Research Article:

PERFORMANCE OF CROSSBRED GOAT KIDS (Khari × Jamunapari) FED WITH RICE POLISH AND MAIZE FLOUR SUPPLEMENTED WITH PROBIOTICS AND ENZYMES IN TANAHUN DISTRICT

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ABSTRACT

An experiment was conducted on 16 crossbred goat kids (Khari×Jamunapari) aged approximately 3-4 months under farmer-managed conditions in Myagde-3, Tanahun, Nepal, from November 15, 2019, to February 15, 2020. The aim of this study was to determine the effects of feeding on crossbred goat kids (Khari × Jamunapari) fed rice polish and maize flour supplemented with probiotics and enzymes. The animals were assigned to a randomized complete block design (RCBD) on the basis of body weight with 4 treatments and were replicated 4 times. The treatment combinations included fodder only (T_1), fodder + rice polish + probiotics + enzymes (T_2), fodder + maize flour + probiotics + enzymes (T_3), and fodder + rice polish + maize flour + probiotics + enzymes (T_4). The parameters studied included proximate nutrient analysis of the feed ingredients, feed consumption, the feed conversion ratio, growth parameters (body length, wither height, heart girth and neck girth) and economic analysis. Body weight gain was recorded at fortnightly intervals, and body weight was measured once a month. The cumulative body weight and fortnightly and daily body weight gains were greatest in the goats reared on fodder + rice polish + maize flour + probiotics + enzymes (T_4), at 15540.00 g, 7690.00 g, and 91.55 g, respectively. The mean daily feed consumption was highest in goats fed fodder + maize flour + probiotics + enzymes (T_3), at 567.54 g. The feed conversion ratio of 5.48 was highest in goats fed fodder along with rice polish and maize flour supplemented with probiotics and enzymes. The greatest body length (4.25 inches), wither height (3.250 inches) and heart girth (4.750 inches) were detected in goats fed fodder along with rice polish and maize flour supplemented with probiotics and enzymes. The highest (1: 3.31) benefit cost ratio was obtained from goats reared on fodder + rice polish + maize flour + probiotics + enzymes (T_4), and the lowest (1: 2.00) benefit cost ratio was obtained from those reared on fodder only (T_1). The results obtained from the feeding trial revealed that crossbred goat kids (Khari × Jamunapari) reared on fodder supplemented with rice polish and maize flour supplemented with enzymes and probiotics improved live weight, daily live weight gain, feed efficiency, net profit over the control, and the cost ratio.

Keywords: crossbred goat kids, feeding, growth parameters, supplemented

INTRODUCTION

In subsistence agriculture, goats are remarkably well accustomed to withstanding and surviving in harsh environments (Devendra & Burn, 1970) and have the largest ecological spectrum of any domesticated species (Epstein, 1997). Goat's business is feasible for landless, marginal and small farmers; it provides continuous income and employment to farm families, including women and children with low input. Goat Farming, as a business, is a rapidly increasing enterprise in Nepalese landscapes. These are raised for diverse purposes (Kattel, 2016) to offer horns,

hooves, blood and bone meals; for power; and for the transportation of meat, milk, manure and fibers in the country (Upreti & Mahato, 1995).

According to MoAD (2012), the livestock sector was responsible for 14% of GDP and 32% of AGDP, thus demonstrating the key importance of the livestock sector to the national economy. However, it was shown that goat meat was responsible for 20% of the total livestock supply. In particular, small ruminants, among which goats are more noticeable, are highly important in terms of the total supply of livestock.

Goats, particularly small ruminants, are remarkably valuable to the entire livestock industry. In the hills of Nepal, goats make up the majority of ruminants; 49.66% of the total ruminants are from hills, followed by Terai, where 36.47% are from hills. However, the predominance of high mountain sheep cannot be ignored. In Nepal, the number of goats was approximately 11.2 million in 2016--17 (MOAC, 2017). Province 1 has a population of approximately 2.2 million, province 2 has 1.3 million people, province 3 has 2.4 million, province 4 has 1.2 million inhabitants, province 5 has 1.8 million, province 6 has 1 million and province 7 has 1.2 million (MOAC, 2017).

