ORIGINAL ARTICLE

EFFECT OF PROBIOTIC FEEDING ON MILK YIELD AND COMPONENTS OF CROSSBRED DAIRY GOATS

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ABSTRACT

A feeding trial was conducted to determine the effect of live probiotic supplements on milk yield and components of crossbred dairy goats. Sixteen lactating crossbred Anglo-Nubian x Saanen dairy goats in early to mid-lactation, 35-40 kg body weight, were randomly assigned into four treatments (four animals per treatments) fed daily with 6 ml of 5 x 10^9 cfu/ml probiotic supplements for 9 weeks: Treatment 1- control (w/o probiotics); Treatment 2 - lactic acid bacteria (*Pediococcus acidilactici* 3G3 and *Lactobacillus plantarum* BS), Treatment 3 - *Saccharomyces cerevisiae* 2030; and Treatment 4 - multi-strain probiotic (*P. acidilactici* 3G3, *L. plantarum* BS, and *S. cerevisiae* 2030). Daily rations for each of the experimental animals consisted of 1 kg concentrate mixed-feed and 4 kg fresh *Pennisetum purpureum* and *Gliciridia sepium* leaves. Results of the study revealed that the milk yield of crossbred lactating goats were not significantly ($P \leq 0.05$) affected by probiotic feeding but induced a total net income increase of PhP8.82 per animal/day compared to the control group. Milk components such as total milk fat yield, solid-non-fat, and lactose were significantly affected ($P \leq 0.05$) by probiotic feeding while total protein yield remained unchanged throughout the experimental period. The findings suggest that live probiotic feeding could have a significant role in improving milk yield and components of crossbred lactating dairy goats.

Keywords: dairy goat, *Lactobacillus*, milk yield, probiotic, *Saccharomyces*

INTRODUCTION

The increasing popularity of goat husbandry throughout the world is shown by the rise in the number of small herds maintained by individuals either as a source of income or as an avocation. Its production in the country is considered as a sunrise industry that is slowly gaining favor with investors (National Science and Technology Program for Slaughter Goat, 2013). They are the best sources of meat, milk, and fiber. Goats require low maintenance because they eat tree leaves, weeds and agricultural by-products and require less feed than cows and carabaos. Despite the potential of goat-raising as an enterprise, in the Philippines total production and value have been one of the lowest in the livestock sector. From 2008 to 2012, the annual average volume of goat production is 77,600 mt (BAS, 2013), representing only 3.24% of the annual average volume of

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livestock production. Various factors such as production environment, climatic conditions, breed, nutrition, poor reproduction techniques and diseases have been pointed out to significantly cause mortality resulting to production losses in goat husbandry (Peters and Laes-Fettback, 1995; Kumar *et al*., 2003 ; Gorski *et al*., 2004).

For many years, manipulation of microbial ecosystem with the use of antibiotics and many other chemicals has been tried on ruminants in order to improve utilization of fibrous feeds. But due to the disadvantages of feeding of antibiotics, like toxicity, allergy and the residues of these feed additives in livestock products, their use is being discouraged (Ramaswani *et al*., 2004). The use of live microbial supplements, such as probiotic, provides a suitable alternative (Wallace and Newbold, 1993; Newbold *et al*., 1996; Jouany *et al*., 1998; Ando *et al*., 2004; Chen *et al*., 2004; Dey *et al*., 2004; Sar *et al*., 2004). Fuller (1989) defined probiotics as "live microbial feed supplement which beneficially affects the host animal by improving its intestinal microbial balance." This definition encompasses single strain or a mixture of two or more species/strains of microbes, with or without growth medium.

In several experiments, supplementing dairy cows with lactate-utilizing and/or lactate-producing bacteria has been shown to increase milk yield (0.75 to 2.0 kg/d) with little change in milk composition (Krehbeil *et al*. 2003). Lehloenya *et al*., (2007) reported a 9% increase in milk yield when a mixture of yeast and *Propionibacterium spp.* was fed to dairy cows from 2 weeks pre-partum to 30 weeks post-partum. Vibhute *et al*. (2011) similarly noted an increased milk yield accompanied with higher milk fat, milk protein and SNF in cows supplemented with multi strain probiotic containing *Lactobacillus acidophilus, Saccharomyces cerevisiae, Saccharomyces boulardii* and *Propionibacterium frendenreichii.* Nevertheless until now, most of the research trials have been performed in bovine with less data on small ruminants. Thus, the present study was undertaken to assess the effect of probiotic feeding on milk yield and components of crossbred lactating dairy goats.

