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Replacement of Soybean Meal by Yeast Fermented-Cassava Chip Protein (YEFECAP) in Concentrate Diets Fed on Rumen Fermentation, Microbial Population and Nutrient Digestibilities in Ruminants

Kissada Boonnop, Metha Wanapat and Chainarong Navanukraw
Tropical Feed Resources Research and Development Center (TROFREC),
Department of Animal Science, Faculty of Agriculture,
Khon Kaen University, Khon Kaen, 40002, Thailand

Abstract: Four, rumen-fistulated Holstein-Friesian dairy crossbred steers were randomly assigned according to a 4×4 Latin square design to evaluate replacement of Soybean Meal (SBM) by yeast-fermented cassava chip protein (YEFECAP) in concentrate diets on rumen fermentation, microbial protein synthesis, nitrogen balance and nutrient digestibilities of dairy crossbred steers. Animals were replacement levels of SBM by YEFECAP at 0, 33, 67 and 100%, respectively. The results revealed that daily DM intake, rumen ammonia-nitrogen (9.6, 11.9, 13.8 and 15.1 mg% for treatment 1, 2, 3 and 4, respectively) total volatile fatty acids especially molar of propionate (22.0, 23.1, 26.4 and 27.5% for treatment 1, 2, 3 and 4, respectively), fungal zoospores (3.1, 4.4, 7.4 and 6.8×10^5 cell mL^{-1} for treatment 1, 2, 3 and 4, respectively) and bacterial population especially cellulolytic bacteria (1.8, 3.0, 4.2 and 5.2×10^9 cell mL^{-1} for treatment 1, 2, 3 and 4, respectively) and nutrient digestibities were linearly increased ($p<0.01$) with increasing percentages of YEFECAP. The apparent efficiency of net microbial protein synthesis in the rumen increased ($p<0.01$) with concentrate containing proportional increase of YEFECAP. The highest for all parameters were found in treatments 3 and 4 (67 and 100% replacement, respectively). Population of rumen protozoa was significantly decreased with increasing percentage replacement of YEFECAP. Based on this result, the conclusion can be made that using YEFECAP as the main source of protein to completely replace soybean meal was beneficial to cattle in terms of efficiency of rumen fermentation, nutrients digestibities and microbial protein synthesis. However, further study to investigate the use of YEFECAP in productive ruminants especially in lactating cows or feedlot beef cattle should be further investigated.

Key words: Rumen fermentation, volatile fatty acid, microbial population, microbial protein, yeast fermented cassava chip, ruminants

INTRODUCTION

Utilization of these feeds in the tropics including Thailand is limited owing to nutrient deficiencies, particularly of protein (Wanapat, 2003). More important, low quality of proteins has been found in the seasonally dry areas where there is a severe shortage of feed during the dry season was determined by low livestock productivity (Leng, 1990). Concentrate supplemental feeds used to improve overall efficiency of animal production (Wanapat and Cherdthong, 2009) but the expense of importing protein concentrate supplements (soybean meal) limits their widespread use (NRC, 2001). Use of alternative protein sources may help to increase livestock productivity in tropical regions by providing a high protein supplement. In tropical regions, cassava (*Manihot esculenta*, *Crantz*) is an important cash crop widely grown in sandy loam soil receiving low fertilizer application in the dry season (Khampa *et al*., 2006; Wanapat *et al*., 2008). As a crop, cassava root already has advantages in production such as high yields per hectare and as a source of starch (Scott *et al*., 2000). According to Preston and Murgueitio (1992) unfortunately, the protein content of the cassava root is low and as such cannot be regarded as good quality feed for animals. Thus, processes for upgrading the protein value using cassava starch as substrate fermentation by micro-organisms (Antai and Mbongo, 1994). Recently, Oboh and Akindahunsi (2003) reported that *Saccharomyces cerevisae* (10.5%) could also be used for enriching cassava products. There appears to be little information about the utilization in animal feed components upon their

Corresponding Author: Metha Wanapat, Tropical Feed Resources Research and Development Center (TROFREC), Department of Animal Science, Faculty of Agriculture, Khon Kaen University, Khon Kaen, 40002, Thailand

nutritive value. Therefore, the objective of this research was to study the effect of yeast fermented cassasva chip protein (YEFECAP) as a protein source use to replacement for soybean meal in a concentrate diets on rumen ecology would be improving the rumen environment (pH, rumen NH_3-N) to increased fermentation and numbers of cellulolytic bacteria improving the enhance fiber digestibility and microbial protein supply.

