

## ORIGINAL ARTICLE

# Impact of rice gruel on rumen metabolites and growth performance of sheep

Tridip Das<sup>1</sup>, Md. Hasanuzzaman<sup>2</sup>, Eaftekhar Ahmed Rana<sup>1</sup>, Probir Deb<sup>1</sup>, Sri Rajiv Kumar Roy<sup>3</sup>, Md. Saiful Bari<sup>4</sup>

<sup>1</sup>Department of Microbiology and Veterinary Public Health, Chittagong Veterinary and Animal Sciences University, Chittagong, Bangladesh

<sup>2</sup>Department of Animal Science and Nutrition, Chittagong Veterinary and Animal Sciences University, Chittagong, Bangladesh

<sup>3</sup>Palli Karma Sahayak Foundation (PKSF), Dhaka, Bangladesh

<sup>4</sup>Department of Dairy and Poultry Science, Chittagong Veterinary and Animal Sciences University, Chittagong, Bangladesh

### ABSTRACT

**Objectives:** We investigated the impact of rice gruel as an alternative energy source of molasses as well as measured the effectiveness of rice gruel on the physiology of the rumen environment and the growth performance of growing lamb.

**Materials and methods:** A number of 18 sheep with an average age of 7 months and mean body weight of 5.9 kg were selected and divided into three groups for 60 days long feeding trial with urea molasses straw (UMS), urea rice gruel straw (URS), and concentrate feed. Every fortnight interval, live weight was recorded and rumen liquor from every group was collected four times before and after feeding at 4-h interval to examine the rumen environment.

**Results:** Color, odor, consistency, and protozoal motility remain unchanged in all three groups. The pH of the rumen liquor was highest at 8 h of post feeding among three groups. The bacterial count ( $6.1 \times 10^{10}$ ) was higher in the group that consuming UMS than URS and concentrate feed. The rumen protozoa also showed a similar growth pattern in proportion to a number of rumen bacteria. At the end of the 60 days feeding trial, no significant differences ( $p \leq 0.05$ ) were found among the three groups in contrast to body weight gain.

**Conclusion:** In the current feeding trial, the close similar effectiveness of rice gruel and molasses was found as a fermentable energy source. However, we suggest that rice gruel can be supplemented as a substitute for molasses under the situation when molasses are not available or expensive in field condition.

### ARTICLE HISTORY

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## Introduction

A deep-seated component of the rice-based agricultural production system in Bangladesh is documented as livestock that plays a momentous role in the national economy. The contribution of livestock to national gross domestic products and foreign exchange earnings is about 6.5% and 13% [1]. An indispensable role is played in the traditional agriculture and largely subsistence economy of Bangladesh by livestock [2]. In livestock rearing, the most expensive input is nothing but feed [3] which accounts for 60%–70% of the total production cost [4]. The fundamental nutrients obligatory for animal production, including energy, protein, and amino acid as macronutrients, as well as minerals, vitamins, and other micronutrients are provided by livestock feed [5]. The production and accessibility of

livestock feed is very less in amount than the demand since there is a scarcity of lands in our country and therefore the price is sky-high. The poor quality fibrous feed is deficient in readily fermentable carbohydrate, digestible protein, and some minerals [6]. Such fibrous feeds provide about 96%, 91%, and 84% of the dry matter (DM), metabolizable energy, and crude protein (CP), respectively, available for the ruminant animals of Bangladesh [7].

In rice-based agriculture, rice straw is the most available feedstuff throughout the year when green grass is not available around the year. Hence, rice straw is the main energy source for ruminants comprising over 60% of the dietary energy supply in Bangladesh [2].

The lower level of readily fermentable nitrogen and energy for the rumen and volatile fatty acids, amino acids

**Correspondence** Tridip Das ✉ [das.vet671@gmail.com](mailto:das.vet671@gmail.com) 📧 Department of Microbiology and Veterinary Public Health, Chittagong Veterinary and Animal Sciences University, Chittagong, Bangladesh.