MATERIALS AND METHODS

The experiment was conducted at the Naawan Agricultural Development Center (NADC) Goat Project, Naawan, Misamis Oriental. The experimental trial was conducted during the period of 12 September 2014 until 15 November 2014.

Sixteen (16) crossbred Anglo-Nubian x Saanen lactating dairy goats in early to mid-lactation, with body weights ranging from 35 to 40 kg were randomly assigned into four treatments (four animals/treatment) fed daily with or without 6 ml of 5 x 10^9 cfu/ml live probiotic supplements: T1 – control (without probiotic supplements); T2 - lactic acid bacteria (*P. acidilactici 3G3, L. plantarum BS*); T3 – *S. cerevisiae 2030*; and T4 – multi-strain probiotics (*P. acidilactici 3G3, L. plantarum BS, S. cerevisiae 2030*). Throughout the nine weeks of experimental feeding trial, each of the experimental animals were provided daily with 4 kg (50:50) freshly cut *Pennisetum purpureum* and *Gliciridia sepium* leaves and 1 kg mixed concentrate feed (dried *Leucaena leucocephala* leaves and pollard) with free access to fresh and clean water. Fresh grasses and leaves were offered every 9:00 AM, while mixed concentrate feed was offered every 1:00 PM. Proximate analysis of feed used are presented in Table 1.

Probiotic feed supplements were produced in a large scale using coconut paring meal extract and coconut water as base substrate and nutrient source. The optimized specific parameters for *Lb. plantarum BS* and *P. acidilactici 3G3* and *S. cerevisiae 2030* are shown in Table 2.

Table 1. Proximate analysis of dairy goat diet.

Contents %	Napier grass	Madre de cacao leaves	Mixed ipil-ipil leaves & pollard
Moisture	3.90	4.31	11.06
Dry matter	96.10	95.69	88.94
Ash	14.44	8.19	6.30
Crude protein	11.26	20.08	15.35
Crude fiber	31.68	20.06	2.57
Crude fat	1.85	6.59	49.28
Nitrogen free extract	36.87	40.77	1.14
Calcium	0.02	1.45	1.14
Phosphorus	0.62	0.33	0.62

Table 2. Optimized specific parameters for probiotic supplements.

Parameter	*L. plantarum BS*	*P. acidilactici 3G3*	*S. cerevisiae 2030*
Coco paring meal extract	8.38%	40%	-
Coconut water	83.85%	50%	25%
Molasses	2%	0.50%	20%
$(NH_4)_2 SO_4$	-	-	0.52%
Yeast extract	0.50%	0.50%	-
K_2HPO_4	0.20%	2.%	0.15%
Trisodium citrate	0.20%	0.20%	0.06%
$MnSO_4$	0.10%	0.20%	3.91%
$MgSO_4$	0.02%	0.05%	-
Tween 80	0.10%	0.02%	-
Sodium Acetate	0.50%	0.10%	-
Incubation period	37°C for 24 hr	37°C for 24 hr	30°C at 20-24 hr
Agitation speed	-	-	100-125 rpm

Four ml of each medium for a specific culture was produced and sterilized at 15 psi (121ºC) for 15 min and stored at room temperature prior to inoculation. About 3 to 5% of the cultures *Lb. plantarum BS, P. acidilactici 3G3* and *S. cerevisiae 2030* were inoculated into the specified medium and incubated at 37ºC for 24 hr and 30°C for 20-24 hr, respectively. Afterwards, the produced probiotic feed supplements were dispensed into sterile plastic containers according to treatments: T_2 – 50% *Lb. plantarum BS* and 50% *P. acidilactici 3G3*; T_3 – 100% *S. cerevisiae 2030*; T_4 – 33% *Lb. plantarum BS*, 33% *P. acidilactici 3G3* and 33% *S. cerevisiae 2030* . These containers were stored under refrigeration until used.