MATERIALS AND METHODS

Production process of yeast fermented cassava chip protein: A strain of *Saccharomyces cerevisae* was cultured and inoculated into 0.5 kg of the mash (cassava chip) as the starter culture and 250 mL nutrient solution [urea (48 g) and molasses (24 g)] were added and then allowed for fermentation for 132 h; the incubation temperature and the relative humidity of the air were 30°C and 90-93%, respectively. After, the fermentation, fermented cassava chip were sun-dried and milled into yeast fermented cassava products.

Experimental design, animals and treatments: Four-fistulated dairy steers (Holstein Friesian-based, 380±8.5 kg BW^{-1}) were used in a 4×4 latin Square Design to determine the effects of yeast fermented-cassava chip protein (YEFECAP) on ruminal fermentation, microbial population, digestibility of nutrients, nitrogen balance and ruminal microbial protein synthesis. Dietary treatments were four levels of replacement of soybean meal (SBM) by YEFECAP at 0, 33, 67 and 100% for dietary treatment 1, 2, 3 and 4, respectively.

Experimental feeds and dairy steers management: Urea-Treated Rice Straw (UTRS) was prepared by using 5% urea mixed with 100 kg of water in 10 kg of Rice Straw (RS) batches (50:50, water to straw) and poured over a stack of straw and then covered with a plastic sheet for a minimum of 10 days before feeding to animals (Wanapat and Cherdthong, 2009; Wanapat *et al*., 2009). Concentrates were offered at 1.0% of body weight/hd/day and UTRS 5% was offered *ad libitum* as a roughage source. All animals were kept in individual pens and received free choice of water. Each period lasted 28 days with the first 21 days for diet adaptation followed by 7 days for data collection. Animal were in metabolism crated for total collection during which they were restricted to 90% of the previous voluntary feed intake of straw. Chemical and composition of concentrate and UTS used are shown in Table 1.

Metabolism study: Measurement of daily voluntary feeds intake offered and residues were recorded along with the 24 h and subjected to analysis for proximate composition of sample. During each collection period, Animal were fitted with fecal collection bags and feces were collected twice daily at 8:00 and 16:00 h. Total feces were weighed and subsamples (10% aliquot) were collected and dried in a forced-air oven at 60°C for 48 h. Dried fecal materials were composited by animal in each period and ground to pass a 1 mm screen. Feed samples and feed refusal were collected daily, dried and composited. Dried feed refusal and feed samples were ground similar to the fecal samples. Dried feed, feed refusal and fecal samples were analyzed for Dry Matter (DM), ash, Ether Extract (EE) and Crude Protein (CP) according to procedures of AOAC (1990), Neutral detergent Fiber (NDF) and Acid Detergent Fiber (ADF) as described by Van Soest (1994).

Total urine was collected during the first 24 h of each collection period. Urine was collected at the end of each urination by cutting one of the lower corners of the bag

Table 1: Chemical composition of concentrate and urea-treated rice straw (UTS) (DM%)

	Treatments[1]					
Feed composition	T1	T2	T3	T4	YEFECAP	UTS
Cassava chip	66.3	64.5	61.1	58.5	-	-
Rice bran	8.6	8.4	8.2	8.1	-	-
Molasses	2.1	2.1	2.0	2.0	-	-
YEFECAP	0.0	7.1	16.9	28.0	-	-
Soybean meal	19.5	14.4	8.3	0.0	-	-
Urea	1.0	1.0	1.0	1.0	-	-
Premixture	1.0	1.0	1.0	1.0	-	-
Sulfur	0.5	0.5	0.5	0.5	-	-
Salt	1.0	1.0	1.0	1.0	-	-
Chemical composition (%)						
DM	85.9	84.1	85.8	84.5	85.0	55.6
OM	94.3	95.8	95.9	95.3	94.5	91.5
CP	14.2	14.1	14.3	14.4	30.4	7.9
EE	2.5	3.2	3.9	4.3	5.8	0.9
NDF	14.5	14.7	15.3	16.8	7.5	71.3
ADF	8.7	9.1	9.3	9.6	6.0	42.2