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for the animal provided by the rice straw are primary limitations to ruminant production in this country [7,8]. Sugarcane molasses is one such non-conventional feed, which is rich in soluble carbohydrate and widely available in Bangladesh. So, on a straw-based diet, urea and molasses are added to upgrade the quality of the feed [9,10]. Supplementation of poor quality roughage with molasses increased their intake or growths of cattle [5,11].

However, molasses is not always available due to poor distribution channel and higher cost [12]. Supplementation of other high-energy source is impractical. On contrary, every household and residential educational institute of our country produces a considerable amount of rice gruel during rice cooking, containing a significant amount of soluble starch material. Traditionally, it is being used in the sheep diet as a drink with water. Sheep population has been increasing in Bangladesh either in the household or commercial farming. Though some works have been carried out with rice gruel on sheep to assess the rural fattening program with traditional feeding practices (tethering, grazing, and tree leaves with rice straw), no concise work has been done to evaluate the rice gruel as one of the major sources of energy after replacing the molasses. Keeping this view in mind, the current study was designed to investigate the possibility of rice gruel as a non-conventional feed resource compared to other expensive energy source (molasses) on growth performance of native growing sheep, as well as to find the impact on rumen protozoa and bacteria.

## Materials and Methods

### Study area

Chittagong Veterinary and Animal Sciences University (CVASU) sheep farm, which is situated within the campus premises of CVASU, Chittagong, Bangladesh was selected as the study area for feeding trial with rice gruel, in addition to concentrate ration compared to the molasses as an energy source for a time period of 60 days.

### Selection of animals

A total number of 18 healthy, diseased free growing lambs of approximately same age and size but of different sexes were selected for the growth trial from CVASU sheep farm. The animals were divided into three trial groups T<sub>1</sub>, T<sub>2</sub>, and T<sub>3</sub> with six animals in each group having three male and three female with the age range between 6 and 8 months, where T<sub>1</sub>, T<sub>2</sub>, and T<sub>3</sub> having the average body weight of 6, 5.7, and 5.8 kg, respectively.

### Ethical approvals for animal experimentation

During strained rumen liquor (SRL) collection from the sheep of CVASU sheep farm, appropriate measures were taken to minimize pain or discomfort. Indispensable approvals were taken from concerned farm authority as well as Institutional Ethics committee (Approval no: EC/2017/930-3) for conducting the study. Animal dealings and experiments were carried in accordance with local laws and regulations.

### Proximate analysis of feeds for trial

Fresh rice gruel was collected and after preparing urea rice gruel straw (URS), urea molasses straw (UMS), and concentrated feed ration, the proximate analysis was done at Animal Nutrition Laboratory, CVASU.

### Preparation of experimental shed

The ceiling, walls, and floor of the experimental shed for sheep were properly washed and cleaned by using tap water before the experiment and the shed was washed and cleaned in the same manner daily during the entire study period. The whole shed was washed with disinfectant solution weekly. Feces of sheep and other dirt were regularly removed and disposed of properly.

### Preparation of animals for trial

Before 2 weeks of the trial, clinical examinations were done of all the selected animals thoroughly to detect the presence of ectoparasites, endoparasites, and blood parasites by close inspection, coproscopy, and blood smear technique, respectively. The animals were dewormed by using anthelmintic according to the parasites found. In the peripheral blood smears from the sheep under the study after Giemsa staining, there were no blood protozoa.

### Feeding of animals

Required amount of feed was offered to the sheep on the basis of their group mean body weight. UMS was provided to group T<sub>1</sub>, URS was given to group T<sub>2</sub>, and concentrate ration was offered to T<sub>3</sub> group twice daily according to the requirement of their group mean body weight. UMS contains urea (3%) + molasses (15%) and URS contains urea (3%) + rice gruel (30%). Concentrated ration contained wheat bran (24.5%), rice polish (17%), broken rice (6%), maize (13%), molasses (2%), pea bran (20.5%), soybean meal (7%), soybean oil cake (8.5%), and common salt (1.5%). Fresh and clean drinking water was offered to all animals round the day as an *ad lib* basis.