Lactating dairy goats were orally fed daily with 6 ml of 5 x 10^9 cfu/ml of lactic acid bacteria, *S. cerevisiae 2030*, and their combinations for 9 weeks. Feeding of probiotics was administered orally with the aid of 10 ml syringe every morning at around 7:00 AM before milking. Milking of the experimental animals was conducted once daily every 8:00 AM, where animals had free access to urea molasses mineral salt block. Milk yield was individually weighed and recorded daily. A 7-ml composite milk sample was taken once a week from each of the experimental animals for the analyses of fat, protein, lactose and solid-non-fat. Analyses of the milk quality drawn from the experimental animals were done at Highland Fresh Laboratory Center, El Salvador, Misamis Oriental using milk sonic analyzer machine.

Analysis of Variance (ANOVA) of Randomized Complete Block Design (RCBD) was used in determining the significant result of the different factors. Differences among treatment means were determined using Least Significant Difference (LSD). All data obtained from the study were processed and analyzed using SPSS version 20 with homogeneity of variance tested using Levene's Test.

RESULTS AND DISCUSSION

Total milk yield from crossbred lactating dairy goats orally fed with lactic acid bacteria, yeast and their combination are presented on Figure1. Data showed that probiotic-treated groups such as T_2, T_3, and T_4 had slightly higher milk yield when compared to T_1 (control). However, based on ANOVA, no significant (P>0.05) differences between probiotic-treated groups and control group were observed. The non-significant effects on milk yield upon probiotic supplementation were also reported by several authors - Griger-Reverdein *et al*. (1996) and Hadjipanayiotou *et al*. (1997) in dairy goats and Wang *et al*. (2001), Raeth-knight (2007) and Oetzel *et al*. (2007) in dairy cows. Contrary to these findings, positive response on milk yield with probiotic supplementation were also reported in goats (Rekleweska *et al*., 2000; Abd El-Ghani *et al*., 2004; Stella *et al*., 2007) and in cows (Savoini *et al*., 2000; Dutta *et al*., 2008; Ayad *et al*., 2013). Varied responses in milk yield to probiotic supplementation could be due to several factors such as animal characteristic (genetics, condition, and age); environment (stressors pathogens), and the type of diet (proportion of fiber, sugar and protein) which can play a part in the animal response towards probiotics (Williams *et al*., 1991; Piva *et al*., 1993; Lesmeister *et al*., 2004).

Milk composition and quality are important attributes that determine the nutritive

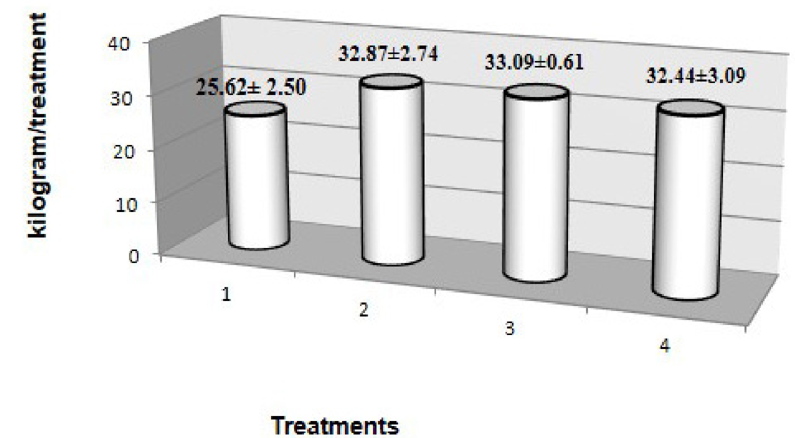

Figure 1. Effect of probiotic feeding on total milk yield of crossbred lactating dairy goats.

value and consumer acceptability. In this study, significant differences (P<0.05) between the probiotic-treated groups and non-treated group in terms of fat, solid-non-fat and lactose yield were observed (Table 3). No significant differences however, were found among the treatment groups in protein yield.

The findings of this study are in harmony with the findings of Abd- El Ghani *et al*., (2004) who reported significant (P≤0.05) increase in milk fat yield and lactose yield of goats fed rations with 6 g/day yeast culture (YC) compared to 3 g/day YC and the control. Stella *et al*., (2007) also reported higher lactose yield on goats fed with *S. cerevisiae* compared to the control group. Vibhute *et al*., (2011) reported higher (P≤0.05) SNF yield in cows supplemented with multi-strain probiotics. In this experiment, the significant increase in milk fat, solid-non-fat, and lactose yield observed from microbial treated groups, particularly

Table 3. Effect of probiotic feeding on milk components of crossbred dairy goats.

