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Replacement of wheat bran by biogas slurry and their effect on intake and digestibility of deshi sheep

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Abstract: The present experiment was conducted to study the effect of feeding biogas slurry (BGS) on the feed intake, digestibility and growth performance of sheep taking four indigenous male sheep were housed in individual pens in a 4×4 latin square design at each feeding trial of 7 days preliminary period followed by 7 days measurement period at Sheep and Goat farm, BAU, Mymensingh. Standard grower ration was formulated and wheat bran was replaced by 5, 10 and 15% by biogas slurry. The crude protein of wheat bran is slightly higher than slurry but there exists no significant effect on feed intake and digestibility of sheep. Crude protein consumption linearly decreased with the increase of slurry in the ration but difference among the diets was not significant. Crude fibre consumption per unit gain increased ($p<0.05$) with each replacement of wheat bran with slurry. Incorporation of BGS significantly ($p<0.05$) affected the digestibility of various nutrients. Significant ($p<0.05$) effects of incorporating the biogas slurry in the control diet was observed. Average daily body weight gain of sheep was similar even the increase of biogas slurry in diet up to 15% instead of wheat bran. The above data postulated that the biogas slurry may be incorporated up to 15 % in growing sheep diets without disturbing its growth and other common physiology.

Key words: Biogas slurry, digestibility, growth, sheep.

Introduction

Various unconventional sources of feed ingredients of plant and animal origin are being wasted in Bangladesh. Some of these may be utilized as important sources of protein and energy in the diet of livestock. In recent years, agro-industrial wastes e.g. poultry droppings, cowdung, sugarcane biogases, wood pulp and slaughter house waste have attracted the attention to the nutritionists for their economical and nutritional potentialities for the feeding of animals. Animal wastes are valuable resources if utilized properly. Options available for using the animal wastes include: 1) sources of plant nutrients, 2) feeding ingredients for farm animals, poultry and fish, 3) substrate for methane generation, and 4) substrate for microbial protein synthesis. Utilization of animal wastes to produce microbial or insect protein is feasible technically but not economically (Calvert, 1979). On the other hand, methane generation from animal wastes is technically feasible (Smith *et al.*, 1979), but the wastes possess low monetary value for this purpose. Thus, the most feasible methods of recycling animal wastes are as sources of nutrients for animals. In Bangladesh cow/buffaloes dung is conventionally used as manure in the fields and dried cakes as fuel. Dung is also being exploited to produce gas for use in kitchens leaving behind a huge amount of waste/slurry. During the fermentation process in the bio gas digester there may be the production of microbial proteins, and several simple molecules in the useable form (Sikka, 2006). To formulate economical rations it is imperative to tap alternative feed sources. Keeping in view the high cost of conventional feeds and competition for grains, the present experiment was conducted to find out the effect of incorporating biogas slurry (BGS) in the rations on the growth performance and digestibility of nutrients in growing sheep.

Materials and Methods

The feeding trial was conducted for a period of 56 days at Goat and Sheep farm, Bangladesh Agricultural University (BAU), Mymensingh, Bangladesh. Animals were adapted with experiment feed and metabolic crates for 21 days before the feeding trial. A 4×4 Latin Square Design was used where 4 sheep and 4 feeds constituted the experimental animal and treatments, respectively. The feeds were - natural grass + concentrate mixture (F_1), natural grass + concentrate mixture containing 5% slurry (F_2), natural grass + concentrate mixture containing 10% slurry (F_3) and natural grass + concentrate mixture containing 15% slurry (F_4). The length of each trial was 14 days having 7 days of preliminary and 7 days of measurement periods. In this experiment, ingredients of concentrate mixture were wheat bran, rice polish, maize (mash), mustard oil cake, molasses, and salt and biogas slurry (Table 3.2). For the preparation of 100 kg of concentrate mixture, 17 kg maize mash, 20 kg rice polish, 16 kg mustard oil cake, 5 kg molasses and 1 kg salt were common in all feed. Forty one kg wheat barn was added in feed-1(F-1). Wheat bran was replaced by slurry at the rate of 5, 10, and 15% slurry in feed-2 (F-2), feed-3 (F-3) and feed-4 (F-4), respectability. So F-2, F-3 and F-4 were contained 36, 31 and 26 kg of wheat bran, respectively. Before commencement of feeding trial, ten sheep from the farm was adapted to the slurry feeding. Out of them, four adult sheep of 14-18 months old and 13.73±0.90kg live weight were selected for experiment. Sheep were kept in individual metabolic crate in well ventilated room throughout the experiment. The crates were facilitated for individual feeding, watering and separator made of wire mess. Sheep were drenched against gastro-intestinal parasites and fed at the rate of 3.5 kg DM/100 kg live weight to satisfy the appetite of the animals. This was adjusted weekly on the basis of live weight change of the animals in all treatment groups. Required dry matter for individual animal was supplied by both roughage and concentrate sources of the ration at the ratio of 2:1. The concentrate mixture was supplied to each animal individually at 7.00 a.m. Grasses were supplied twice daily, 60% in the morning and the rest in the afternoon. Water was supplied *ad libitum* basis. At the beginning of experiment, animals were weighed for three consecutive days before supplying of morning feed. Average weight was taken as initial weight. Thereafter, animals were weighed individually throughout the experimental period every 7 days interval at a fixed time of 7 a.m. At the end of experiment, animals were weighed for three consecutive days and average weight was considered as final weight. Live weight gain was measured by subtracting initial weight from final weight. The daily live weight gain was calculated by dividing the total weight gain by total number of experimental days. Faeces were collected from each sheep separately and weighted during the feeding period. From the composite samples of about 10% of well mixed faeces of each animal were preserved in a refrigerator during the collection period. After collection, about 10% of mixed faeces were allowed to sun dry. Before drying, 10g of mixed sample was taken separately to determine of dry matter of the faeces. The digestibility of the feed was calculated by using the following formula:

$$\text{Digestibility (\%)} = \frac{Intake - Outgo}{Intake} X100$$

Representative samples of feed, refusal and faces were subjected to chemical analysis for the determination of dry matter (DM), Organic matter (OM), crude protein (CP), crude fiber (CF) following the methods of AOAC (1990). All the samples were analyzed in duplicate and mean values were recorded. The data were statistically analyzed as a Latin Square Design by analysis of variance using MSTAT-C statistical programme. The treatment mean for each parameter were tested using Duncun Multiple Range Test (DMRT).

Results and Discussion

The present experiment was aimed to determine feeding value of biogas slurry and its effect on intake and digestibility in sheep. The results obtained from this research are discussed as below:

Nutrient composition of feed ingredients

Nutrient composition of the feed ingredients used in this experiment is presented in Table 1. Wheat bran contains 92.87, 14.86, 11.38, 7.14%, OM, CP, CF and ash, respectively. However, slurry contains 75.1, 14.77, 19.3 and 24.9%, OM, CP, CF and ash. Therefore, CP content in wheat bran and biogas slurry was similar but CF and ash content in slurry were 69.59% and 248.73% higher than in wheat bran.

Table 1 Proximate composition of different feed ingredients used in experiment

Ingredients	DM (g/100g)	Composition (g/100 g DM)			
		OM	CP	CF	Ash
Natural grass	16.6 ±0.28	88.5±1.41	11.2±0.42	22.9±0.71	11.5±0.28
Wheat bran	87.82±0.08	92.87±1.22	14.86±0.14	11.38±0.28	7.14±0.06
Maize bran	88.90±0.42	97.6±0.42	9.2±0.28	2.0±0.28	2.4±0.14
Rice polish	89.24±0.06	88.47±0.14	12.45±0.14	22.74±0.28	11.54±0.42
Mustard oil cake	88.28±0.16	90.82±1.41	35.17±1.13	8.84±1.27	9.18±0.71
Molasses	75.52±1.01	97.70±0.95	0.9±0.28	-	2.3±0.14
Slurry	89.4±0.85	75.10±1.41	14.77±0.14	19.3±0.42	24.9±0.71

It is indicated that fermentation of the dung in the digester reduced its OM and CF contents but increased CP content. The probable reason may be for using of the CF by the microbes for their propagation. It was further observed that partial replacement of wheat bran of the control diet with BGS increased the CF and total ash (TA) but decreased OM contents of the experimental diets. The report of Sikka (2006) also showed that after anerobic fermentation in the biogas digester increase CF and Ash and decrease OM value.

Feed intake

Dry matter and nutrient intake in different groups of animals fed on different diet are shown in Table 2. It showed that total DM intake was higher in F-1 and lower in F-3 ($p<0.05$). Almost similar DM, OM and CP intakes were observed among the different groups of sheep fed F-1, F-2 and F-4. The CF intake in sheep fed diet F-4 were significantly ($p<0.01$) higher. In the present study, daily DM intake similar among treatment groups indicating that the palatability of diets was slightly affected by incorporation of biogas slurry (Table 2). Similar trend was reported by Kishan and Hasain (1977) and Toro and Mudgal (1984). Montagomey and Baumgaidt (1965) reported that dry matter intake by the ruminant in regulated by the need of the energy and simultaneously with the extent to which the physical distention of the rumen could take place.