According to the MOAC (2011), approximately 75% of households in Nepal are engaged in goat farming. This reflects the preference of the farmers for goats over other livestock species. Goats live under traditional management practices that include an open grazing system. The method of raising goats is extensive and involves less investment, natural grassland, forestland and crop residues. The increase in the number of goats helps poor families in rural areas as a side financial opportunity. Farmers generally use seasonal fodder and natural resources to keep goats, which means that they are not very cautious about the energy, protein, vitamin and mineral requirements of goat feed. Grain leftovers such as maize flour, rice polish or wheat bran are usually fed to goats by farmers only in the late stage of pregnancy or when they are kidding. The absence of proper nutrition, which is related to unsatisfactory conditions and resulting heavy losses, is the main factor leading to the low productivity of the goat production chain. The most critical economically bound traits of goats, such as growth and reproduction, are directly related to the protein and energy contents of the feed and forage.

The total digestible nutrient (TDN) feed balance at the country level decreased from 30.9% in the 1980s to 20.05% in 2016/17, with a maximum value of -24.09% in the middle hills sector, followed by Terai, with a value of -18.91. The ecological belt showed a good situation of feed in high hills, with a deficit of -3.56% (Rajbhandari & Shah,1981). Regions 1 and 3 of Nepal were the most affected, with values of -30.48% and -38.44%, respectively. The feed deficit in the remaining provinces varied from -9.19% to -15.85%, whereas a positive balance was observed in Province 6 (+6.35%) (Singh et al., 2019). In general, the inadequate production and poor performance of animal husbandry are a result of a low supply of good-quality animal feeds as well as the inefficient use of available feed resources. The feeding resources of Nepal are crop residues, rice and wheat straw, maize stovers, tree fodder, leaf litter and other green fodder that can be collected from cultivated lands and forests.

Most small ruminants, such as goats in the middle hills of Nepal, depend entirely on grazing for feed. Farmers do not provide goats with any other diet based on concentrates to support the best growth performance of goats. More than 90% of the small ruminant population is owned by landless and marginal farmers. As such, this study aims to analyze the potential performance of goat kids through the application of local feed concentrates such as Rice Polish and Maize Flour, as well as to determine the degree of nutritional deficiency and increase in the income of small-scale farmers in the middle hills of Nepal. The study was aimed at the following

objectives: to estimate the performance (live weight, FCR, body length, heart girth, neck girth and wither height) of crossbred goat kids (Khari × Jamunapari) fed with Polish and maize flour, probiotics and enzymes.

MATERIALS AND METHODS

Experimental site and duration

The experiment was conducted at Farmers Field Myagde-3, Kilchowk, Tanahun, from Nov. 15, 2019, to Feb. 15, 2020. The site is located approximately 15 km southwest of Damauli, Tanahun. It lies in temperate midhills located in the southern part of central Nepal. It is situated between 27°59’35" north longitude and 84°07’40" east latitude at 450 masl.

Selection of experimental kids

In total, 16 kids aged 3–4 months were weighed individually, and their mean weights were taken as their initial weights. They were allowed to adapt for 15 days so that the kids could easily consume the rice bran and maize flour. They were treated against ectoparasites and endoparasites by injecting “Ivermectin” subcutneously l ml/25 kg body weight. The kids were divided into four treatment groups. Each treatment group had a similar average weight, with 4 replications.

Experimental design

The experiment was conducted via a randomized complete block design (RCBD). Four treatments of 4 replicates each were used. The children were taken as individual treatment units. The kids were classified into a different block on the basis of their live weight.

Treatments combination

T_1: Stall feeding ad libitum fodder only
T_2: Stall feeding ad libitum fodder + Rice polish + probiotics + enzymes.
T_3: Stall feeding ad libitum fodder + maize flour + probiotics + enzymes.
T_4: Stall feeding ad libitum fodder + Rice polish + Maize flour + Probiotics + enzymes.

Feed preparation and feeding

The desired feed ingredients and feed supplements, such as rice polish, maize flour, enzymes (microzymes), probiotics, minerals (Agriminforte) and salt, were purchased from the local market. The enzymes (500 g/ton) and probiotics (1 kg/ton) were mixed with the ingredients to be fed to the kids.

Morning and evening feeding were also performed as per the feeding schedule in two equal parts of the allowance. The tree fodder from Khanayo (*Ficus semicordata*) was weighed and provided ad libitum. All the feed and tre fodder were stall-based. Rice polish and maize flour were fed at rates of 100 g, 150 g and 200 g in the 1st, 2nd and 3rd months, respectively, in two split doses every morning and in the evening.

Nutrient analysis

To determine the dry matter content, the feed samples from each of the treatments were dried in an oven at 70 °C for 24 hours. For dry matter determination, 100 grams of Polish rice and maize flour (from each treatment) were taken as samples to evaluate dry matter. The proximate nutritional composition of the samples from all the treatments was evaluated twice throughout the entire experimental period. Crude protein (CP), crude fiber (CF), ether extracts (EEs) and total ash were studied at the Animal Nutrition Laboratory according to the AOAC (1994).

