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Effect of yeast (*S. cerevisiae*) fermented sugarcane bagasse and concentrate on nutrient intake, digestibility, and growth performance of sheep

Nusrat Zahan Shoshe[1], Md. Abdul Baset[1], Md. Jasim Uddin[2] and Mohammad Mehedi Hasan Khan[3]

[1]Department of Livestock Production and Management, Sylhet Agricultural University, Sylhet, Bangladesh
[2]Department of Animal Nutrition, Sylhet Agricultural University, Sylhet, Bangladesh
[3]Department of Biochemistry and Chemistry, Sylhet Agricultural University, Sylhet, Bangladesh

ABSTRACT

This study investigates the application of yeast (*S. cerevisiae*) fermentation to enhance the nutritional quality of sugarcane bagasse as feed for sheep. The experiment, conducted at Sylhet Agricultural University, spanned from April to July 2021, using 12 growing sheep divided into three groups (T_0, T_1, and T_2). Group T_0 received an 85% green grass and 15% concentrate mixture. T_1 received a composition of 60% green grass, 20% fermented sugarcane bagasse, and 20% fermented concentrate mixture, while T_2 received 60% fermented sugarcane bagasse and 40% fermented concentrate mixture. Results indicate that fermented feed-supplied groups demonstrated improved nutrient intake, digestibility, and growth compared to the non-fermented feed group. In the T_2 group, Dry Matter Intake (DMI), Crude Protein Intake (CPI), Crude Fiber Intake (CFI), and Ether Extract Intake (EEI) increased by 48.91%, 40.27%, 29.44%, and 39.89%, respectively. The Net Feed Efficiency Index (NFEI) and Organic Matter Intake (OMI) increased by 79.57% and 55.75% in the T_2 group, respectively. Total Ash Intake (TAI) and Metabolizable Energy Intake (MEI) increased by 5.36% and 6.52%, respectively. DMI and CPI per kg metabolic weight (kg $w^{0.75}$) increased by 30.93% and 23.28%, respectively. Weight gain increased by 57.11% in the T_2 group, but nutrient digestibility, Feed Conversion Ratio (FCR), and economic profit were superior in the T_1 group. Further research is recommended to explore the utilization of yeast-fermented sugarcane bagasse in sheep farming, focusing on meat quality characteristics.

KEYWORDS

S.cerevisiae; Yeast fermentation; Sugarcane bagasse; Sheep nutrition; Feed digestibility

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Introduction

Crops, in addition to primary products, yield byproducts, some of which serve as valuable resources in animal feed due to their protein and high fiber content. Livestock feed is a composition of various single and combined ingredients, both processed and unprocessed, administered to animals for sustenance, productivity, and reproduction [1]. The agricultural sector generates substantial quantities of residues and byproducts, presenting opportunities for utilization [2]. Sugarcane bagasse emerges as a potential animal feed source, particularly when forages are limited. It is low in protein, has poor palatability and digestibility, and has less nutritional value. Various treatments have been attempted to improve the palatability and digestibility of bagasse as substitutes for conventional roughages. Bagasse contains high fiber and lignocellulosic materials. The lignification degree and the presence of crystalline cellulose act as a steric barrier that prevents the enzymatic attack of ruminal microorganisms on cellulose and hemicellulose. There are various treatments available to improve the nutritional value of these low-quality byproducts. These are physical, chemical, and biological treatments. Biological treatments comprise composting, ensiling, microbial fermentation, and enzyme addition [3]. Solid-state fermentation is an appropriate treatment to improve the nutritional value of sugarcane bagasse [4]. It is a low-quality roughage containing 40% ingestible fiber and protein (CP) content, though a great advantage of sugarcane bagasse is its availability during a shortage of fodder and its low cost compared with other roughage [5]. Sugarcane bagasse contains about 50% cellulose, 25% hemicellulose, and 25% lignin [6]. It has high fiber and cellulose (40-50)% and less than 3% crude protein. Hemicellulose and lignin content of bagasse are (28-30)% and (19-21)% respectively [7]. Sugarcane bagasse can be recycled to produce value-added products such as protein-enriched animal feed, enzymes, amino acids, organic acids, and compounds of pharmaceutical importance [6]. Feed technology should be applied to improve the quality of sugarcane bagasse. Fermentation is one of the methods that can be applied to increase animal feed quality. Fermentation can be a promising alternative to increase the nutritional value of residues byproducts into valuable animal feed. Application of sugarcane bagasse as animal feed has been reported, where bagasse was fermented by fungi (*Lentinula edodes, Pleurotus eryngii, Pleurotus salmoneostramineus, Ceriporiopsis subvermispora*) at 26°C for 8, 12 or 16 weeks of the incubation period [8]. The result showed that fermentation influences *in vitro* organic matter digestibility (IVOMD) and *in vitro* neutral detergent fiber digestibility (IVNDFD). Sugarcane bagasse silage is reported to be improvised by the fermentation method [9]. Since microbial fermentation improves the nutritive value of bagasse, the objectives of this feeding trial were to nutritionally upgrade