DM = Dry Matter, OM = Organic Matter, CP = Crude Protein, NDF =Nneutral-Detergent Fiber, ADF = Acid, Detergent fiber, YEFECAP = Yeast Fermented-Cassava Chip Protein, Urea-treated rice straw

which was then sealed with an adhesive tape. Following each collection total volume of urine was recorded, acidified with 100 mL of 1 M sulfuric acid (final pH of the urine <3) and sub-sampled. Urine sub-samples (10 mL) were centrifuged at 2000 g for 20 min at 4°C and kept frozen at -20°C prior to analysis. There were urine samples were analyzed for Kjeldahl N (AOAC, 1990) and purine derivatives (allantoin) according to Chen and Gomez (1995).

The amount of microbial purines absorbed (x mmol day^{-1}) corresponding to the purine derivatives excreted (Y mmol day^{-1}) was calculated according to Chen *et al.* (1990) as follows: $Y = 0.84x + (0.15BW^{0.75} e^{-0.25x})$ where BW is the body weight. Microbial N supplied to the small intestine was calculated from microbial purine absorbed (x) according to the equation of Chen and Gomez (1995): Microbial N (g day^{-1}) = 70×/0.83×0.116×1000.

Rumen fermentation: On day 28 of each period, samples of ruminal fluid (300 mL) and jugular blood samples were collected from different sites in the rumen immediately prior to feeding and at 0, 2, 4 and 6 h post-feeding. Rumen fluid was immediately measured for pH and temperature using a portable pH and temperature meter (HANNA instruments HI 8424 microcomputer, Singapore). Rumen fluid samples were then filtered through four layers of cheesecloth.

The samples were divided into three portions. The first portion was used for ammonia-nitrogen (NH_3-N) analysis where 5 mL of H_2SO_4 solution (1 M) was added to 50 mL of rumen fluid. The mixture was centrifuged at 16,000×g for 15 min (Table Top Centrifuge PLC-02, USA) and supernatant was stored at -20°C prior to NH_3-N and Volatile Fatty Acid (VFA) analyses using a HPLC (Instruments by control water model 600 E; water model 484 UV detector; colum novapak C_{18}; colum size 4×150 mm; moblie phase 10 mM H_2PO_4 (pH 2.5) according to Samuel *et al*., 1997). Second portion was fixed with 10% formalin solution in normal saline (Galyean, 1989).

The total direct count of bacteria, protozoa and fungal zoospores were made using the method of Galyean (1989) based on the use of a haemacytometer (Boeco). Third portion was taken to study cultured groups of viable bacteria using roll-tube technique groups (Hungate, 1969) for identifying bacteria group (cellulolytic, proteolytic, amylolytic and total viable count bacteria). Blood samples from jugular vein were collected in serum tubes from all animals at the beginning and end of the experimental feeding. Collected serum samples were stored at -20°C until further analysis of Blood Urea Nitrogen (BUN) according to the method of Crocker (1967).

Statistical analyses: Data were analyzed using Proc GLM (SAS, 1996). The following models were used to determine treatment mean differences using Duncan's New Multiple Range Test.

RESULTS AND DISCUSSION

Feed composition: Chemical composition of DM, OM, CP, EE, NDF and ADF of the YEFECAP were 85.0, 94.5, 30.4, 5.8, 7.5 and 6.0% of DM, respectively. The concentrate supplements and Urea-Treated rice Straw (UTS) contained CP 14.0 and 7.9% of DM, respectively. The OM content was 91.5% of DM in UTS and 94.5% of DM in concentrate diets. Similarly, NDF and ADF contents were in concentrate diets. Whereas, EE content was higher in concentrate supplement yeast fermented cassava chip protein as a protein source (Table 1).

Effect on nutrient intake and digestibility: Intake of concentrate diets, total DM intake and apparent rumen digestibility are shown in Table 2. Voluntary feed intake of urea-treated rice straw and total DM, in terms of BW% were significantly ($p<0.01$). Total DM intake was increased linearly ($p<0.01$) with increasing percentages replacement YEFECAP in concentrate diet and averaged dry matter intake of the urea-treated rice straw varied between 8.29 and 8.70 kg day^{-1} of DM.