Economic analysis

The total variable cost for each treatment was calculated considering the feed cost, health care cost, and labor cost. The cost of the rice polish was NRs. 35/kg, the cost of the

maize flour was NRs. 45/kg, the cost of the probiotics was NRs. 220/kg, the mineral cost was NRs. 160/kg, and the salt cost was NRs. 18/kg in the locality. The labor cost was considered to be the number of NRs. 500 per day for taking care of 16 young kids. The fodder used to feed the kids was considered free of cost. Fixed costs and miscellaneous expenses, such as the costs of utensils and ropes, were not considered. Similarly, the cost of live body weight was NR.500 per kg of live body weight. The amount of dung voided by the animals was 1.5 kg per week on a dry matter basis, and the manure was sold at NRs. 4 kg/kg dry manure. The cost–benefit ratio was calculated by dividing the gross return by the total variable cost of rearing.

Statistical analysis

Recorded data were tabulated in Ms-Excel. One-way analysis of variance (ANOVA) was performed via M statistics (C Version 6.1.4). Least significant difference (LSD) tests were used to compare the means. The initial weight of the kids at the beginning of the experiment was taken as a covariate to minimize the variability due to differences in initial weight. The graphical representations of the data were generated via Microsoft Excel.

The statistical model for the analysis of the parameters is as follows:

Y_{ij} = any observation for which
i is the treatment factor
j is the replication factor
= the mean
T_i = The effect of being in treatment i
B_j = the effect of being in replication j

RESULTS

Analysis of the experimental diets

All the feeding materials were analyzed in the nutrition laboratory of Agriculture and Forestry University (AFU) according to AOAC (1994). The chemical composition and nutritive value of the materials fed to experimental crossbred kids are presented in Table 1. Accordingly, the maximum dry matter content (91.35%) was recorded in Maize Flour + Probiotics + Enzymes, followed by the dry matter content (91.06%) of Rice polish +Maize flour + Probiotics + Enzymes. However, the minimum dry matter content (34.6%) was recorded in Khaniyo. The maximum percentage of ether extract (12.65%) was recorded in Rice polish + Probiotics + Enzymes, and the minimum percentage was recorded in Khaniyo (2.85%). However, other crude fiber treatments were used to compare rice polishing and khaniyu. The maximum crude fiber content (25.6%) was recorded in khaniyo, and the minimum crude fiber content (4.35%) was recorded in Maize Flour; the crude fiber contents of the other treatments were between those of the Khaniyo and Maize Flour treatments. The crude protein content ranged between 9.84% and 12.68%. Similarly, the ash contents of the experimental diets of goats ranged between 5.7% and 8.3%.

Table 1. Chemical composition of the feed materials of crossbred kids fed a diet supplemented with enzymes and probiotics at Myagde-3, Tanahun, 2019

Treatments	%DM	%EE	%CF	%CP	%Ash
Khaniyo (*Ficus semicordata*)	34.6	2.85	25.6	10.475	5.7
Rice polish + probiotics + enzymes	89.8	12.65	5.2	12.68	6.35
Maize flour + Probiotics + enzymes.	91.35	7.08	4.35	9.84	8.3
Rice polish+ maize flour + probiotics + enzymes	91.06	7.65	4.45	10.165	7.0

Feed consumption

Daily feed consumption

The mean daily feed consumption (g) of crossbred kids fed a diet supplemented with enzymes and probiotics is presented in Table 2. The mean daily feed consumption during the 1st fortnight and 2nd fortnights was similar (p >0.05).

The mean daily feed consumption at 3rd fortnight was significantly different (p <0.05); the maximum daily feed consumption (562.02 g) was observed in the treatment group fed Fodder + rice polish + probiotics + enzymes, which was statistically similar to that in the treatment groups fed Fodder + maize flour + probiotics + enzymes and Fodder + rice polish + maize flour + probiotics + enzymes. However, the minimum mean daily feed consumption (78.95 g) was observed in the treatment group fed with Fodder only.