*Correspondence: Dr. Nusrat Zahan Shoshe, Associate professor, Department of Livestock Production and Management, Sylhet Agricultural University, Sylhet, Bangladesh, e-mail: shoshe.lpm@sau.ac.bd

poor-quality sugarcane bagasse through yeast (*S.cerevisiae*) fermentation and to study the effect of fermented feed on the growth performance of sheep. Further, the aim was to assess the economical cost-benefit analysis of yeast (*S.cerevisiae*) fermented feed and to apply the fermentation method in sheep feeding.

Methodology

The study was conducted to evaluate the growth performance of sheep in response to fermented sugarcane bagasse and was arranged according to Completely Randomized Design (CRD) experimental procedures. The details of the experimental procedures and techniques are given below. The study was conducted in the Animal Nutrition shed at Sylhet Agricultural University, Sylhet. The experiment was conducted from April 2021 to July 2021. Twelve growing sheep, divided into three groups, were used in this experiment. Groups were T_0, T_1, and T_2. The animals were serially tagged in the neck region using a filament. All animals were vaccinated (PPR) at the beginning of the trial period. De-worming was done regularly. After seven days of purchasing, initial body weights were measured using a digital weighing balance (Model-TF/TFS-1020-2t). Regular body weights were documented at 15-day intervals during the experimental period.

Preparation of fermented feed

Green grass, fermented sugarcane bagasse, and fermented concentrate mixture were fed to the experimental animals as per the requirements of the groups. Green grass was collected from the fodder plot of the Animal Nutrition Department at Sylhet Agricultural University. The concentrate mixture was prepared with wheat bran and rice polish at a 3:2 ratio.

Sugarcane bagasse fermentation

Sugarcane bagasse was collected from roadside sugarcane juice shops from Ambarkhana, Zindabazar, Chouhatta Point, and Sylhet City Corporation. After the extraction of juice from sugarcane, the leftover bagasse was purchased from the shop. The collected bagasse was sun-dried for 2-3 days prior to chopping with a manual chopper. Once the chopping was accomplished thoroughly, bagasse was fermented with 5% instant dry yeast (*S. cerevisiae*) in a plastic bag for an incubation period of 5 days. Post incubation, fermented bagasse was dried completely in sunlight. Finally, it was crushed by a crushing machine (Rainbow Machinery Co. Ltd.), and the feed was ready to use.

Concentrate mixture fermentation

The concentrate mixture was prepared with 60% wheat bran and 40% rice polish. All of these ingredients were properly mixed. Then, this mixture was fermented with 3% instant dry yeast (*S. cerevisiae*) in a plastic bag. The incubation period for this fermented mixture was 5 days. Post incubation, the mixture was dried in sunlight thoroughly. Then, it was ready to feed the animal.