**Table 1.** Animal groups with the daily amount of feed offered.

Group	Average body weight (kg)	Grazing period (h)	UMS/animal (Kg)	URS/animal (Kg)	Concentrate feed/ animal (kg)
T <sub>1</sub>	6	-	0.49	-	-
T <sub>2</sub>	5.7	-	-	0.63	-
T <sub>3</sub>	5.8	-	-	-	0.24

**Table 2.** Proximate value of UMS, URS, and concentrate feed.

Feedstuff	DM (%)	CP (%)	CF (%)	Ash (%)	EE (%)	NFE (%)
UMS	63.27	9.825	28.19	14.905	1.32	45.76
URS	50.27	8.325	32.89	15.87	1.15	41.76
Concentrate	90.82	13.45	25.02	4.927	1.92	53.253

### Body weight gain

The body weight of sheep was recorded at initial, final, and in between fortnightly basis level of the trial by using a digital weight machine. Body weight gain of the sheep of all groups was calculated by deducting previous weight from current weight and the average value was calculated by dividing total weight gain by the number of days and animals.

### Physical examination of rumen liquor

Rumen liquor was collected from each animal of each group by means of rumenocentesis after properly restraining the animal once before 4 h of feeding and thrice after feeding at 0, 4, and 8 h of post-feeding hours totally for four times at fortnight interval. Immediately after collection, the rumen fluid was transported from the collection site to the laboratory through a thermo flask to maintain 39°C temperature in thermo flask. The color, consistency, and odor of individual animal SRL were examined by the organoleptic test. Portable digital pH meter was used to measure the pH of SRL. Smears were prepared with SRL on the glass slide separately and the movement of protozoa was examined under low magnification (10×) of microscope after placing a coverslip over the smear.

### Estimation of bacteria of SRL

The SRL was centrifuged at 3,000 rpm for 5 min. A volume of 5 ml of centrifuged content and 5 ml of 10% formalin were mixed in a test tube to kill the bacteria. After that, 2-ml mixture and 8-ml distilled water were mixed for serial dilution up to  $1 \times 10^{-4}$  accordingly. Exactly 0.01 ml of sample from  $1 \times 10^{-4}$  dilution was placed on a clean glass slide on a marked area of  $2 \times 2$  cm and stained with negative stain (Nigrosin) to observe the presence of bacteria [13]. The slide was kept on a hot plate for 2 sec to dry the smear and counting was done under oil immersion lens where bacteria appear colorless against a black background. The bacteria were counted from 10 different fields from each smear in a zigzag manner and the

average number of bacteria per field was calculated by the following formula:

Ruminal bacteria per ml of SRL = [Average number of bacteria per field × microscopic factor (1,000) × dilution factor ( $10^6$ )]

### Estimation of total protozoa in rumen liquor

Nearly, 1 ml of SRL and 9 ml of Lugol's Iodine solution were added and mixed gently. Afterward, a smear ( $24 \times 60$  mm) was prepared for each sample with 0.1 ml of diluted mixture. Protozoa were counted under low power magnification (10×) of the microscope in a zigzag manner. Thirty fields were counted per slide and average count per field was calculated. Total protozoal count per ml was calculated by the following formula:

Total protozoa per ml of SRL = [(Average No. of protozoa count per field) × (Microscopic factor) × (Dilution factor)]

### Statistical analysis

All the data obtained from the study were entered into Microsoft Excel 2007 according to the selective parameters and analyzed by applying STATA-13 (Stata corp, 4905, Lakeway River, College Station, TX) for statistical analysis. The analysis of variance used at different trial was addressed at the respective parameters.

## Results

### Proximate analysis of feedstuff

The DM of UMS, URS, and concentrate feed was 63.27%, 50.27%, and 90.82%, respectively. Other proximate like CP, crude fiber (CF), ether extract (EE), ash, and nitrogen-free extract (NFE) also were estimated (Table 1 and 2) according to The Association of Official Analytical Chemists [14].