Table 2. Mean daily feed consumption (g) of crossbred kids fed a diet supplemented with probiotics and enzymes at Myagde-3, Tanahun, 2019

Treatment	1st fortnight	2nd fortnight	3rd fortnight	4th fortnight	5th fortnight	6th Fortnight	Total feed consumption	average daily feed consumption
Fodder only	227.98	513.20	78.95 ^{b}	176.27	425.87	280.37	1702.64	283.77
Fodder + rice polish + probiotics + enzymes	759.71	663.55	562.02^{ab}	300.05	369.27	309.45	2964.05	494.01
Fodder + maize flour + probiotics + enzymes	665.41	569.29	338.77^{ab}	336.54	977.75	517.48	3405.23	567.54
Fodder + rice polish + maize flour + probiotics + enzymes	923.66	510.14	300.08 ^{b}	489.39	436.29	349.73	3009.29	501.55
Grand mean	644.19	564.04	319.95	325.56	552.29	364.26	2770.30	461.72
SEM	10.00	6.38	7.07	5.37	10.09	7.79	26.97	4.483
F value	2.42^{ns}	0.42^{ns}	4.30*	2.45^{ns}	2.96^{ns}	0.33^{ns}	3.33^{ns}	3.33^{ns}
Probability	> 0.05	> 0.05	< 0.05	> 0.05	> 0.05	> 0.05	> 0.05	> 0.05
LSD	-	-	28.75	-	-	-	-	-

The means in columns followed by the same superscript are not significantly different (p > 0.05) and are significantly different (p < 0.05).

* Significant at the 5% level, ** significant at the 1% level, ^{ns} not significantly different

Feed conversion ratio (FCR)

The mean feed conversion ratios of the crossbred kids fed diets supplemented with probiotics and enzymes are presented in Table 3. The mean feed conversion ratio at 1st fortnight was significantly different (p<0.01); a better feed conversion ratio (FCR of 5.76) was recorded in the Fodder + rice polish + maize flour + probiotics + enzyme treatment group than in the other treatment groups (p<0.01). However, a poor feed conversion ratio (FCR 8.89) was observed in the treatment group fed with fodder only without supplementation with probiotics or enzymes. Others were in between fodder only and Fodder + rice polish + maize flour + probiotics + enzymes.

Similarly, the mean feed conversion ratios on the 2nd, 3rd, 4th, 5th and 6th fortnights were also significantly different (p<0.01).

The overall mean feed conversion ratio of the kids was significantly (p<0.01) greater than the feed conversion ratio (FCR 5.48) recorded in the Fodder + rice plymish + maize flour + probiotics + enzyme treatment group, which was significantly different (p< 0.01) from the results of the other treatments. However, a poor feed conversion ratio (FCR 8.93) was recorded in the treatment group fed with fodder only without supplementation with probiotics

or enzymes. Others were in between fodder only and Fodder + rice polish + maize flour + probiotics + enzymes.

Table 3. Mean feed conversion ratio (FCR) of crossbred kids fed a diet supplemented with probiotics and enzymes at Myagde-3, Tanahun, 2019

Treatment	1st fortnight	2nd fortnight	3rd fortnight	4th fortnight	5th fortnight	6th fortnight	Overall gain
Fodder only	8.89[a]	9.20[a]	10.33[a]	9.14[a]	8.78[a]	9.04[a]	8.93[a]
Fodder + polish + probiotics + enzymes	7.49[a]	7.68[b]	8.24[ab]	8.97[a]	8.32[a]	8.26[a]	8.02[b]
Fodder + maize flour + probiotics + enzymes	7.505[a]	7.19[b]	6.87[bc]	6.770[b]	7.15[b]	6.83[b]	7.11[c]
Fodder + rice polish + maize flour + probiotics + enzymes	5.76[b]	5.52[c]	5.270[c]	5.27[b]	5.28[c]	5.39[c]	5.48[d]
Grand mean	7.413	7.397	7.678	7.539	7.382	7.381	7.385
SEM	0.346	0.307	0.629	0.503	0.403	0.406	0.361
F value	7.57**	17.17**	7.47**	13.84**	18.00**	28.77**	52.83**
Probability	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
LSD	1.407	1.01	2.363	1.506	1.109	0.906	0.610

The means in columns followed by the same superscript are not significantly different ($p > 0.05$) and are significantly different ($p < 0.05$).
* Significant at the 5% level, ** significant at the 1% level, [ns] not significantly different

Growth performance of crossbred kids

Daily Weight Gain

The mean daily body weight gain (g) of crossbred kids fed a diet supplemented with probiotics and enzymes is shown in Table 4. The 1st fortnight mean daily body weight gain was significantly different ($p < 0.05$); the highest daily body weight gain (158.750 g) was observed in the treatment group (Fodder + rice polish + maize flour + probiotics + enzymes), and it was statistically at par with that of the treatment groups fed Fodder + rice polish + maize flour + probiotics + enzymes, which was statistically similar to that of the treatment groups fed Fodder + maize flour + probiotics + enzymes and Fodder + rice polish + maize flour + probiotics + enzymes. However, the minimum daily body weight gain (25.00 g) was observed in the treatment group fed with Fodder only.