Ration formulation for three groups

A feed consisting of 85% green grass and 15% non-fermented concentrate mixture was supplied to the control group (T_0). A mixture of 20% fermented sugarcane bagasse (FSB), 60% green grass (GG), and 20% fermented concentrate mixture (FCM) was supplied to group T_1. Further, the T_2 group was provided a feed comprising 60% FSB and 40% FCM (Tables 1 and 2).

Table 1. Ration for feeding trial composing 4 no. of growing sheep having LW.

Feed ingredients	Treatment								
	T_0			T_1			T_2		
	DM feed (kg)	CP	ME	DM feed (kg)	CP	ME	DM feed (kg)	CP	ME
GG	3.82	404.9	31.24	2.4	254	19.63	0	-	-
CM	0.67	121.4	5.96	0	-	-	0	-	-
FSB	0	-	-	0.8	19.2	3.73	1.8	43.2	8.4
FCM	0	-	-	0.8	192	6.24	1.2	288	9.36
Total	4.5	116.9	8.26	4	116.4	7.4	3	110.4	5.93

GG= Green grass, CM= Concentrate mixture, FSB=Fermented sugarcane bagasse, FCM= Fermented concentrate mixture, CP=g/kg, ME=MJ/kg

Determination of the chemical composition of supplied ration for nutrient intake calculation of sheep

The chemical composition of non-fermented feeds and fermented feed (Fermented sugarcane bagasse and fermented concentrate mixture) was analyzed using the Association Of Official Analytical Collaboration (AOAC) method (2011).

Table 2. Chemical composition of supplied ration.

Feed	DM%	CP%	CF%	EE%	TA%	NFE%	ME MJ/kg
GG	24.5	10.6	34.3	3.7	9.5	41.8	8.1
CM	86	18.1	7.9	8.6	7.9	57.4	9.4
FSB	75.3	2.4	39.2	1.9	3.1	53.2	4.6
FCM	78	24	7	7.5	8.1	53.3	9.4

GG= Green grass, CM= Concentrate mixture, FSB=Fermented sugarcane bagasse, FCM= Fermented concentrate mixture

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In vivo digestibility trial

The standard digestion trial approach was used to measure the *in vivo* feed nutrient digestibility. The last fifteen days were considered as an animal digestibility study period, and 105 days were considered an adjustment period. Daily feed intake, refusals, and fecal output records were maintained accurately. Samples from each animal, usually 10% of the daily output in the case of feces, were retained for analysis. When estimates of nitrogen balance were desired, Urine output was measured to estimate the nitrogen balance. A metabolic cage was used to collect the excreta of animals for the digestibility trial. The metabolic cage used was more of a stall or box that was large enough for the animal to set legs from a height of 50 cm to 1 m. The design allowed for the quantitative collection of urine and feces. The experimental animals were comfortable enough during that period. The space allowed was large enough for the free movement of animals. The digestibility of nutrients was calculated using the following formula:

Nutrient digestibility %= {(Nutrient intake - Nutrient in feces) / Nutrient intake} × 100

Vaccination and de-worming

Experimental animals were vaccinated (PPR) at the beginning of the trial. De-worming and ecto-parasitic (Ivermectin) treatments were done regularly.

Statistical analysis

The data were arranged according to ANOVA and treatment variation was determined using Tukey's test with Minitab 19 statistical software program. Nutrient intake, digestibility, and growth of sheep fed with fermented sugarcane bagasse and fermented mixed concentrate were considered. The level of significance was determined at $p<0.05$.

Result and Discussion

Results represent the nutrient intake, digestibility, body weight gain, and nutrient intake per kg metabolic weight, i.e., $W^{0.75}$ of sheep feed, fermented sugarcane bagasse, and concentrate mixture. Twelve sheep were divided into three groups T_0, T_1, and T_2. Table 3 showed that nutrient intake was highest in group T_2. In this group, DMI, CPI, CFI, and EEI increased by 48.91%, 40.27%, 29.44%, and 39.89%, respectively, compared to the control group T_0. The NFEI and OMI increased by 79.57% and 55.75% in reference to the group T_0. TAI and MEI increased by 5.36%, and 6.52%, respectively, in the T_2 group.