### Body weight gain

Three groups were treated with different feeds with repeated observation (Initial, first fortnight, second

**Table 3.** Consecutive body weight gain of groups (kg).

Trial group	Initial body weight (kg)	First Fort- night (kg)	Second Fort-night (kg)	Third Fort-night (kg)	Final body weight (kg)	Weight gain average (kg)
T <sub>1</sub>	6.07	6.53	7.03	7.57	8.07	2.0
T <sub>2</sub>	5.7	6.53	6.7	7.23	7.77	2.07
T <sub>3</sub>	5.7	6.2	6.67	7.17	7.7	2.0

**Table 4.** Effect of diet and time on various physical parameters of rumen liquor.

Parameters	Group	Pre feeding		Hours of post feeding	
		4 h	0 h	4 h	8 h
Color	T <sub>1</sub>	Gray	Gray	Greenish	Gray
	T <sub>2</sub>	Gray	Gray	Gray	Greenish
	T <sub>3</sub>	Gray	Gray	Gray	Gray
Odor	T <sub>1</sub>	Aromatic	Aromatic	Aromatic	Aromatic
	T <sub>2</sub>	Aromatic	Aromatic	Aromatic	Aromatic
	T <sub>3</sub>	Aromatic	Aromatic	Aromatic	Aromatic
Consistency	T <sub>1</sub>	Viscous	Viscous	Viscous	Viscous
	T <sub>2</sub>	Viscous	Viscous	Viscous	Viscous
	T <sub>3</sub>	Viscous	Viscous	Viscous	Viscous
Protozoal motility	T <sub>1</sub>	Very rapid	Very rapid	Rapid	Very rapid
	T <sub>2</sub>	Very rapid	Very rapid	Rapid	Very rapid
	T <sub>3</sub>	Very rapid	Rapid	Rapid	Very rapid
pH	T <sub>1</sub>	6.3	6.2	6.4	6.6
	T <sub>2</sub>	6.2	6.2	6.3	6.4
	T <sub>3</sub>	6.2	6.1	6.4	6.5

fortnight, third fortnight, final). The average body weight gain in UMS, URS, and concentrate treated group was 2, 2.07, and 2 kg, respectively (Table 3).

#### Examination of physical characters of SRL

Rumen liquor was collected at 4 h of pre feeding and 0, 4, and 8 h of post feeding for once from each animal of all the groups in fortnight interval. The SRL color was grayish in almost every time with aromatic odor having viscous consistency, where protozoal motility was very rapid. The highest pH value (6.6) was found in T<sub>1</sub> at 8 h post feeding SRL and the lowest (6.1) at 0 h of feeding (Table 4).

#### Bacterial count

Bacterial population was counted from the SRL after collecting at 4 h of pre feeding and 0, 4, and 8 h of post feeding from each treatment. The bacterial population (cell × 10<sup>10</sup>) ranged from 4.7 to 6.3, 4.9 to 5.8, and 4.9 to 6.1 per ml of SRL in T<sub>1</sub>, T<sub>2</sub>, and T<sub>3</sub> diets, respectively (Fig. 1), where it was higher in T<sub>1</sub> at 8 h of post feeding than others and lower in T<sub>1</sub> at 0 h of post feeding.

#### Protozoal count

Both ciliated and non-ciliated protozoal population were counted from the SRL after collecting SRL at 4 h of pre feeding and 0, 4, and 8 h of post feeding from each treatment (Figs. 2 and 3). The rumen mixed protozoal population