The mean daily body weight gains during the 2nd fortnight and 3rd fortnights were similar ($p > 0.05$). There was a statistically significant difference ($p < 0.05$) in the mean daily body weight gain of the kids at the 4th fortnight, with significantly greater (91.96 g) daily body weight gain in the Fodder + rice polish + maize flour + probiotics + enzymes group than in all the other treatment groups ($p < 0.05$). However, the daily minimum body weight gain during the 5th fortnight and the 6th fortnight was similar ($p > 0.05$).

Overall, the mean daily body weight gain of the kids was highly significantly ($p < 0.01$) greater than the maximum daily body weight gain (91.55 g) found in the Fodder + rice polish+ maize flour + probiotics + enzymes treatment, which was significantly different from the T1 and T2 treatments but was similar to the T3 treatment. However, the lowest minimum daily body weight gain (31.70 g) was found in the Fodder treatment group.

Table 4. Mean daily body weight gain (g) of crossbred kids fed a diet supplemented with probiotics and enzymes at Myagde-3, Tanahun, 2019

Treatment	1st fortnight	2nd fortnight	3rd fortnight	4th fortnight	5th fortnight	6th fortnight	Average daily gain
Fodder only	25.00^{c}	59.11	9.29	19.64 ^{b}	47.68	29.46	31.70 ^{c}
Fodder + rice polish + probiotics + enzymes	98.93^{ab}	86.08	68.75	38.57^{b}	48.21	36.43	62.83 ^{b}
Fodder + maize flour + probiotics + enzymes	86.96^{bc}	95.36	55.72	52.68 ^{b}	132.86	77.32	81.10^{ab}
Fodder + rice polish + maize flour + probiotics + enzymes	158.75^{c}	93.36	56.43	91.96 ^{a}	81.25	67.50	91.55 ^{a}
Grand mean	92.41	79.91	47.54	50.71	77.50	52.68	66.79
SEM	15.55	9.46	10.50	9.83	13.90	12.00	7.84
F value	5.39*	1.24^{ns}	3.58^{ns}	6.81*	3.09^{ns}	0.75^{ns}	7.79**
Probability	< 0.05	> 0.05	> 0.05	< 0.05	> 0.05	> 0.05	< 0.01
LSD	7.13	-	-	3.55	-	-	2.82

The means in columns followed by the same superscript are not significantly different ($p > 0.05$) and are significantly different ($p < 0.05$).

* Significant at the 5% level, ** significant at the 1% level, ^{ns} not significantly different

Morphological attributes of crossbred kids

Body Length

The mean monthly body length (inch) of crossbred kids fed a diet supplemented with probiotics and enzymes is presented in Table 5. The initial mean monthly body length was statistically similar ($p > 0.05$) across the different treatments. Similarly, during the 1st and 2nd months of the experimental period, the mean monthly body length was not significantly different ($p > 0.05$). The mean monthly body length at the 3rd month was significantly different ($p < 0.05$) from the maximum body length (19.00 inches) recorded in the treatment group fed with Fodder + rice polish + maize flour + probiotics + enzymes, which was significantly different ($p < 0.05$) from those at T_1 and T_3 but was similar to that at T_2. However, the minimum body length (15.75 inches) was recorded in the treatment group fed with fodder only. The overall increase in the mean monthly body length was also significantly different ($p < 0.05$); the maximum body length (4.25 inches) was recorded in the treatment group fed with Fodder + rice polish + maize flour + probiotics + enzymes, which was significantly different ($p < 0.05$) from that at T_1 and T_3 but was similar to that at T2. However, the minimum body length (1.50 inches) was recorded in the treatment group fed with fodder only.

Table 5. Mean monthly body length (inch) of crossbred kids fed a diet supplemented with probiotics and enzymes at Myagde-3 Tanahun, 2019

Treatment	Initial	1st month	2nd month	3rd month	Overall increase
Fodder only	14.25	15.00	15.00	15.75^{c}	1.50^{c}
Fodder + rice polish + probiotics + enzymes	14.75	16.25	16.25	18.12^{ab}	3.25^{ab}
Fodder + maize flour + probiotics + enzymes	14.26	15.50	15.75	16.75^{bc}	2.50^{bc}
Fodder + rice polish+ maize flour + probiotics + enzymes	14.76	16.50	17.25	19.00^{a}	4.25^{a}
Grand mean	14.50	15.81	16.06	17.37	2.87
SEM	0.27	0.33	0.41	0.51	0.35
F value	0.43^{ns}	3.74^{ns}	2.20^{ns}	6.47*	5.27*
Probability	> 0.05	>0.05	>0.05	< 0.05	< 0.05
LSD	-	-	-	1.68	1.53

The means in columns followed by the same superscript are not significantly different ($p > 0.05$) and are significantly different ($p < 0.05$).

