal's diets changed the pattern of the end products of rumen fermentation, suggesting a shift in metabolic activities of rumen microflora. The results of the present investigation are corroborated by the findings of Lascano and Heinrichs (2009), Kumar et al. (1997) and Erasmus et al. (1992) who reported 10% reduction in rumen ammonia concentration and 9.4% more non ammonia nitrogen (NAN) at duodenum by YC supplementation. A decrease in NH_3 concentration is attributed to ruminal

microbial proliferation, due to the increase of microbial use of available NH_3 (Pinos-Rodriguez et al., 2008). However, Panda et al. (1995), Panda et al. (1999), Rao et al. (2001), Rao et al. (2003), Chaudhary et al. (2008), Laborde (2008) and Tripathi et al. (2008) found non-significant differences among treatment groups but NH_3-N levels tend to be lower in yeast supplemented group. Thus, it could be inferred that live yeast (*Saccharomyces cerevisiae*) supplementation in ration decreased NH_3-N level because of its utilization for microbial protein synthesis.

Total nitrogen:-
The average total nitrogen in SRL was 92.85, 108.36 and 111.55 mg/dl in T_0, T_1 and T_2 groups, respectively. There was significant ($P<0.05$) higher total nitrogen in T_1 and T_2 groups, as compared to T_0 (control) group. Pandey and Agrawal (2001a) found significantly higher total nitrogen values for animals fed probiotics. It was evident that group T_0, T_1 and T_2 groups manifested same pattern of total-N concentration showing no difference within the groups. The peak concentration was found at 4 h post feeding and then declined up to 8th h post feeding. The periodical changes in total nitrogen were found to be significant ($P<0.05$).

Non protein nitrogen:-
The result revealed that average non protein nitrogen in SRL of T_0, T_1 and T_2 groups was 28.78, 31.36 and 31.53 mg/dl, respectively. The highest concentration was found in T_2 group, but the treatment groups did not differ from each other. Kumar et al. (1997) reported the similar trend, whereas, Pandey and Agrawal (2001a) found significantly higher values in the group of animals supplemented with probiotics. The treatment and interaction between treatments and intervals did not differ significantly. Maximum non protein nitrogen concentration was recorded at 4 h and then declined up to 8 h post feeding with the same pattern in all the three treatment groups. Pandey and Agrawal (2001a) and Chaudhary et al. (2008) reported significantly ($P<0.05$) higher rumen pH, total N and NPN in yeast supplemented group.

TCA precipitable nitrogen:-
The results revealed that average TCA nitrogen in SRL of T_0, T_1 and T_2 groups was 54.67, 64.64 and 66.82 mg/dl, respectively (Table 3). There was significant higher TCA-N in T_1 and T_2 groups, as compared to T_0 group. Pandey and Agrawal (2001a) reported significantly higher values in the group of animals supplemented with probiotics, whereas, Kumar et al. (1997) found no effect of TCA-N values in the animals supplemented with live yeast. The treatment and interaction between treatments and intervals found differed significantly ($P<0.05$). Maximum TCA-N concentration was recorded at 2 h and then declined up to 8 h post feeding with the same pattern in all the three treatment groups.

Total volatile fatty acids (TVFA):-
The maximum TVFA concentration was found at 4 h and then declined up to 8 h of post feeding with the same pattern in all treatment groups. The average TVFA concentration in SRL was 9.92, 13.65 and 14.03 mM in T_0, T_1 and T_2 groups, respectively. The highest concentration was found in T_2 group. The treatment and the periodical changes in TVFA were found to be significant ($P<0.05$). These results agreed with the review of Robinson and Garret (1999), which showed an average increase in pH (1.6%) and an overall increase in TVFA (5.4%). Kumar et al. (1997), Rao et al. (2003), Quigley et al. (2007), Laborde (2008) and Lascano and Heinrichs (2009) also reported that addition of YC to the diet significantly increased the concentration of TVFA. However, Dawson et al (1990), Yadav et al. (1996) and Chaudhary et al. (2008) reported that concentration of TVFA was not altered in the continuous cultures and rumen of steers and buffalo calves. Thus, the role of live yeast cell is as a rumen microbial activity enhancer and capable of influencing some aspects of rumen fermentation processes to increase the outcome of TVFA's production fortifying the total number of anaerobic bacteria, particularly cellulolytic bacteria and to plunge NH_3-N. Thus, inclusion of live yeast (*Saccharomyces cerevisiae*) in the ration had positive influence on ruminal TVFA concentration. It may be due to ability of yeast to provide soluble growth factors that stimulate growth of cellulolytic bacteria and cellulose digestion (Callaway and Martin, 1997).