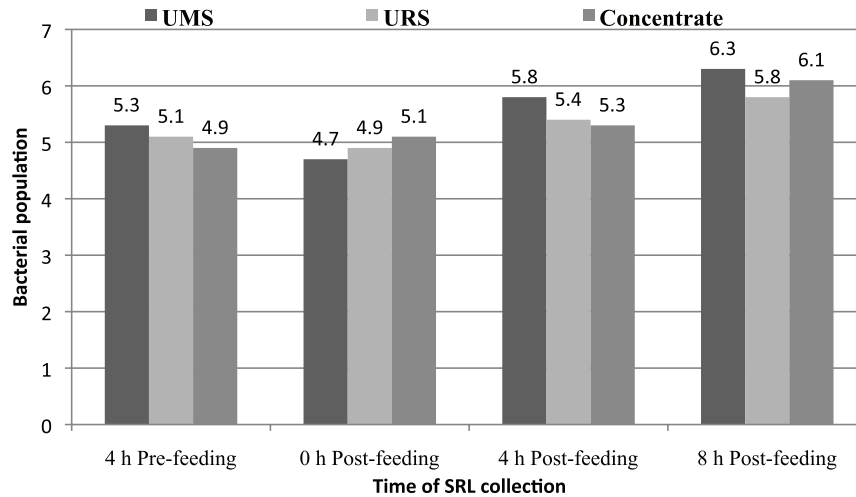
(cell × 10<sup>6</sup>) ranged from 3.05 to 4.26, 2.34 to 3.38, and 2.12 to 2.89 per ml of SRL, respectively in T<sub>1</sub>, T<sub>2</sub>, and T<sub>3</sub> diet and being highest at 4 h of post feeding in diet of all groups and lowest in 4 h of pre feeding in diet of all groups.

#### Discussion

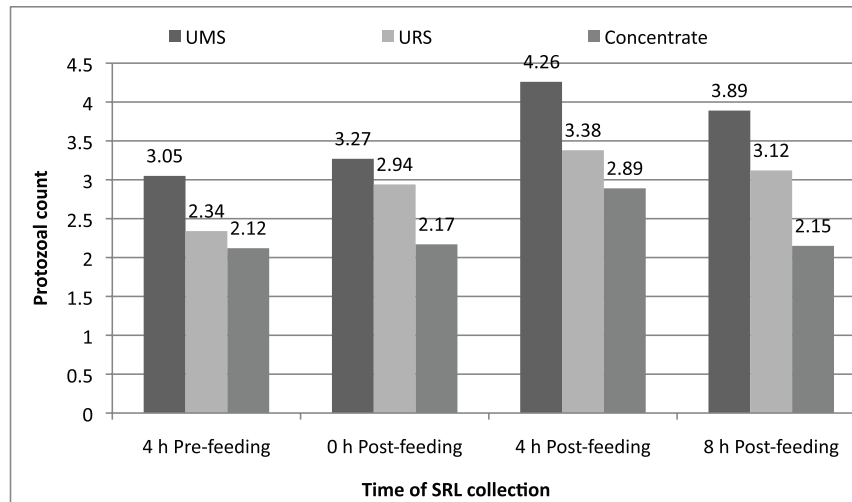
Livestock as well as sheep population in Bangladesh has been remarkably increasing nowadays. Due to a huge gap between demand and accessibility of feed, livestock are mainly fed on reduced quality feed, which are low in energy, protein, and other essential nutrients. However, the use of balanced rations consisting locally available good quality unconventional feed resources may bridge this gap to improve the feed utilization efficacy and performance of animals.

Nutritive value of URS was apparently similar with UMS, where UMS had a higher DM than URS. In comparison with CP and NFE, UMS had higher nutritive value [4]. Furthermore, CF and ash remained in higher proportion in case URS than UMS that was recommended by Talukder et al. [2].

The pH of the rumen liquor varied from 5.9 to 6.6, 6.0 to 6.7, and 6.1 to 6.6 in T<sub>1</sub>, T<sub>2</sub>, and T<sub>3</sub>, correspondingly. The highest values of pH were found at 8 h and lowest values were found at 4 h in T<sub>2</sub> and T<sub>1</sub>, respectively. Alam et al. [15] reported the lowest value of rumen pH in sheep at 1–2 h post feeding. In case of cattle and buffalo, the rumen pH