* Significant at the 5% level, ** significant at the 1% level, ^{ns} not significantly different

Wither height

The average monthly wither height (inch) of the crossbred kids given a diet with added enzymes and probiotics is shown in Table 6. Similarly, ($p > 0.05$), represents the mean monthly withering heights in the initial, 1st and 2nd months. The mean monthly wither height at the 3rd month was significantly different ($p<0.05$) from the maximum wither height (19.25 inches) recorded in the treatment group fed with Fodder + rice polish + maize flour + probiotics + enzymes, which was significantly different ($p<0.05$) from the highest recorded height at T1 and was similar to those recorded at T2 and T3 (Table 1). Nonetheless, the shortest body length (16.00 inches) was obtained from the treatment group, which was fed only fodder. The mean monthly body length significantly increased ($p <0.05$), and the maximum body length (3.26 inches) in the treatment group, Fodder + rice polish + maize flour + probiotics + enzymes, significantly differed ($p<0.01$) from that in T1 and was statistically similar to that in T2 and T3. On the other hand, the minimum body length (0.75 in) was noted for the treatment group fed with fodder alone.

Table 6. Mean monthly wither height (inch) of crossbred kids fed a diet supplemented with probiotics and enzymes at Myagde-3 Tanahun, 2019

Treatment	Initial	1st month	2nd month	3rd month	Overall Increase
Fodder only	15.25	15.50	15.25	16.00^{b}	0.75^{b}
Fodder + rice polish + probiotics + enzymes	16.25	17.50	17.25	19.00^{a}	2.75^{a}
Fodder + maize flour + probiotics + enzymes	15.25	17.25	16.75	18.50^{a}	3.25^{a}
Fodder + rice polish + maize flour + probiotics + enzymes	16.00	18.25	17.50	19.25^{a}	3.26^{a}
Grand mean	15.69	17.12	16.81	18.19	2.50
SEM	0.36	0.45	0.39	0.53	0.33
F value	0.57^{ns}	3.19^{ns}	2.38^{ns}	4.55*	9.27**
Probability	> 0.05	> 0.05	> 0.05	< 0.05	< 0.01
LSD	-	-	-	2.10	1.18

The means in columns followed by the same superscript are not significantly different ($p > 0.05$) and are significantly different ($p < 0.05$).

* Significant at the 5% level, ** significant at the 1% level, ^{ns} not significantly different

Heart Girth

Table 7 shows the mean monthly heart girth (inches) of crossbred kids on a diet supplemented with probiotics and enzymes. Notably, the initial mean monthly heart girth was statistically similar ($p > 0.05$) across the different treatments. Furthermore, during the 1st and 2nd months of the experimental period, the mean monthly heart girth did not differ significantly ($p > 0.05$). The mean heart girth for the 3rd month was significantly ($p <0.05$) greater than the maximum recorded heart girth (23.00 inches) in the treatment group, which was fed with Fodder + rice polish + maize flour + probiotics + enzymes and was significantly different ($p<0.05$) from that at T1 and statistically similar to that at T2 and T3. In contrast, the minimum body length (19.75 inches) was observed in the treatment group fed with fodder only.

The mean monthly body length significantly increased ($p <0.01$), whereas the maximum body length (4.75) was found in treatment T3 (Fodder + Rice polish + Maize Flour + Probiotics + Enzymes), which was significantly ($p<0.05$) different from that in T1 and T3 and statistically ($p<0.05$) different from that in T2. The shortest body size (1.50 inches) was obtained from the treated group, which was fed only fodder.