Nutrient digestibility of feed

Table 3 showed that the DM digestibility did not differ significantly ($p<0.01$) among the groups while digestibility of OM, CP and CF differ significantly. Digestibility of CF were higher in F-1 and F-4 (57.01 and 56.73), than in F-2 and F-3 (54.65 and 52.92) groups. CP digestibility in F-1, F-4 and F-2 were similar but F-1 and F-4 were higher than F-3. There was no significance difference between F-2 and F-3. Digestibility of OM in F-1 was higher than in F-2 and F-3. No significant difference in OM digestibility was found between F-2, F-3, and F-4. OM digestibility of F-1 and F-4 was similar.

Table 2 Effect of diets on intake of animal (g/kg $W^{0.75}$/d)

Parameter	Feeds (Mean ± SD)				SEM	Level of significance
	F-1	F-2	F-3	F-4		
DM	60.51±1.59	58.74±2.23	58.94±0.91	59.77±0.21	0.452	NS
OM	58.34±1.53	55.51±2.20	56.08±0.56	57.28±1.41	0.446	NS
CP	10.86±0.29	10.52±0.42	10.3±0.12	10.65±0.31	0.078	NS
CF	$7.52±0.20^{b}$	$7.52±.029^{b}$	$7.68±0.09^{b}$	$8.19±0.03^{a}$	0.082	**

Table 3 Nutrient digestibility (g/100g) of different diet fed by sheep

Parameter	Nutrient digestibility(g/100g)				SEM	Level of significance
	F-1	F-2	F-3	F-4		
DM	70.79±1.39	71.34±0.63	69.68±0.96	70.37±0.62	0.2631	NS
OM	$68.44±1.88^{a}$	$64.80±1.73^{b}$	$65.85±0.47^{b}$	$66.44±0.64^{ab}$	0.4545	*
CP	$57.01±3.08^{a}$	$54.65±0.57^{ab}$	$52.92±0.65^{b}$	$56.73±0.72^{a}$	0.5646	*
CF	$66.39±1.45^{a}$	$64.45±0.30^{b}$	$63.63±0.55^{b}$	$65.97±0.81^{a}$	0.3671	**

Table 4 Cost benefits of feeding experimental diet

Parameter	Experimental feeds				SEM	Level of significance
	F_1	F_2	F_3	F_4		
Cost of Roughage diet (Tk/h/d)	1.11±0.04	1.077±0.04	1.047±0.05	1.085±0.04	0.04	NS
Cost of concentrates diet (Tk/h/d)	$3.09±0.01^{a}$	$2.947±0.02^{b}$	$2.79±0.01^{c}$	$2.632±0.02^{d}$	0.01	**
Total feed cost(Tk/h/d)	$4.20±0.08^{a}$	$4.024±0.03^{b}$	$3.84±0.03^{c}$	$3.718±0.01^{d}$	0.05	**
Total feed cost/kg LWG	$86.92±0.82^{a}$	$86.49±0.82^{a}$	$83.02±0.04^{b}$	$79.76±0.37^{c}$	0.76	**

Means with different superscripts within the same row differ significantly ($p<0.05$); NS=Non-significant; **Significant ($p<0.01$); *Significant ($p<0.05$); SEM= Standard error of mean

F-1: Natural grass + concentrate mixture; F-2: Natural grass + concentrate mixture containing 5% slurry

F-3: Natural grass + concentrate mixture containing 10% slurry; F-4: Natural grass + concentrate mixture containing 15% slurry

The inclusion level of slurry had no major effect on the overall digestibility of feeds (Table 3). OM digestibility of the diet resulted in moderate decrease over that of the control diet containing wheat bran which agrees with the report of (Ramana *et al.*, 1988). The present study showed that CF digestibility in sheep was higher than non ruminant animal like pig (Sikka and Chawla 1984). The higher CF in diets had negative effect on the digestibility of nutrients. Poor digestibility of the nutrients in slurry containing diets can be attributed to the high crude fibre content which might have increased passage rate of the digesta through the gastro-intestinal tract or due to the gel forming properties of fibre which might have entrapped the nutrients and reduced their exposure to the enzymatic digestion. Our results are in agreement with the earlier reports on feeding of maize and rice bran replaced with slurry to pigs affected the digestibility of various nutrients (Sikka and Chawla 1984, 1986; Sikka 1990).

Live weight gain

In Figure 1, it was found that the average live weight gain with a period of 56 days were 2.704, 2.656, 2.65 and 2.618 kg for sheep fed F-1, F-2, F-3 and F-4 diets, respectively. The animals fed diet F-1 (wheat bran) gained (48.28 g/d) the highest followed by F-2 (47.42) and F-3 (47.32) while the lowest body weight was F-(46.75) g/d diet. Although the gain varied among the groups, they were not statistically significant.