**Figure 1.** Effect of diet and time on bacterial count (cell  $\times 10^{10}$ )/ml of SRL.

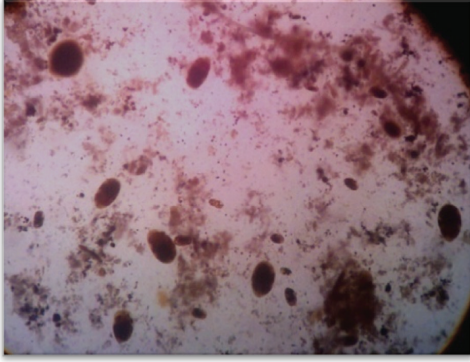


**Figure 2.** Effect of diet and time on protozoal count (cell  $\times 10^6$ )/ml of SRL.

was notably lesser at 3–4 h post feeding when rumen protozoa might be present or absent from [16,17]. Grazing on either natural grassland or silvi-pasture system maintained a rumen pH of 7.30–7.96 [18]. The other experiment by Samanta et al. [18] showed that the sheep's grazing on natural pasture; the rumen pH was always highest above 6.8 irrespective of post-feeding intervals.  $T_2$  was highest in the study irrespective of post-feeding intervals as compared with  $T_1$  and  $T_3$ , which might be as a result of higher alkaline saliva secretion [4]. The color, odor, consistency, and motility shown in Table 4 were within the physiological limit as supported by Hasanuzzaman et al. [4].

The microbial population (cell  $\times 10^{10}$ ) in case of rumen bacteria ranged from 4.7 to 6.3, 4.9 to 5.8, and 4.9 to 6.1 per ml of SRL in  $T_1$ ,  $T_2$ , and  $T_3$  diets, respectively, which was recommended by Meyer et al. [19]. The bacterial population attained peak level at 8 h of post feeding and lowest values found at 4 h of pre feeding [20]. The total number of bacteria was a bit higher but not significant in  $T_1$  as well as in  $T_3$  diet which is significant in  $T_2$  and supported by [4,5,21]. The rumen mixed protozoal population (cell  $\times 10^6$ ) ranged from 3.05 to 4.26, 2.34 to 3.38, and 2.12 to 2.89 per ml of SRL, respectively in  $T_1$ ,  $T_2$ , and  $T_3$  diet and being highest at 4 h of post feeding in diet of all groups [19,20].





**Figure 3.** Rumen protozoa under a microscope (100× magnification).

The body weight gain of the animals belonging to  $T_1$ ,  $T_2$ , and  $T_3$  was, respectively, 2, 2.07, and 2 kg, where  $T_2$  was numerically higher than the animals belonging to  $T_1$  and  $T_3$ . The result was in close agreement with the findings of Baset et al. [22]. Again, this body weight gain was closer to the findings of Babu et al. [23] and Hasanuzzaman et al. [4].

Above results reflected that rice gruel was apparently less effective than molasses as a fermentable energy source [24]. But it enhanced the rumen bacterial and protozoal population as like as molasses. There were no significant differences in body weight gain in case of rice gruel straw [4,22,23]. However, in the situation where molasses is not available or costly, rice gruel does appear to have a place as a readily fermentable energy source.

## Conclusion

The study was conducted to see the impact of rice gruel on rumen physiology as well as growth performance of sheep. Sheep population has been increasing day-by-day and there is an extra demand of feed for the increased population. This extra demand of feed for livestock can be minimized by means of using an unconventional feed like rice gruel as a source of readily fermentable energy. This study revealed that rice gruel diet assures a bit better rumen metabolites for growth and multiplication of rumen bacteria, protozoa as well as body weight gain.

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## Conflict of Interest

The authors declare that they have no conflict of interest.

## Author Contribution

Tridip Das, Md. Saiful Bari, and Md. Hasanuzzaman planned the study, analyzed, as well as interpreted the data, and drafted the current manuscript. Eaftekhari Ahmed Rana and Probir Deb collected the data and also assisted in the preparation of the manuscript. Sri Rajiv Kumar Roy helped in preparing, drafting, and correcting of this manuscript.

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