Table 7. Mean monthly heart girth (inch) of crossbred kids fed a diet supplemented with probiotics and enzymes at Myagde-3 Tanahun, 2019

Treatment	Initial	1st month	2nd Month	3rd month	Overall Increase
Fodder only	18.25	18.50	18.25	19.75^{b}	1.50^{c}
Fodder+ Rice polish +probiotics +enzymes	18.01	18.75	19.75	22.00^{a}	4.00^{ab}
Fodder + Maize flour +Probiotics +enzymes	18.00	18.25	18.75	21.50^{a}	3.50^{b}
Fodder+ Rice polish+ Maize flour +Probiotics +enzymes	18.26	19.75	20.50	23.00^{a}	4.75^{a}
Grand mean	18.12	18.81	19.31	21.56	3.44
SEM	0.39	0.46	0.57	0.55	0.36
F value	0.16^{ns}	1.47^{ns}	2.21^{ns}	6.61*	13.74**
Probability	> 0.05	> 0.05	> 0.05	< 0.05	< 0.01
LSD	-	-	-	4.90	1.13

The means in columns followed by the same superscript are not significantly different (p > 0.05) and are significantly different (p < 0.05).
* Significant at the 5% level, ** significant at the 1% level, ^{ns} not significantly different

Neck Girth

The mean monthly neck girth (inch) of the crossbred kids fed a diet supplemented with enzymes and probiotics is presented in Table 8. The initial, 1st-month and 2nd-month mean monthly neck girth values were similar (p >0.05).

The results from the third month revealed that the difference in the mean number of neck girths was significant (p < 0.01). The maximum neck girth was recorded in the treatment group fed Fodder + Rice polish + Maize Flour + Probiotics + Enzymes, which was significantly different (p<0.05) from that at T1 but was on par (p<0.05) with those at T2 and T3. However, the minimum body length in inches was recorded in the treatment group fed with fodder only.

The mean monthly body length increase described above was significantly (p<0.05) greater than the maximum body length of 4.25 inches shown in the treatment group fed Fodder + Maize Flour + Probiotics + Enzymes, which was significantly different (p<0.05) from that of T1 and T2 but was on par (p<0.05) with that of T3. The minimum body length of 1.75 inches was recorded in the treatment group fed with Fodder only.

Table 8. Mean monthly neck girth (inch) of crossbred kids fed a diet supplemented with probiotics and enzymes at Myagde-3 Tanahun, 2019

Treatment	Initial	1st Month	2nd month	3rd month	Overall Increase
Fodder only	9.00	9.75	10.50	10.75^{b}	1.75^{c}
Fodder+ Rice polish +probiotics +enzymes	10.00	10.50	11.50	13.00^{a}	3.00^{b}
Fodder + Maize flour +Probiotics +enzymes	9.500	10.50	11.25	13.75^{a}	4.25^{a}
Fodder+ Rice polish+ Maize flour +Probiotics +enzymes	10.25	11.25	12.50	13.76^{a}	3.50^{ab}
Grand mean	9.68	10.50	11.44	12.81	3.12
SEM	0.19	0.30	0.34	0.40	0.30
F value	2.72^{ns}	2.08^{ns}	3.25^{ns}	9.59**	7.57**
Probability	>0.05	> 0.05	> 0.05	< 0.01	< 0.01
LSD	-	-	-	1.38	1.15

The means in columns followed by the same superscript are not significantly different (p > 0.05) and are significantly different (p < 0.05).
* Significant at the 5% level, ** significant at the 1% level, ^{ns} not significantly different

Economic analysis

Table 9 presents the economic analysis of the crossbred kids that received a diet supplemented with probiotics and enzymes. (Rs.2628. 2) In the treatment group, they received Fodder + Maize flour + Probiotics + enzymes. However, the lowest (Rs.1042. 8) expense was noted just in fed with fodder alone treatment group. The net income was highest (Rs.5392. 3744.483) in the treatment group (Table 8). 2) and fodder (Rs.4114. 2) Treatment groups. However, the lowest (Rs.3632. 8) between the treatment and control groups fed with Fodder + Maize flour +Probiotics +enzymes only.

The net profit over the control was highest (Rs.1278.6) in the treatment group fed Fodder+ Rice polish+ Maize flour +Probiotics +enzymes, but it decreased in the treatment groups fed Fodder+ Rice polish+ Maize flour +Probiotics +enzymes (Rs.481.4) and Fodder+ Rice polish +probiotics +enzymes (Rs.213). The benefit cost ratio was the lowest (1:2.00) in the treatment group fed with Fodder only, and it increased in the treatment groups fed with Fodder + Maize flour +Probiotics +enzymes (1:2.38) and Fodder+ Rice polish +probiotics +enzymes (1:2.85). The highest (1:3.31) benefit cost ratio was recorded in the treatment group fed with Fodder+ Rice polish+ Maize flour +Probiotics +enzymes.