In this study, differences in total DM intake of suggest that many factors are known to influence appetite but the ones that have been considered for YEFECAP in ruminants have been palatability. Nevertheless, found that live yeast can increase DM intake, in response was greater with high levels of rumen fermentation carbohydrates patterns (Pinos-Rodriguez *et al*., 2008).

Apparent digestibility of DM, OM, CP, EE, NDF and ADF showed linearly ($p<0.01$) with increasing levels of YEFECAP concentrate diets in these animals. Moreover, NDF digestibility was greater for dairy steer fed diets, which appears to be partially due to a higher DM intake. Emmanuel *et al.* (1970) found an increase digestibility of cellulose of 5.9% with the addition of yeast. Optimum pH for activation of celulase in the rumen is between 6 and 7 (Emmanuel *et al*., 1970; Mertens and Ely, 1979).

Which range has been reported as optimal for microbial digestion of fiber and also digestion of protein 6.5-7.0 (Firkins, 1996). Such effects could explain the improvement of ruminal fiber degradation observed in some studies with experimental animals. Which may have increased rate of passage of fiber particles from the rumen. The factors that influence fiber digestion are: nutritional

Table 2: Effect of YEFECAP on voluntary feed intake and nutrient digestibility in dairy steers

	Treatments[1]					Contrasts[2]		
Items	T1	T2	T3	T4	SEM	L	Q	C
UTS DM intake								
kg day^{-1}	8.29	8.45	8.63	8.70	0.14	NS	NS	NS
BW (%)	2.08^{a}	2.12^{a}	2.22^{b}	2.26^{b}	0.02	**	NS	NS
g kg^{-1} BW$^{0.75}$	93.80	96.20	98.60	97.70	1.60	NS	NS	NS
Total DM intake								
kg day^{-1}	11.80	12.70	12.70	12.60	0.39	NS	NS	NS
BW (%)	3.08^{a}	3.12^{ab}	3.22^{b}	3.26^{b}	0.03	*	NS	NS
g kg^{-1} BW$^{0.75}$	138.20	140.50	143.00	142.20	1.60	NS	NS	NS
Apparent digestibility (%)								
DM	64.00^{a}	66.90^{b}	70.10^{c}	69.20^{c}	0.49	**	NS	NS
OM	67.80^{a}	70.00^{b}	73.10^{c}	75.00^{d}	0.52	**	NS	NS
CP	65.20^{a}	68.80^{b}	73.70^{c}	72.90^{c}	0.51	**	NS	NS
EE	61.60^{a}	64.10^{b}	67.30^{c}	67.00^{c}	0.31	**	NS	NS
NDF	61.10^{a}	64.30^{b}	66.90^{c}	68.10^{d}	0.29	**	NS	NS
ADF	57.90^{a}	61.30^{b}	64.70^{c}	65.80^{c}	0.47	**	NS	NS

[1]L = linear effect, Q = quadratic effect, C = cubic effect; [a, b, c, d] Values on the same row with different superscripts differ ($p<0.05$); T1: Concentrate containing the proportion of soybean meal 100%; T2: , Concentrate containing the proportion of soybean meal and YEFECAP 33:67%; T3: Concentrate, containing the proportion of soybean meal and YEFECAP 67:33%; T4: Concentrate containing, the proportion of YEFECAP 100%, SEM = Standard Error of Means, **$p<0.01$; *$p<0.05$; NS = Non-Significant

Table 3: Effect of YEFECAP on ruminal pH, temperature, NH_3-N and volatile fatty acid (VFA) concentrations in dairy steers