Table 4 represents the nutrient digestibility of yeast-fermented sugarcane bagasse and concentrate mixture. Results indicated an increasing trend of nutrient digestibility in fermented feed-supplied groups, T_1 and T_2. The digestibility of DM, CP, CF, and EE was highest in the T_1 group, corresponding to 78.73, 82.41, 79.16 and 84.22%, respectively. In the T_2 group, DM, CP, CF, and EE digestibility was 74.37, 80.81, 77.46, and 82.96%, respectively, and 61.78, 68.80, 71.92, and 71.12%, respectively in the T_0 group. OM digestibility was higher in the T_2 group, which was 76.94% compared to 64.30% in the control T_0 group. Digestibility was recorded as the highest in the T_1 group. In contrast, T_0 showed the lowest nutrient digestibility. In the T_1 group, CP, CF, EE, and OM digestibility increased by 19.78%, 10.06%, 18.41%, and 19.65% when compared to the control group T_0.

Table 3. Nutrient intake of sheep-fed yeast fermented feed.

Nutrient intake parameter	Treatments			SEM	p-value
	T_0	T_1	T_2		
MEI (MJ/day)	2.76c	3.03a	2.94b	0.1	<0.001
DMI (g/day)	333.87c	493.75a	497.19a	1.57	<0.001
CPI (g/day)	39.13c	47.76b	54.89a	0.17	<0.001
CFI (g/day)	101.36c	122.51b	131.21a	0.42	<0.001
EEI (g/day)	14.89c	16.94b	20.83a	0.06	<0.001
TAI (g/day)	30.92b	32.58a	25.36c	0.09	<0.001
NFEI (g/day)	147.50c	190.45b	264.87a	0.82	<0.001
OMI (g/day)	302.95c	377.70b	471.86a	3.74	<0.001

T_0 = (85%GG+15%CM), T_1 = (20%FSB+60%GG+20%FCM), T_2= (60%FSB+40%FCM), GG=green grass, FSB=Fermented sugarcane bagasse, FCM=Fermented concentrate mixture, DMI=Dry matter intake, CPI=Crude protein intake, CFI=Crudefiber intake, EEI=Ether extract intake, TAI=Total ash intake, NFEI=Nitrogen free extract intake, OMI= Organic matter intake.

Table 4. Nutrients Digestibility of sheep fed fermented feed.

Nutrient digestibility Parameter %	Treatments			SEM	p-value
	T_0	T_1	T_2		
DMD	61.78c	78.73a	74.37b	0.2	<0.001
CPD	68.80b	82.41a	80.81a	0.3	<0.001
CFD	71.92c	79.16a	77.46a	0.41	<0.001
EED	71.12b	84.22a	82.96a	0.4	<0.001
OMD	64.30b	76.21a	76.94a	0.36	<0.001

T_0= (85% GG +15% CM), T_1= (20%FSB+ 60% GG+20%FCM), T_2= (60% FSB+40%FCM), GG=green grass, FSB=Fermented sugarcane bagasse, FCM= Fermented concentrate mixture, DMD= Dry matter digestibility, CPD= Crude protein digestibility, CFD= Crude fiber digestibility, EED= Ether extract digestibility, OMD= Organic matter digestibility.

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$W^{0.75}$

Table 5 displayed no significant difference in growth rate between the treatment groups. Though a significant difference was noted in the initial weight gain and daily weight gain among the treatment groups. Total weight gain was noted to be 7.61 kg and 8.50 kg in the T_1 and T_2 groups, respectively, in contrast to 5.41 kg in the T_0 group. Daily weight gain was 63.47 and 70.90 (g/day) in the T_1 and T_2 groups respectively. Reduced FCR (kg feed /kg gain) was observed in T_1 compared to T_0 and T_2 groups because of less DM intake. FCR of the T_0, T_1, and T_2 groups was 7.63, 6.54, and 7.50 (kg feed/kg gain) respectively. Results indicated that in the T_2 group, total weight gain (TWG) increased by 57.11% compared to the control T_0 group, and FCR and profit improved by 14.28% and 47.59%, respectively, in the T_1 group in contrast to the control group T_0.