Treatment	In kgs/treatment			
	Fat	Protein	Solid-non-Fat	Lactose
T_1 - Control	19.22±1.34^b	10.83±0.73	24.74±2.63^b	11.73±0.84^b
T_2 – LAB	26.99±2.52^a	13.27±1.34	34.10±3.38^a	14.94±1.09^a
T_3 - *S. cerevisiae 2030*	29.43±0.74^a	14.97±1.56	38.36±1.04^a	17.12±0.68^a
T_4 - Multi-strain	27.38±2.40^a	13.46±0.73	34.47±3.90^a	14.82±1.13^a

Mean and standard error of mean (±SEM) of fat yield, protein, solid-non-fat, and lactose obtained during the 63 days experimental trial from four (4) treatments. Values on the same vertical columns followed with different letters are significantly different (P≤0.05).

in T3, could be due to enhanced microbial activity stimulated by yeast culture inside the rumen which increases cellulolysis and microbial protein flow living in the rumen (Denev *et al*., 2007). This increases nutrient availability in the mammary gland to be utilized in the synthesis of milk components. Yeast culture has been known to stimulate growth of ruminal bacteria and increase the concentration of the specific groups of beneficial bacteria (Jouany, 2001; Dawson, 2002; Dawson and Tricarico, 2002) such as anaerobic bacteria, cellulolytic bacteria, lactic-acid-utilizing bacteria (Edwards, 1991; Girard *et al*., 1993; Girard, 1997; Jouany, 2001) and bacteria that convert molecular hydrogen to acetate in the rumen (Chaucheyras *et al*., 1995). These increased microbial concentrations are expected to lead to an increase of microbial activities enhancing digestive processes (Newbold *et al*., 1996), fiber digestion and reduce lactate accumulation, reduce the concentration of oxygen in rumen fluid and improve utilization of starch supplied in the feeding ration.

Moreover, no significant differences were found between the treatment groups in terms of protein yield. The result was found to be consistent with other studies on goats (Stella *et al*., 2007), ewes (Masek *et al*., 2007), cows (Raeth *et al*., 2007) and buffaloes (Degirmencioglu *et al*., 2013). On the other hand, several authors reported positive response in milk proteins of cows upon probiotics supplementation (Ondarza *et al*., 2010; El-Ashry *et al*., 2003 and Abdel-Khalek, 2003). Ayad *et al*. (2013) stated that dietary supplementation of *S. cerevisiae* is not always associated with improved protein content of milk. Opposite to milk fat, the amount of protein found in milk is not easily affected by dietary alteration. Hence, the synthesis of casein from the amino acid taken up from the blood is under the control of genetic material (Massimo *et al*., 2012).

The economic analysis of probiotic feeding in comparison to control based on the mean milk yield of experimental animal per treatments during the 63 days of feeding trial is shown in Table 4. The experimental animals were provided with the same kind and amount of feed throughout the experimental period. Hence, only probiotic cost was considered in the computation to avoid unnecessary calculations. Economic analysis showed that probiotic-treated groups could yield a higher net income compared to the control group despite the added cost of probiotics. The slight increase in milk yield from the probiotic-treated groups (26.79% or 0.46 kg/animal/day) created an average net income of PhP 8.82 per animal/day. Thus, the obtained economic benefit from probiotic feeding could provide an assurance that the use of microbial products could help in improving daily farm income of the farmers.

Table 4. Economic benefits of probiotic feeding in crossbred dairy goats.

Parameter	Treatment*			
	T1	T2	T3	T4
Average milk prod'n/ animal	25.623	32.87	33.09	32.44
Probiotic used/animal (ml)	-	378.00	37.00	378.00
Cost of probiotic/ml	-	0.05	0.05	0.05
Price of milk/liter	80.00	80.00	80.00	80.00
Total income of milk	2,049.60	2,629.60	2,647.20	2,595.00
Total cost of probiotics	-	18.90	18.90	18.90
Net income/animal	2,049.60	2,610.70	2,628.30	2,576.10
Net income /animal/day	32.53	41.44	41.72	40.89

*T1 – control; T2 - LAB (P. acidilactici 3g3, L. plantarum BS); T3 – S.cerevisiae 2030; T4 – multi-strain (combined T2 & T3).

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