	Treatments[1]					Contrasts[2]		
Items	T1	T2	T3	T4	SEM	L	Q	C
Ruminal pH	6.33^{a}	6.55^{b}	6.59^{b}	6.71^{c}	0.01	*	NS	NS
Ruminal temperature	39.20	39.40	39.40	39.40	0.12	NS	NS	NS
NH_3-N (mg/100 mL)	9.60^{a}	11.90^{b}	13.80^{c}	15.10^{c}	0.40	**	NS	NS
BUN (mg/100 mL)	15.80^{a}	13.60^{b}	11.40^{c}	12.20^{c}	0.33	**	NS	NS
Molar proportion of VFA (moL/100 moL)								
Total VFA (mmol L^{-1})	104.70^{a}	108.00^{a}	114.70^{b}	116.10^{b}	1.70	**	NS	NS
Acetic acid (%)	63.40^{a}	62.60^{ab}	59.70^{bc}	58.60^{c}	1.20	*	NS	NS
Propionic acid (%)	22.00^{a}	23.10^{a}	26.40^{b}	27.50^{b}	0.85	**	NS	NS
Butyric acid (%)	14.60	14.30	14.00	13.90	0.60	NS	NS	NS
C_2/C_3 ratio	3.30^{a}	2.00^{ab}	2.70^{bc}	2.50^{c}	0.14	**	NS	NS

[1]L = linear effect, Q = quadratic effect, C = cubic effect; [a-d]Values on the same row with different superscripts differ ($p<0.05$); T1: Concentrate containing the proportion of soybean meal 100%; T2: Concentrate containing the proportion of soybean meal and YEFECAP 33:67%; T3: Concentrate containing the proportion of soybean meal and YEFECAP 67:33%; T4: Concentrate containing the proportion of YEFECAP 100% SEM = Standard Error of Mean, **$p<0.01$; * $p<0.05$; NS = Non-Significant

factors such as lignin content, physical form and carbohydrate, mineral and nitrogen content and characteristics of rumen environment such as pH and microbial population (Kawas *et al*., 2007).

Effect on rumen fermentation: Rumen temperature, pH, NH_3-N, VFA and BUN concentration are shown in Table 3. The rumen temperature in rumen fluid of dairy steer was not different significantly ($p>0.05$). Mean average rumen fluid pH was increase ($p<0.01$) but ranged from 6.33-6.71 among treatments. The higher pH observed for concentrate diets containing increasing levels of YEFECAP. Thus, YEFECAP is likely more effective in stimulating the chewing activity and saliva production than soybean meal which helps explain the linearly effect on ruminal pH as a result of particle size inclusion. Several animal studies have reported effects of live yeasts on rumen pH stabilisation. A pH stabilisation effect was also reported in rumen cannulated dairy cows fed an active dry yeasts daily. In these studies, higher rumen pH occurred together with lesser lactate concentrations in the rumen of supplemented animals (Williams *et al*., 1991).

Moreover, rumen cannulated sheep receiving anactive dry yeasts during their adaptation to a high-concentrate diet, it has been reported that rumen pH was maintained at values compatible with an efficient rumen function as shown by higher fibrolytic activities in the rumen of the supplemented animals versus controls (Chaucheyras-Durand and Fonty, 2006). The ammonia nitrogen concentration in ruminal fluid of dairy steer was higher ($p<0.01$) with group-fed concentrate containing the proportion of YEFECAP (33, 67, 100%) while on the other group-fed the concentration decreased. This value is greater than 5 mg NH_3-N mg^{-1} proposed by Satter and Slyter (1975) proposed by Wanapat and pimpa (1999) as necessary for maximization of microbial growth and digestibility in the rumen, respectively. However, Leng (1990) reported that values close to 10 mg NH_3-N g^{-1} as

Table 4: Effect of YEFECAP on microbial population in the rumen of dietary steers

	Treatments[1]					Contrasts[2]		
Items	T1	T2	T3	T4	SEM	L	Q	C
Total direct count (Cell mL^{-1})								
Bacteria (×10^{10})	2.6^{a}	3.6^{b}	5.1^{c}	6.4^{d}	0.19	**	NS	NS
Protozoa (×10^{5})	15.4^{a}	12.3^{a}	7.0^{b}	7.7^{b}	1.1	**	NS	NS
Fungi zoospores (×10^{5})	3.1^{a}	4.5^{b}	7.5^{c}	6.8^{c}	0.37	**	NS	NS
Grouping bacteria (CFU mL SEM)								
Total viable bacteria (×10^{9})	3.0^{a}	4.0^{b}	7.0^{c}	7.3^{c}	0.24	**	NS	NS
Cellulolytic bacteria (×10^{9})	1.9^{a}	3.1^{b}	5.0^{c}	5.4^{c}	0.22	**	NS	NS
Amylolytic bacteria (×10^{8})	2.9^{a}	3.2^{ab}	4.3^{c}	4.0^{cd}	0.34	*	NS	NS
Proteolytic bacteria (×10^{8})	1.9^{a}	2.2^{b}	4.6^{c}	3.6^{d}	0.25	**	NS	NS