The mean values of initial and final $W^{0.75}$ (metabolic body weight), DM, CP, and ME intake of sheep per kg $W^{0.75}$ are discussed in Table 6. Final $W^{0.75}$ (metabolic weight) was 6.55 kg in the T_0 group, 7.31 kg in T_1, and 7.45 kg in the T_2 group. DMI and CPI (g/kg $W^{0.75}$) were significantly higher in the fermented feed-supplied groups in comparison to control group T_0.DMI was 66.74 g/kg $W^{0.75}$ and 56.12 g/kg $W^{0.75}$ in T_1 and T_2 groups, respectively in contrast to 50.97 g/kg $W^{0.75}$ to T_0 group. Next, CPI was 7.36 g/kg $W^{0.75}$ and 6.53 g/kg $W^{0.75}$ in the T_2 and T_1 groups, respectively, and 5.97 g/kg $W^{0.75}$ in the T_0 group. MEI was higher in the Control group T_0 which was 0.42 (MJ/kg $W^{0.75}$), whereas it was recorded 0.41(MJ/kg $W^{0.75}$) in T_1 and 0.39 (MJ/kg $W^{0.75}$) in the T_2 group. The result established that, in the T_2 group, DMI and CPI (kg $W^{0.75}$) increased by 30.93% and 23.28%, respectively, compared to the Control group T_0.

Table 5. Growth of sheep-fed fermented feed.

Body weight gain Parameter %	Treatments			SEM	p-value
	T_0	T_1	T_2		
IBW (kg)	6.85a	6.58 ab	6.05b	0.21	0.04
1st MG (kg)	0.75b	1.22a	1.25a	0.12	0.008
2nd MG (kg)	1.2b	1.6a	1.49a	0.1	0.03
3rd MG (kg)	1.35b	2.1a	1.85ab	0.18	0.02
4th MG (kg)	1.64c	2.22b	3.55a	0.16	<0.001
TWG(kg)	5.41c	7.61a	8.50b	0.24	<0.001
WG (g/ day)	45.13c	63.47b	70.90a	2.06	<0.001
FCR(kg feed/kg gain)	7.63	6.54	7.5	0.31	0.32
Feed cost(tk./Animal)	1249.86c	1737.45a	2314.98b	131.45	<0.001
Selling cost (wg*600tk/Anima)	1990.13c	2830.05a	2770.02b	164.9	0.048
Profit tk./Animal	740.27c	1092.6c	455.04c	137.06	0.16

T_0= (85% GG +15% CM), T_1= (20% FSB+ 60% GG+20% FCM), T_2= (60% FSB+40% FCM), GG=green grass, FSB=Fermented sugarcane bagasse, FCM= Fermented concentrate mixture, IBW=Initial body weight, MG= Month growth, WG=Weight gain, TWG= Total weight gain, FCR= Feed conversion ratio.

Table 6. Nutrient intake (kg $W^{0.75}$) of sheep.

Nutrient intake/kg $W^{0.75}$ Parameter	Treatments			SEM	p-value
	T_0	T_1	T_2		
Initial $W^{0.75}$(kg)	4.22a	4.10a	3.85b	0.06	0.04
Final $W^{0.75}$(kg)	6.55b	7.31a	7.45a	0.07	<0.001
DMI g/kg$W^{0.75}$	50.97c	56.12b	66.74a	0.36	<0.001
CPI g/kg$W^{0.75}$	5.97c	6.53b	7.36a	0.03	<0.001
MEI MJ/kg$W^{0.75}$	0.42	0.41	0.39	0.0009	<0.001

T_0= (85% GG +15% CM), T_1= (20% FSB+ 60% GG+20% FCM), T_2= (60% FSB+40% FCM), GG=green grass, FSB=Fermented sugarcane bagasse, FCM= Fermented concentrate mixture, DMI= Dry matter intake, CPI= Crude protein intake, CFI= Crude fiber intake, MEI=Metabolizable energy intake, kg$W^{0.75}$ = Metabolic weight.