Molar proportion of volatile fatty acids (VFA) in SRL:-
The results revealed that average molar proportion of acetate, propionate and butyrate, respectively was 59.17±0.76, 23.34±0.41 and 12.18±0.33 mM in T_0 group, 54.21±0.23, 28.90±0.63 and 11.69±0.48 mM in T_1 group and 54.50±0.62, 29.14±0.81 and 11.23±0.16 mM in T_2 group (Table 4). There was significant ($P<0.05$) reduction in acetate and butyrate concentrations and increase in propionate concentration in T_1 and T_2 groups, as compared to T_0 group. Acetate to propionate (A:P) ratio was also decreased in the yeast supplemented groups, as compared to control group. The dietary yeast culture strains YC 1026 and YC-1077 supplementation to experimental animals resulted in

decreased molar proportion of acetate and butyrate, acetate to propionate ratio and increased molar proportion of propionate. Harrison et al. (1988) found decreased molar proportion of acetate and acetate to propionate ratio and increased molar proportion of propionate in rumen fluid of Holstein cows supplemented with a yeast culture containing *S. cerevisiae*. The yeast supplementation to animals changed the pattern of the end products of ruminal fermentation, suggesting a shift in metabolic activities of ruminal microflora (Kobayashi et al., 1995).

Table 4:- Effect of supplementing yeast cultures on molar proportion of VFAs (mM) and total bacteria counts in SRL in different treatment groups

Attributes	T_0 (Control) group	T_1 (YC-1026) group	T_2 (YC-1077) group
Acetate	59.17^{b}±0.76	54.21^{a}±0.43	54.50^{a}±0.62
Propionate	23.34^{a}±0.41	28.90^{b}±0.63	29.14^{b}±0.81
Iso-butyrate	1.37±0.04	1.31±0.05	1.34±0.05
Butyrate	12.18^{b}±0.33	11.69^{a}±0.48	11.23^{a}±0.16
Iso-valerate	1.59±0.02	1.52±0.07	1.53±0.07
Valerate	2.35±0.08	2.36±0.15	2.27±0.24
Iso-acids	5.32±0.10	5.19±0.24	5.14±0.33
A:P ratio	2.54^{b}±0.08	1.88^{a}±0.04	1.88^{a}±0.07
Total anaerobic bacteria (log_{10} value/ml)	8.71^{a}±0.27	10.40^{b}±0.25	11.01^{b}±0.08
Total cellulolytic bacteria (log_{10} value/ml)	7.79^{a}±0.17	8.98^{b}±0.04	9.15^{b}±0.12

^{a,b}Means bearing different superscripts in a row differ significantly at P<0.05