[1]L = linear effect, Q = quadratic effect, C = cubic effect; [a-d]Values on the same row with different superscripts differ ($p<0.05$); T1: Concentrate containing the proportion of soybean meal 100%; T2: Concentrate containing the proportion of soybean meal and YEFECAP 33:67%; T3: Concentrate containing the proportion of soybean meal and YEFECAP 67:33%; T4: Concentrate containing the proportion of YEFECAP 100% SEM = Standard Error of Mean, **$p<0.01$; *$p<0.05$; NS = Non-Significant

Table 5: Nitrogen blance, excretion of Purine Derivatives (PD) in dairy steers used to YEFECAP replacement protein source for soybean meal in concentrate feed

	Treatments					Contrasts[1]		
Items	T1	T2	T3	T4	SEM	L	Q	C
Nitrogen balance (g day^{-1})								
N Intake	178.9^{a}	184.4^{b}	186.9^{b}	191.4^{c}	0.75	*	NS	NS
N Fecal	77.0^{a}	74.0^{b}	72.9^{bc}	70.9^{c}	0.84	**	NS	NS
N Urinary	68.0^{a}	65.2^{b}	62.2^{c}	61.7^{c}	0.74	**	NS	NS
N Absorption	101.9^{a}	110.4^{b}	114.0^{b}	120.5^{b}	1.00	**	NS	NS
N Retained	33.9^{a}	45.2^{a}	51.8^{b}	58.8^{c}	1.59	**	NS	NS
N Retained, %	19.1^{a}	24.5^{b}	27.7^{c}	30.7^{d}	0.10	**	NS	NS
Allantoin excretion								
mmol day^{-1}	135.0^{a}	149.0^{b}	162.3^{c}	177.8^{d}	2.7	**	NS	NS
Purine excretion	158.8^{a}	175.8^{b}	190.9^{c}	209.1^{d}	3.3	**	NS	NS
Purine absorption	124.9^{a}	141.5^{b}	157.1^{c}	175.2^{d}	3.0	**	NS	NS
Microbial N supply (g day^{-1})	90.8^{a}	102.9^{b}	114.2^{c}	127.4^{d}	2.3	**	NS	NS
Efficiency of microbial N synthesis								
(g microbial N kg^{-1} DOMR)	18.8^{a}	19.0^{a}	20.2^{a}	22.0^{b}	0.33	**	NS	NS

[1]L = linear effect, Q = quadratic effect, C = cubic effect; [a-d]Values on the same row with different superscripts differ ($p<0.05$); DOMR: Digestible Organic Matter in Rumen; T1: Concentrate containing the proportion of soybean meal 100%; T2: Concentrate containing the proportion of soybean meal and YEFECAP 33:67%; T3: Concentrate containing the proportion of soybean meal and YEFECAP 67:33%; T4: Concentrate containing the proportion of YEFECAP 100%, SEM = Standard Error of Mean, **$p<0.01$; *$p<0.05$; NS = Non-Significant

non-limiting for microbial growth in tropical conditions. Results have been variable for rumen ammonia-N concentrations when *Saccharomyces cerevisiae* has been supplemented by others with no differences or an increment (Newbold *et al*., 1995) which may have been due to a response of rumen microorganisms to substrate supply rather than a shift in fermentation (Newbold *et al*., 1995). Further, studies use to increasing level of YEFECAP replacement soybean meal were due to higher activities of proteolytic and cellulolytic bacteria in the rumen which may partly explain the increase in ruminal NH_3-N in the present study.