Discussion

The current study illustrated that yeast (*S. cerevisiae*) fermentation improves the nutrient intake, feed digestibility, and growth performance of sheep. Many researchers have conducted several experiments on the fermentation effects of feed on animal performance. Fermentation is a known feasible method for increasing protein digestibility [10]. Fermentation of wheat straw by *Crinipellis sp*. holds the potential to upgrade the nutritional worth of feeding growing calves. Digestibility of nutrients for DM, OM, CP, NDF, ADF, hemicellulose, cellulose, and total carbohydrates was better in the fermented feed-supplied group compared to the control group. Mahesh et al. have reported that higher daily intake of DM ($p < 0.05$), digestible CP ($P < 0.01$), and ME ($p < 0.05$) in the fermented feed supplied group resulted in a significant ($p < 0.05$) higher average daily body weight gain (135 *vs.* 102 g/day) [11]. Our study supports the findings of Ojokoh et al. [12]. They observed improved protein digestibility of soya protein products after fermentation by *Bacillus natto* in contrast to the raw soya meal. Yeast-fermented feed is a source of non-conventional protein and it can be used in concentrate ration. It has a positive impact on nutrient intake, and digestibility in ruminants [13]. The addition of yeast to a diet contributes to increasing amounts of dry matter intake due to its acidogenic nature. This may be

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attributed to the fact that the yeast-on intake effect is insignificant with a diet, rich in concentrate (high energy intake), which produces major Volatile fatty acids (VFA) from carbohydrates i.e. fast fermentable. Thus, feed intake increases on a rich diet due to the direct action of yeast on communities that degrade fiber in the rumen at the level of oxygen consumption and promote the fibrinolytic action to accelerate intestinal transit and subsequently increase the amount of dry matter intake [14,15]. The report of Maamouri et al. showed that the body weight of lambs increased from 22.5 to 30.5 kg in the control group compared to 22.3 to 34.5 kg for the group supplied with yeast fermented feed [16]. They observed that lambs that received yeast (*S. cerevisiae*) fermented feed had a more cumulate body weight gain (12.3 ± 2.6 kg) than the tcontrol group (8.0 ± 2.4 kg). Feed supplemented by *S. cerevisiae* had a more body weight gain of 12.3 kg than the control group of 8kg. In yeast supplemented group the daily weight gain was 223 g/day while in the control group was 145 g/day. Feed conversion decreased notably for the yeast feeding group than the control. When animals are fed yeast fermented feed, a significant increase in daily body weight gain due to yeast effect limits the disruption of fermentation in the concentrate-rich diet [17]. Yeast (*S. cerevisiae*) allows lactate produced from the rumen flora to prevent accumulation of lactic acid in nutritional situations leading to acidosis formation. Fermentation of starch (carbohydrate of concentrate) is much faster producing a greater amount of VFA and the intermediate production of lactic acid is less rapidly metabolized. Therefore, yeast can stimulate lactic acid bacteria in rumen digestion and improve the flow of microbial protein in the rumen, resulting in increased weight gain [18]. Zhang et al. observed that fermented feed has a beneficial effect on the growth performance of animals whereas feed effectiveness was strongly associated with the incubated species and strains and the substrates used for fermentation [19].