Total anaerobic bacteria and cellulolytic bacteria counts in SRL:-

Total anaerobic bacteria concentrations (log_{10} ml^{-1}) in SRL were 8.71, 10.40 and 11.01 in T_0, T_1 and T_2 groups, respectively. Concentrations of cellulolytic bacteria were 7.79, 8.98 and 9.15 in T_0, T_1 and T_2 groups, respectively (Table 4). Animals receiving supplemental YC in T_1 and T_2 groups tended to have significantly (P<0.05) higher total anaerobic bacteria and cellulolytic bacteria concentrations in SRL than animals in T_0 group. Increased numbers of total anaerobic bacteria and cellulolytic bacteria with addition of YC culture are in agreement with other studies (Dawson and Newman, 1987 and Weidmeier et al., 1987). Greater concentrations of total anaerobic bacteria and cellulolytic bacteria may explain why ruminal ammonia concentrations are lower in animals fed YC (Mosoni et al., 2007; Chaucheyras-Durand and Fonty 2001). Ammonia is the preferred source of N for a large proportion of the ruminal microbial population (Bryant and Robinson, 1963) and incorporation of ammonia into ruminal bacteria has been demonstrated by Mathison and Milligan (1971). An increase in the number of total viable bacteria (Koul et al., 1998) and cellulolytic bacteria (Weidmeier et al., 1987; Harrison et al., 1988 and Koul et al., 1998) were also observed when the yeast culture was used as a feed supplement to cattle with already developed rumen. Lower concentrations of ammonia in the rumen of animals fed YC may reflect increased transportation of ammonia into microbial protein. Cellulolytic bacterial activity accounts for the majority of fibre digestion in the rumen. These bacteria capture most of the energy from fibre when pH is maintained at or above pH 6.0. By nurturing a healthy, dynamic population of cellulolytic or fibre digesting bacteria, yeast culture helps increase fibre digestibility.

Haemato-biochemical and enzymatic profile of experimental animals:-

Blood metabolites are frequently used to monitor the metabolic health status of dairy cows (Ametaj et al., 2009). The average haemato-biochemical and enzymatic profile of experimental animals in T_0, T_1 and T_2 groups are presented in Table 5**.**

Total protein:-

The serum protein level indicates the balance between anabolism and catabolism of proteins in the body. The serum protein level at any given time in turn is a function of hormonal balance, nutritional status, water balance and other factors affecting the state of health. The average total protein (g/dl) concentration of experimental animals in T_0, T_1 and T_2 groups was 6.36±0.22, 6.80±0.13 and 6.94±0.19, respectively, among which T_1 and T_2 groups differed significantly (P<0.05) from T_0 group. The animals under T_1 group had an intermediate position between T_0 and T_2 groups. The levels were within the normal range, as reported by Kaneko et al. (1997). Chaudhary et al. (2008) and Hossain et al. (2012) reported similar total protein concentration in control animals and the animals supplemented with probiotics.

Table 5:- Average haemato-biochemical and enzymatic profile of experimental animals

Parameters	Treatments		
	T_0	T_1	T_2
Glucose (mg/dl)	48.0^{a}±1.30	64.2^{b}±1.50	63.2^{b}±2.13
Total protein(g/dl)	6.4^{a}±0.22	6.8^{b}±0.13	6.9^{b}±0.19
Albumin (g/dl)	2.5±0.10	2.4±0.07	2.5±0.07
Globulin (g/dl)	3.9^{a}±0.22	4.4^{b}±0.18	4.5^{b}±0.19
ALT/SGPT (U/L)	38.4±3.08	38.6±1.90	36.0±2.84
AST/SGOT (U/L)	59.4±6.71	63.0±1.48	62.6±4.93
AKP (U/L)	207.6±4.68	259.2±16.01	282.4±20.98
Creatinine (mg/dl)	1.4±0.08	1.4±0.06	1.4±0.04
Hb (g/dl)	10.4^{a}±0.11	11.4^{ab}±0.46	12.0^{b}±0.20
PCV (%)	31.2±.49	33.6±1.24	33.7±1.24
RBCs ($x10^6$)	7.7±0.23	8.4±0.27	8.4±0.32
WBCs ($x10^3$)	7.4±0.41	8.6±0.48	7.9±0.16

[a,b]Means bearing different superscripts in a row differ significantly at P<0.05

Albumin:-

The albumin is synthesized by liver and catabolized by wide variety of tissues. Albumin supplies a readily available pool of amino acids to meet the tissue needs depending on nutritional status as its synthesis is diminished during fasting or mal-nutrition, hormonal imbalance and general poor condition of liver (Jain, 1993). The average albumin (g/dl) concentration in experimental animals in T_0, T_1 and T_2 groups was 2.46±0.10, 2.42±0.07 and 2.46±0.07, respectively. The treatment groups did not differ significantly (P<0.05) from each other. The levels were within the normal range reported by Kaneko et al. (1997). Chaudhary et al. (2008) and Hossain et al. (2012) reported similar albumin concentration in control animals and the animals given probiotics.