Table 9. Cost benefit analysis of the experimental crossbred kids fed a diet supplemented with probiotics and enzymes at Myagde-3 Tanahun, 2019

Expenditure	T_1	T_2	T_3	T_4
Fodder Consumed (kg DM)	67.10	64.10	65.90	65.90
Fodder Cost @ Rs 8/kg	536.8	512.8	527.2	527.2
Rice polish consumed (kg)	-	27	-	13.5
Rice polish Cost @ Rs 35/kg	-	945	-	472.5
Maize flour consumed (kg)	-	-	27	13.5
Maize flour cost@ Rs 45/kg	-	-	1215	607.5
Probiotics +Enzyme consumed (Rs)	-	220	220	220
Minerals (Rs)	180	180	180	180
Salt (Rs)	6	6	6	6
Labor (Rs)	500	500	500	500
Total Expenditure	1042.8	2343.8	2628.2	2333.2
Income				
Live weight (kg)	9.63	12.67	11.85	14.78
Income from sale of goat @ Rs.500/kg	4815	6335	5925	7390
Income from dung (Rs)	336	336	336	336
Total Income (Rs)	5151	6671	6261	7726
Net Income (Rs)	4114.2	4327.2	3632.8	5392.8
Net Profit over control	-	213	481.4	1278.6
Benefit cost ratio (B : C)	1:2.00	1:2.85	1:2.38	1:3.31

*Labor cost Rs.500/day, rice polishing cost Rs.35/kg, maize flour cost Rs.45/kg, live weight Rs.500/kg and dung Rs.4/kg.

DISCUSSION

Feed Intake

The feed intake (average daily intake) was highest in the goats fed the fodder in combination with probiotics and enzymes 7. Higher feed intake may result from the efficient utilization of nutrients. These results are supported by the work of Das et al. (2001), Kim et al. (1992) and Weidmeire et al (1987). Gomez-Alarcon et al. (1987) demonstrated that the addition of yeast culture to the rumen of dairy cows increased feed intake. Beauchemin et al. (1998), Judkins and Stobart (1988), Krause et al. (1998) and Kung et al. (1998) reported that the application

of fibrolytic enzymes enhanced digestion, which was associated with increases in feed consumption and the particulate passage rate. Enzymes have been shown to increase the rate of feed consumption by dairy calves (Dong, 1998; Feng et al., 1996) and to exert beneficial effects (Beauchemin et al., 1998; Yang et al., 1998). An increase in the passage rate can be associated with a faster rate of particle size reduction in the rumen and a corresponding increase in feed intake (Maertens et al., 1984).

Growth Performance

The weight gain of crossbred kids in the treatment group, which had a diet supplemented with probiotics and enzymes, was high. This weight gain is probably the result of a more efficient intake of the dietary nutrients where probiotics and enzymes are included in the diet. The daily weight gain of beef cows and calves maintained on poor-quality pasture increased from 0.57 to 0.80 kg per day when supplemented with Aspergillus oryzae (Weidmeire, 1989). Dawson (1989) and Weidmeier et al. (1987) reported that the addition of yeast culture to dairy cows increased the total number of viable bacteria and cellulolytic bacteria by 1.3- and 1.5-fold, respectively. A *Saccharomyces cerevisiae* strain for growth stimulated the growth of *Fibrobacter succinogenes* S85 and reduced the log time for the growth of *Ruminococcus albus 7, Ruminococcus flavefaciens* FD1 and *Butyrivibrio fibrisolvens* D1 in vitro (Girard and Dawson, 1994). The use of *Enterococcus faecium* (EF212), a lactate-producing bacterium, alone or in combination with yeast, to feedlot cattle fed a high-grain diet could improve feed digestion (Beauchemin et al., 2003). Chaucheyras-Durant and Fonty (2001) reported that most polysaccharide and glycoside-hydrolase activities increased in the presence of this yeast product. Harrison et al. (1988a) reported a 60% increase in the total bacterial population and an 82% increase in the number of cellulolytic bacteria in the rumen of lactating dairy cows supplemented with 57 g/day *Saccharomyces cerevisiae*. Frumholtz et al. (1989a) reported an 80% increase in the total bacterial population and an 88% increase in the cellulolytic bacterial population in the rumen of lactating cows supplemented with 250 mg/day. Fiems et al. (1993) reported that the effect of yeast on ruminal pH was more pronounced in sheep fed a maize silage/cereal-based concentrate diet (high sugar/starch contents) than in those fed grass hay- and sugar beet pulp-based concentrates.

CONCLUSION

Maize flour feed is relatively expensive, but mixing maize flour with Polish rice flour is economical for small-scale goat production. The proper growth performance of crossbred goats can be achieved via the consumption of locally available ingredients such as maize flour and rice polish. Further verification of the results is needed by conducting multiple trials with a large number of goats.

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