Yeast (*S. cerevisiae*) amplifies the ruminal bacterial population and improves the dry matter intake along with fiber and protein digestibility [20]. Yeast-fermented feed improves rumen fermentation and dry matter intake, as reported by numerous studies [21]. It improves fiber digestion, which is helpful for rumen fermentation and nutrient digestion by reducing the accumulation of lactic acid and oxygen in the rumen [22]. Wanapat et al. found a significant change in dry matter intake after replacing soybean meal with yeast-fermented cassava chips [23]. They have reported that soybean meal can be wholly replaced by yeast-fermented cassava chips with any undesirable effect. Yeast supplementation (*S. cerevisiae*) improves the DMI (dry matter intake) in ruminants because of its particular smell with better tastiness. Yeast (*S. cerevisiae*) addition improves the DM, CP, and CF digestibility of feed [24]. The digestibility improves due to the increased nitrogen substance in the rumen, which increases the microbial population [25]. Supplementation of dry yeast increased fiber digestibility ($p < 0.5$) due to yeast having the ability to scavenge excess oxygen in the rumen, lower the redox potential, and improve the degradability of fiber [26]. Sartori et al. stated that the highest total intake and average daily gain were observed in cattle supplemented with yeast [27]. The addition of dry yeast at 3g/animal/day improved total feed intake, rumen fermentation, and total bacteria populations while reducing protozoal population and methane (CH_4) production in beef cattle fed with urea–urea-lime-treated rice straw [28]. They observed that cattle fed a low plane of nutrition diet supplemented with yeast significantly increased average daily gain and achieved a comparable level with cattle fed with a high plane of nutrition diet, which also agrees with Geng et al. [29]. Lamb ration (fermented soybean meal or wheat bran) enhanced the nutrient digestibility which is consistent with the current study [19]. Similar results were found by He et al. [30]. They observed the average daily weight gain significantly increased and the feed gain ratio decreased significantly ($P < 0.05$) with dietary fermented concentrate (wheat bran) of growing-finishing pigs. The higher growth rate might be due to increased microbial protein flow escaping from the rumen and an enhanced supply of different amino acids entering the small intestine [24].

Conclusions

Nutritional feed is important to improve animal health and the quality of livestock products. It is a challenge for the livestock sector to supply safe and nutritious feed to animals. Providing adequate and balanced diets is essential to enhance the productivity and welfare of livestock. So, the current study was conducted to improve the nutritional quality of low-quality sugarcane bagasse as feed for sheep farming. This research was done to improve the nutritional value of crop residues like sugarcane bagasse and energy-based concentrate mixtures like wheat bran, and rice polish. Fermentation is a method to improve the nutritional quality of feed. Results showed that sheep's feed digestibility, body growth, FCR, and economic profit were best in fermented feed-supplied groups. The findings were that yeast (*S. cerevisiae*) fermented feed can be a good nutritional source for animal growth. Comparatively, yeast fermented feed increases the amount of feed intake more than non-fermented feed. Fermented feed improves nutrient digestibility (%) and reduces the FCR (kg-feed/kg-gain) of feed. For this reason, Yeast (*S. cerevisiae*) fermented sugarcane bagasse as a roughage source can be provided to sheep for better body growth and performance. Fermentation is an effective method to improve the nutritional value of poor-quality feed. Nutrient intake and body weight gain were highest in the T_2 group, which was supplied with 60% fermented sugarcane bagasse and 40% fermented concentrate mixture. Nutrient digestibility, FCR, and economic profit were best in the T_1 group, which was supplied by 20% fermented sugarcane bagasse, 20% fermented concentrate mixture, and 60% green grass. The growth performance of sheep was better in fermented feed-supplied group T_1 and T_2 than in non-fermented feed-supplied group T_0. In Bangladesh, maximum crop residues are poor in nutritive value, so for better utilization of a large number of crop residues, solid-state fermentation is an appropriate biotechnological technique. By using solid-state fermentation, we can upgrade the nutritive value of these poor-quality crop residues.

The limitations of this study are that the meat characteristics of sheep were not tested in the laboratory to know the effect of fermented feed on the mutton quality, such as taste, tenderness, juiciness, marbling, etc.

Sugarcane bagasse is a poor-quality crop residue. The future respect of this study is proper utilization of this agricultural byproduct, which can be fed to sheep by upgrading its nutritional quality, especially protein.

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Disclosure statement

No potential conflict of interest was reported by the authors.

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