Globulin:-

The serum globulin, especially α and β globulin increased due to acute inflammatory conditions, whereas γ globulins are responsible for the immune status of the animal (Jain 1993). Thus, the comparable serum globulin levels observed during present study indicates that there was no significant inflammatory change in the body and animals maintained normal immune body status. The average globulin (g/dl) concentration in experimental animals in T_0, T_1 and T_2 groups was 3.90±0.22, 4.38±0.18 and 4.48±0.19, respectively, among which T_2 group was significantly (P<0.05) higher than T_0 group. The animals under T_1 group had an intermediate position. The levels were within the normal range, as reported by Kaneko et al. (1997). Chaudhary et al. (2008) and Hossain et al. (2012) reported similar globulin concentration in control animals and the animals given probiotics. However, Piva et al. (1993) reported that glucose, total protein and albumin of blood plasma were not affected by supplementation with yeast culture.

Glucose:-

The serum glucose level is an indicator of physiological condition of the animals. Glucose represents the synthesis of carbohydrates and is in the form in which carbohydrate is supplied to cell from body fluids. The average glucose (mg/dl) concentration in experimental animals in T_0, T_1 and T_2 groups was 48.00±1.30, 64.20±1.50 and 63.20±1.50, respectively, among which T_1 and T_2 groups differed significantly (P<0.05) from T_0 group. Chaudhary et al. (2008) and Hossain et al. (2012) reported similar glucose concentration in control animals and the animals given probiotics. However, Putnam et al. (1997) observed that serum glucose was not affected by daily 10 g yeast culture addition to the diets of lactating cows.

Alanine amino-transferase (ALT)/ Serum glutamic pyruvate transaminase (SGPT):-

Average ALT concentration of experimental animals in T_0, T_1 and T_2 groups was 38.40±3.08, 38.60±1.90 and 36.00±2.84 U/L, respectively. The three groups did not differ significantly (P<0.05) from each other. The levels were within the normal range, as reported by Kaneko et al. (1997).

Aspartate amino-transferase (AST) / Sreum glutamate oxaloacetate transaminase (SGOT):-

The SGOT activity is commonly seen in many tissues and it is a good marker of soft tissue. SGOT is both cyto-plasmic and mitochondrial enzyme which is released even during mild degenerative changes that increase membrane

permeability (Evans 1988). SGOT level is raised during acute and chronic disorders of liver and muscle damage (Cornelius, 1980 and Pensent, 1983). Because of the presence of AST (SGOT) activity in a number of tissues its serum level will be good marker of soft tissue damage, but precludes its use as an organ specific enzyme (Boyd, 1983). Marked elevation of SGOT preceded by lowered creatinine kinase activity could serve as an indicator of muscle damage (Kramer, 1989). In the present study, the average AST concentration of experimental animals in T_0, T_1 and T_2 groups was 59.40±6.71, 63.00±4.93 and 62.60±4.93 U/L, respectively. The three groups did not differ significantly ($P<0.05$) from each other. The levels were within the normal range as reported by Kaneko et al. (1997).

Alkaline phosphatase (AKP):-
The average AKP concentration of experimental animals in T_0, T_1 and T_2 groups was 207.60±4.68, 259.20±16.01 and 282.40±20.98 U/L, respectively. The three groups did not differ significantly from each other. The levels were within the normal range as reported by Kaneko et al. (1997). Hossain et al. (2012) reported that similar AKP levels in animals supplemented with live yeast. Thus, inclusion of live yeast (*Saccharomyces cerevisiae*) in the ration had no influence on serum enzyme profile.