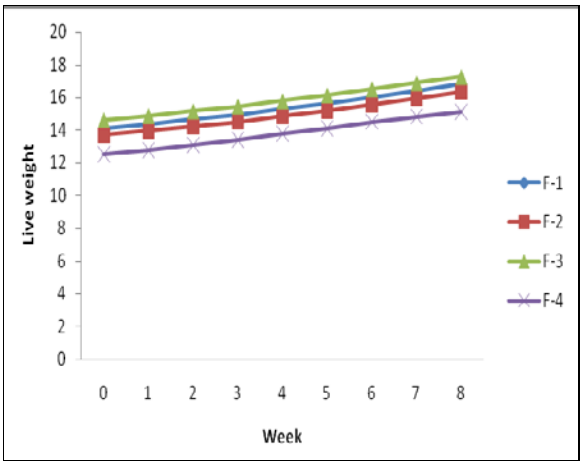

Figure 1 Effect of different diet on growth

F-1: Natural grass + concentrate mixture

F-2: Natural grass + concentrate mixture containing 5% slurry

F-3: Natural grass + concentrate mixture containing 10% slurry

F-4: Natural grass + concentrate mixture containing 15% slurry

The live weight gain of sheep in the present study is consistent with the report of Kishan and Husain (1977) who found that body weight gain did not differ significantly when growing calves were fed concentrate mixtures containing different level of poultry excreta. Ramana *et al.* (1988) also noted similar body weight gain in growing animals fed concentrate mixtures containing 0, 15 and 30% protein from poultry litter. Although the live weight gain did not differ significantly, slightly lower body weight gain was observed due to fed biogas slurry feeding. This might be due to inadequate utilization of dietary protein provided by slurry comparing wheat bran. It may also cause due to the low energy level in slurry added feed. Due to the anaerobic fermentation, volatile fatty acids are reduced in slurry which serves as primary source of energy for the ruminant (Prior *et al*. 1981).

Several report revealed that the average daily gain also decreased linearly with addition of slurry in the diet (Sikka and Chawla, 1986). They also reported that pigs fed control as well as 10% biogas slurry containing diet gained significantly ($p<0.05$) higher than those fed 20 % slurry. The decrease in average daily gain can be attributed to increase in CF content of the diet. (Sikka and Chawla, 1986) and (Sikka and Mehta, 1986) who reported that the growth performance of growing and finishing pigs had inverse relation with the dietary crude fibre contents.

Feed cost and benefit

During the experimental period, the feed cost was based on the market price of taka 0.5, 17, 13, 16, 18, 12, 11, 1.5 per kg for roughage, wheat bran, rice polish, maize bran, mustard oil cake, molasses, common salt and biogas slurry, respectively. Price of grass and biogas slurry was applied on the basis of cost of labour involved to prepare or collect these and the price of cowdung. Cost benefit analysis of feeding biogas slurry was studied to know the profitability of sheep farming under this experimental condition. The cost of concentrate feed mixture was 3.09, 2.95, 2.79 and 2.63 Tk/h/d for sheep belonged to F-1, F-2, F-3 and F-4 groups, respectively (Table 4).The feed cost was higher (4.20Tk/h/d) in control group. It was found that the lowest cost was in group, F-4 (3.72 Tk/h/d) fed 15% slurry. There was highly significant ($P<0.01$) differences in feed cost among the groups. Total feed cost per kg live weight gain was 86.92, 86.49, 83.02 and 79.76Tk for F-1, F-2, F-3 and F-4 groups, respectively. The lowest cost was (79.76 Tk/kg live weight gain) observed in F-4 group. The significantly lower feed cost per animal per day in groups supplied with biogas slurry diet compared to that in animals fed wheat bran might be due to very low price (almost nil) of slurry which involved only labour cost for collection and drying and cost of dung. On the contrary, the price of wheat bran was very high (Tk 17.00/kg). As regards to total feed cost per kilo live weight gain, animals fed biogas slurry containing ration showed significantly lower value compared to that of animals fed wheat bran. Although the feed intake was lower, it did not result any remarkable changes in growth of the sheep and looked apparently healthy. Digestibility of feeds and live weight gain were not significantly affected due to inclusion of biogas slurry. Even after finishing the trial, all the animals were normal and no mortality was found. In this experiment, the carcass characteristic and meat quality were not studied. The effects of biogas slurry on physiological activities of sheep were not examined in details. From the above discussion it is apparent that partial replacement of wheat bran by slurry at 15% of the ration had no depressing effect on feed intake, digestibility and growth of growing sheep. The feed cost and production cost were significantly lower in slurry containing ration compared to those of wheat bran.

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