Blood urea nitrogen was significantly decreased with increasing percentages replacement YEFECAP. In the present study, the group concentrate containing the proportion of soybean meal (33, 67, 100%) fed the experimental diet had higher blood urea nitrogen concentrations than those fed the YEFECAP 100% diet. The values of blood urea nitrogen constituents under investigation were with in normal range as reported by Rosler *et al*. (1993). Total VFA and propionic production in rumen fluid of dairy steer were affected ($p<0.01$) with increasing percentages replacement YEFECAP. Concentration of acetic acid and acetic acid to propionic acid ration significantly different ($p<0.01$) were among treatments, it trended to be lower in increasing percentages replacement YEFECAP. Butyric acid concentration was not different ($p>0.05$) among treatments.

The high concentration of propionate observed in this study coincides with results reported by Kawas *et al*. (2007) who observed that yeast in the diet maintained a high rumen pH and altered rumen microbial populations subsequently increasing activity that molar percent propionate was higher than that of acetate.

Fermentations high in propionate are more energetically efficient that those high in acetate (Hungate, 1969). Which are positive effects of feeding yeast on

ruminal fermentation may be related to DM intake since *Saccharomyces cerevisiae* influences microbial colonization in the rumen which could influence fermentation, principally of carbohydrates which would stimulate DM intake (Galvao *et al*., 2005).

Effect on ruminal microbial population: The population of total bacteria, total viable bacteria, cellulolytic bacteria, amylolytic bacteria, proteolytic bacteria and fungi higher in concentrate containing the proportion of YEFECAP (33, 67, 100 %) were significantly ($p<0.01$) when compared with the concentrate containing the proportion of soybean meal 100% (Table 4). Protein source for YEFECAP used in dairy steer are usually containing as mixtures of a few grams of live or death cell of yeast nutrients in yeast may also be responsible for the stimulation of bacterial population observed in the present study.

As pointed out by Jouany (2006) some researchers have suggested that this could be due to the stimulation of bacterial population of the yeast cells in the rumen may be related to the ability of yeast cells to decrease potentially inhibitory concentration of rumen fluid oxygen for rumen microbes. The result for microbial population agree with Kumar *et al*. (1997) who reported that yeast supplement could be increase total bacteria, total viable bacteria, cellulolytic and amylolytic in rumen.

Population of rumen protozoa was significantly decreased with increasing percentages replacement YEFECAP. In some studies, protozoal numbers were decrease in sheep when *Saccharomyces cerevisiae* was added. *Saccharomyces cerevisiae* had no effect on the predatory activity of protozoa but numbers tended to reduce in sheep (Corona *et al*., 1999).

Effect on nitrogen retention and microbial protein synthesis: Nitrogen retention and microbial protein synthesis are shown in Table 5. N absorption and retention were significantly ($p<0.01$) different among treatments. Fecal and urinary N excretion were decrease ($p<0.01$) in animals fed concentrate containing the proportion of YEFECAP (33, 67, 100%). N-retention expressed as g day^{-1}, percent of intake as well as percent absorbed increased with increasing percentages replacement YEFECAP.

The N-balance is considered as the most common index of the protein nutrition status of ruminants (Owens and Zinn, 1988). Therefore, higher N intake, greater protein and organic digestibilities are resulted in higher N-balance. Moreover, positive nitrogen retention in all the groups was replacement soybean meal by YEFECAP in dairy steer. As expected, there was a substantial increase in the level of allantoin in the urine of dairy steer fed, when replacement level of soybean by YEFECAP meal (33, 67, 100%) as a protein source in concentrate diets. Microbial N supply (g day^{-1}) and Efficiency of Microbial N Synthesis (EMNS) were higher ($p<0.01$) with concentrate containing the proportion of YEFECAP (33, 67, 100%). Urinary purine derivatives are the by products of ruminal microbial protein degradation (Chen *et al*., 1990) and when OM or N intake is increased in ruminants, microbial protein synthesis is typically increased. Therefore, the higher OM and N intake in dairy steer fed diets containing YEFECAP in this study, probably explains their greater purine-derivative output and their higher microbial N yield and efficiency of microbial N synthesis.

CONCLUSION

Based on this result, the conclusion can be made that using YEFECAP as the main source of protein to completely replace soybean meal was beneficial to cattle in terms of efficiency of rumen fermentation, microbial protein synthesis, nitrogen retention and nutrients digestibities. However, further study to investigate the use of YEFECAP in productive ruminants especially in lactating cows or feedlot beef cattle should be further investigated.

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