Serum creatinine:-
The average creatinine concentration of experimental animals in T_0, T_1 and T_2 groups was 1.42±0.08, 1.40±0.06 and 1.38±0.04 mg/dl, respectively. The three groups did not differ significantly from each other. The levels were within the normal range as reported by Kaneko et al. (1997). Thus, inclusion of live yeast (*Saccharomyces cerevisiae*) in the ration had no influence on serum creatinine concentration.

Haemoglobin (Hb):-
The average Hb (g/dl) concentration of experimental animals in T_0, T_1 and T_2 groups was 10.36±0.1, 11.44±0.46 and 12.00±0.20, respectively, among which T_1 and T_2 groups differed significantly ($P<0.05$) from T_0 group. The levels were within the normal range as reported by Kaneko et al. (1997).

Packed cell volume (PCV):-
The PCV (%) content of experimental animals in T_0, T_1 and T_2 groups was 31.22±1.24, 33.60±1.24 and 33.70±1.24, respectively. The three groups did not differ significantly from each other. Lesmeister et al. (2004) and Chaudhary et al. (2008) reported similar PCV% in control animals and the animals given probiotics.

Red blood cells (RBCs):-
The average RBCs ($x10^6$) content of experimental animals in T_0, T_1 and T_2 groups was 7.72±0.23, 8.37±0.27 and 8.44±0.32, respectively. The three groups did not differ significantly from each other. Sakine et al. (2011) reported similar RBCs level in control animals and the animals given probiotics.

White blood cells (WBCs):-
The average WBCs ($x10^3$) content of experimental animals in T_0, T_1 and T_2 groups was 7.40±0.41, 8.56±0.48 and 7.90±0.16, respectively. The three groups did not differ significantly from each other.

Digestible nutrients:-

CP and TDN content of TMRs:-
The data on content of CP and total digestible nutrients (%) in TMRs is presented in Table 6**.** The average content of CP was 11.39±0.09, 11.76±0.07 and 11.61±0.11% and TDN was 50.72±1.10, 53.21±1.11 and 54.89±0.51% in T_0, T_1 and T_2, respectively. The CP content of TMRs was significantly higher ($P<0.05$) in T_1 group as compared to T_0 and T_2 groups, whereas, the TDN content of the T_2 group was significantly ($P<0.05$) higher than T_0 and T_1 groups.

CP and TDN intake (as the % of requirement) of animals:-
The average daily CP intake as per cent of requirement (NRC, 2001) of experimental animals in T_0, T_1 and T_2 groups during digestion trial was 120.96±5.46, 121.14±6.39 and 119.63±7.41%, respectively (Table 6). The treatment groups did not differ statistically ($P<0.05$) among themselves. The CP intake was enough to support the performance of experimental animals. The average daily TDN intake as per cent of requirement of experimental animals in T_0, T_1 and T_2 groups during digestion trial was 100.14±0.43, 113.64±5.98 and 115.73±5.38%, respectively. The TDN intake as per cent of requirement in treatment groups was also significantly ($P<0.05$) similar. The data on TDN intake as per cent of requirement indicates more than enough intake of TDN to support the performance of experimental animals

CP and TDN intake of animals:-

The average daily crude protein intake (CPI) and total digestible nutrients intake (TDNI) of experimental animals of T_0, T_1 and T_2 groups, during digestion trial are presented in Table 6. The daily CP intake of experimental animals of T_0, T_1 and T_2 groups, during digestion trial was 818.11±28.03, 848.76±34.52 and 860.24±48.48 g/head and 281.38±14.53, 293.46±15.23 and 292.64±10.42 in terms of g/100 kg body weight and the same when expressed as g/ kg $W^{0.75}$ it was 11.60±0.44, 13.10±0.48 and 12.08±0.27. The CP intake of all the three groups was statistically ($P<0.05$) similar.

Table 6:- Average nutrient intake of experimental animals

Particular	Dietary treatments		
	T_0	T_1	T_2
Average CP intake (as % of requirement)	120.96±5.46	121.14±6.39	119.63±7.41
Average TDN intake (as % of requirement)	100.14±0.43	113.64±5.98	115.73±5.38
Average daily CP intake (g/day)	818.11±28.03	848.76±34.52	860.24±48.48
kg/100 kg body weight	281.38±14.53	293.46±15.23	292.64±10.42
g/kg $W^{0.75}$	11.60±0.44	13.10±0.48	12.08±0.27
Average daily TDN intake (kg/day)	3.69^{a}±0.15	4.03^{ab}±0.20	4.33^{b}±0.15
kg/100 kg body weight	1.27±0.05	1.39±0.08	1.49±0.11
g/kg $W^{0.75}$	52.22^{a}±1.45	57.34^{ab}±2.51	61.40^{b}±3.40
Average daily digestible dry matter (DDM) intake (kg/day)	4.90^{a}±0.31	5.14^{b}±0.21	5.32^{b}±0.30
kg/100 kg body weight	1.67^{a}±0.01	1.77^{b}±0.04	1.81^{b}±0.06
g/kg $W^{0.75}$	68.90^{a}±1.27	72.95^{b}±0.76	74.66^{b}±1.82
Average daily DOM intake (kg/day)	3.44^{a}±0.15	4.11^{b}±0.17	4.18^{b}±0.19
kg/100 kg body weight	1.21^{a}±0.04	1.42^{b}±0.05	1.43^{b}±0.05
g/kg $W^{0.75}$	48.66^{a}±1.78	58.38^{b}±1.05	58.86^{b}±1.06

^{a,b}Means bearing different superscripts in a row differ significantly at $P<0.05$

Pandey and Agrawal (2001b) reported similar CP intake in growing animals given *Saccharomyces cerevisiae* in the ration. The average daily TDN intake of experimental animals of T_0, T_1 and T_2 groups during digestion trial was 3.69±0.15, 4.03±0.20 and 4.33±0.15 kg/head, 1.27±0.05, 1.39±0.08 and 1.49±0.11 kg/100 kg body weight and in terms of g/kg $W^{0.75}$; it was recorded as 52.22±1.45, 57.34±2.51 and 61.40±3.40, respectively. The treatment groups T_1 and T_2 recorded statistically higher ($P<0.05$) TDN intake in terms of g/kg $W^{0.75}$ than T_0 group.

Average daily digestible dry matter intake:-

The average daily digestible dry matter intake (DDMI) of the experimental animals (Table 6) in T_0, T_1 and T_2 groups was 4.90±0.31, 5.14±0.21 and 5.32±0.30 kg/d, respectively and the same when expressed as kg/100kg body weight was 1.67±0.01, 1.77±0.04 and 1.81±0.06 and in terms of g/kg $W^{0.75}$ was recorded as 68.90±1.27, 72.95±0.76 and 74.66±1.82, respectively. The DDMI of animals in T_1 and T_2 groups was significantly higher ($P<0.05$) as compared to T_0 group. It is evident that inclusion of live yeast (*Saccharomyces cerevisiae*) in the ration had an influence on the digestible dry matter intake in terms of kg/day, kg/100 kg body weight and metabolic body weight in the experimental animals.

Average daily digestible organic matter intake:-

The average daily digestible organic matter intake (DOMI) of the experimental animals in T_0, T_1 and T_2 groups was 3.44±0.15, 4.11±0.17 and 4.18±0.19 kg/d, respectively and the same when expressed as kg/100kg body weight was 1.21±0.04, 1.42±0.05 and 1.43±0.05 and in terms of g/kg $W^{0.75}$ was recorded as 48.66 ± 1.78, 58.38 ± 1.05 and 58.86 ± 1.06, respectively. The DOMI (g/kg $W^{0.75}$) of animals fed T_1 and T_2 groups were significantly higher ($P<0.05$) as compared to T_0 group. The intake of digestible organic matter of rations in terms of metabolic body weight was influenced by inclusion of live yeast (*Saccharomyces cerevisiae*) in the ration.

Digestion trial to study digestibility of nutrients:-

Digestibility of nutrients:-

The digestibility coefficients of TMRs for DM, OM, CP, NFE, EE, CF, NDF, ADF, cellulose and hemi-cellulose have been depicted in Table 7.

Table 7:- Effect of YC supplementation on average digestibility coefficients (%) of nutrients

Digestibility coefficients (%)	T_0	T_1	T_2
Dry matter digestibility (DMD)	55.50^{a}±0.93	59.73^{b}±0.79	60.10^{b}±0.75
Organic matter digestibility (OMD)	57.65^{a}±1.40	61.87^{b}±1.38	61.30^{b}±0.38
Crude protein digestibility (CPD)	61.18^{a}±0.62	68.08^{b}±0.84	68.11^{b}±0.93
Nitrogen free extract digestibility (NFED)	57.23±0.83	58.81±0.77	58.20±0.53
Ether extract digestibility (EED)	65.76±2.27	70.88±2.22	68.61±1.03
Crude fibre digestibility (CFD)	53.20^{a}±0.65	62.86^{b}±0.68	63.58^{b}±0.81
Neutral detergent fibre digestibility (NDFD)	57.23^{a}±0.83	59.90^{b}±0.74	59.81^{b}±0.18
Acid detergent fibre digestibility (ADFD)	54.46^{a}±1.58	58.47^{b}±0.76	61.17^{b}±0.46
Cellulose digestibility (CD)	55.35^{a}±0.66	61.25^{b}±0.73	60.53^{b}±0.82
Hemi-cellulose digestibility (HCD)	57.65^{a}±0.87	63.88^{b}±0.81	63.03^{b}±0.94

^{a,b}Means bearing different superscripts in a row differ significantly at P<0.05

Dry matter digestibility (DMD):-

The average DM digestibility coefficient (%) of experimental animals in T_0, T_1 and T_2 groups was 55.73±0.50, 59.73±0.79 and 60.10± 0.75, respectively. The DMD of T_1 and T_2 group was significantly (P<0.05) higher than T_0 group. Rao et al. (2001), Kumar and Reddy (2004) and Mahender et al. (2006) reported higher DM digestibility on feeding yeast culture to animals in experimental group. However, Mir and Mir (1994) did not observe any difference in DM digestibility on account of supplementing probiotics. Thus, inclusion of live yeast (*Saccharomyces cerevisiae*) in the ration had a positive influence on the DM digestibility of nutrients in the experimental animals.

Organic matter digestibility (OMD):-

The average OM digestibility coefficient (%) of experimental animals under T_0, T_1 and T_2 groups was 57.65±1.40, 61.87±1.38 and 61.30±0.38, respectively. The OMD of T_1 and T_2 groups was significantly (P<0.01) higher than T_0 group. Mahender et al. (2006) and Pandey and Agrawal (2001b) also reported higher OM digestibility on feeding yeast culture to experimental animals. Yeast supplementation increased rumen pH, VFA concentration, and OM digestibility and tended to decrease rumen lactate concentration.

Crude protein digestibility (CPD):-

The average CP digestibility coefficient (%) of experimental animals under T_0, T_1 and T_2 groups was 61.18±0.62, 68.08±0.84 and 68.11±0.93, respectively. The CPD of animals under T_1 and T_2 groups were significantly higher (P<0.01) as compared to T_0 group. Pandey and Agrawal (2001b), Kumar and Reddy (2004) and Mahender et al. (2006) reported higher CP digestibility on feeding yeast culture to experimental animals. However, Rao et al. (2001) reported significantly lower CP digestibility (P<0.01) in complete rations of animals supplemented with *Saccharomyces cerevisiae*.

Nitrogen free extract digestibility (NFED):-

The average NFE digestibility coefficient (%) of experimental animals under T_0, T_1 and T_2 groups was 57.23±0.83, 58.81±0.77 and 58.20±0.53, respectively. The treatment groups did not differ statistically (P<0.05) from each other. These findings are corroborated by the reports of Kumar and Reddy (2004) and Chaudhary et al. (2008). However, Mahender et al. (2006) observed significantly (P<0.05) higher NFE digestibility in animals reared on complete diet with yeast culture @ 0.1%.

Ether extract digestibility (EED):-

The average EE digestibility coefficient (%) in T_0, T_1 and T_2 groups was 65.76±2.27, 70.88±2.22 and 68.61±1.03, respectively. With respect to the digestibility coefficient of EE, the dietary treatments did not differ. Other workers viz. Pandey and Agrawal (2001b), Mahender *et al*. (2006) and Hossain *et al*. (2012) did not find any influence of inclusion of *Saccharomyces cerevisiae* to experimental animals on different feeding regime. However, Chaudhary et

al. (2008) and Kumar and Reddy (2004) observed improvement in EE digestibility on account of feeding yeast culture.

Crude fibre digestibility (CFD):-
The average CF digestibility coefficient (%) of experimental animals in T_0, T_1 and T_2 groups was 53.20±0.65, 62.86±0.68 and 63.58±0.81, respectively. The CFD of T_1 and T_2 groups was significantly ($P<0.01$) higher than T_0 group. Kumar and Reddy (2004), Mahender et al. (2006), Francia et al. (2008) and Hossain et al. (2012) also observed improvement in CFD when the animals were supplemented with *Saccharomyces cerevisiae*. Similarly, Guedes et al. (2008) observed improved fibre digestibility with supplemental live yeast on low quality versus high-quality corn silage based ration.

Neutral detergent fibre digestibility (NDFD):-
The average NDF digestibility coefficient (%) of experimental animals in T_0, T_1 and T_2 groups was 57.23±0.83, 59.90±0.74 and 59.81±0.18, respectively. The NDFD of T_1 and T_2 groups was significantly ($P<0.01$) higher than T_0 group. Kumar and Reddy (2004), Mahender et al. (2006) and Francia et al. (2008) also observed improvement in NDFD when the growing animals were supplemented with *Saccharomyces cerevisiae*. Bitencourt et al. (2008) found increased total tract NDF digestion by 11.3%, from 43.2% to 48.1%, with the addition of live yeast to the diet.

Acid detergent fibre digestibility (ADFD):-
The average ADF digestibility coefficient (%) of experimental animals in T_0, T_1 and T_2 groups was 54.46±1.58, 58.47±0.76 and 61.17±0.46, respectively. The ADFD of T_1 and T_2 groups was significantly ($P<0.01$) higher than T_0 group. Kumar and Reddy (2004), Mahender et al. (2006) and Francia et al. (2008) also observed improvement in ADFD when the growing animals were supplemented with *Saccharomyces cerevisiae*.

Cellulose digestibility (CD):-
The average cellulose digestibility coefficient (%) of experimental animals in T_0, T_1 and T_2 groups was 55.35±0.66, 61.25±0.73 and 60.53±0.82, respectively. The CD of T_1 and T_2 groups was significantly ($P<0.01$) higher than T_0 group. Kumar and Reddy (2004), Mahender et al. (2006) and Francia et al (2008) also observed improvement in CD when the animals were supplemented with *Saccharomyces cerevisiae*.

Hemi-cellulose digestibility (HCD):-
The average hemi-cellulose digestibility coefficient (%) of experimental animals in T_0, T_1 and T_2 groups was 57.65±0.87, 63.88±0.81 and 63.03±0.94, respectively. The HCD of T_1 and T_2 groups was significantly ($P<0.01$) higher than T_0 group. Kumar and Reddy (2004), Mahender et al. (2006) and Francia et al. (2008) also observed improvement in HCD when the animals were supplemented with *Saccharomyces cerevisiae*.

Conclusion:-
From the present study, it could be concluded that supplementation of yeast culture (*Saccharomyces cerevisiae*) strains YC-1026 and YC-1077 @ 15 and 1.5 g/animal/day, respectively, in the ration of Kankrej cows was found to be beneficial in improving the rumen fermentation and digestibility of nutrients without affecting bio-chemical profile.

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