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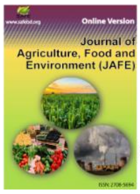

Research Article

Effect of replacing wheat bran with de-oiled rice bran on growth and blood parameters of native sheep

Bishwass KC[1], Surovy NF[1], Shuvo AAS[2], Murshed HM[1], Parvin S[3], Pasha MMH[4], Kabir AKMA[1], Rahman SME[1]*

[1]Department of Animal Science, Bangladesh Agricultural University, Mymensingh-2202
[2]Department of Animal Nutrition, Bangladesh Agricultural University, Mymensingh-2202
[3]Department of Livestock Services, Ministry of Fisheries and Livestock, Bangladesh
[4]Bangladesh Livestock Research Institute (BLRI), Savar, Dhaka

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***Corresponding Author**

Rahman SME, E-mail: ehsan_bau@yahoo.com

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ABSTRACT

This research aimed to explore the impact of substituting wheat bran with de-oiled rice bran on the growth performance and blood parameters of indigenous sheep. Twelve 10-month-old lambs were randomly assigned to four dietary groups, each with three replications. The control group (T1) received a standard diet, while the other groups (T2, T3, and T4) had varying proportions of de-oiled rice bran, wheat bran, and green grass. Results indicated significantly higher body weight gain in T3 and T4 compared to T1, with the highest gain observed in T2. Glucose levels remained non-significant. Notably, T3 exhibited significantly higher levels of albumin, calcium, and phosphorus, while T1 showed lower values. Blood urea and blood nitrogen were notably higher in T3, exhibiting a gradual increase across treatment groups from T1 to T3. The findings suggest that replacing wheat bran with 50g of de-oiled rice bran, supplemented with grazing, positively influenced growth performance and blood profiles. Substituting wheat bran with 50g and 100g of de-oiled rice bran significantly enhanced growth with increased nitrogen levels in the blood, effectively maintaining blood parameters within the normal range. Consequently, replacing wheat bran with de-oiled rice bran at a certain percentage (33%) appears to be a cost-effective strategy for maximizing the growth performance of native sheep under semi-intensive conditions.

Introduction

Livestock holds a pivotal position in the national economy, with sheep playing a particularly significant role in the subsistence economy of Bangladesh (Hossain *et al.*, 2021). With approximately 3.53 million sheep in the country, these multipurpose animals contribute to the economy by providing meat, wool, and skin (Ahmed *et al.*, 2018). Following goats, sheep stand as the largest source of meat and wool, gaining popularity in various Asian countries. Their resilience in adverse conditions surpasses that of goats, making them increasingly appealing to farmers (Utaaker *et al.*, 2021). Presently, there is a growing enthusiasm among farmers to rear sheep, as the production of meat from these animals plays a crucial role in meeting the protein needs of the Bangladeshi population (Islam, 2019). Additionally, sheep prove to be easily manageable under rural conditions, thriving in harsh environments, with the added advantages of minimal management requirements and lower feed consumption (Sekaran *et al.*, 2021; Parvin *et al*. 2017). However, despite the enthusiasm for sheep farming, many farmers adopt an extensive system in a ranged environment without proper supplementation. This production approach results in reduced growth rates and poor reproductive performances, leading to significant economic losses for farmers (Hossain *et al.*, 2021).

Situated as an agricultural hub, Bangladesh is adorned with various agricultural and livestock by-products, including wheat bran and de-oiled rice bran. The utilization of wheat bran in the feed industry has experienced a noticeable and substantial increase in the past decade (Islam and Khan, 2021). Examining wheat bran from a histological perspective reveals its composition of distinct tissues, namely the pericarp, testa, and aleurone layer, accounting for 4-5%, 1%, and 6-9% of the wheat grain, respectively (Hemery *et al.*, 2007). These histological compartments represent different properties and compositions within the wheat kernel. Broadly, wheat bran contains around 12% water, 13-18% protein, 3.5% fat, and 56% carbohydrates (Onipe *et al.*, 2015).

Rice bran, rich in cellulose and hemicellulose, contains varying levels of starch resulting from endosperm breakage during milling, typically ranging from 10-20% or higher (Kalpanadevi *et al.*, 2018). Despite being a valuable by-product, rice bran has not been efficiently utilized, primarily due to the presence of anti-nutritional or toxic factors (Irakli *et al.*, 2021). While it offers excellent nutrition, these factors limit its use in human or animal diets, relegating it to lower-quality livestock or poultry feed (Attia *et al.*, 2023). The presence of field fungi and bacteria in rice bran contributes to nutrient degradation, off-flavors, color browning, and even aflatoxin production. Additionally, rice bran's susceptibility to rancidity, high phytate content, enzyme inhibitors, and elevated fiber levels restrict its application in sheep diets, impacting both nutritive value and overall performance (Gallinger *et al.*, 2004).

Rice bran, a by-product of rice processing, has traditionally been used in animal feeds, including for sheep (Casas *et al.*, 2018). However, growing demand for high-grade oil for human consumption has led to increased extraction from full-fat rice bran (FFRB) (Friedman, 2013). This process has resulted in the availability of defatted rice bran (DORB) for animal feeding, with its Metabolizable Energy (MEn) value being 75% of that of FFRB. De-oiled rice bran, a plentiful by-product in rice-based agricultural countries like Bangladesh, is rich in protein, vitamins, and trace minerals (Friedman, 2013). Concentrate feeds, including de-oiled rice bran, promote rapid growth in sheep and cattle, reduce methane production, and enhance ruminal propionate production, improving overall dietary energy utilization for body weight gain (Shinkai *et al.*, 2012). Concentrate supplements are known to enhance the utilization of poor feeds by improving rumen fermentation parameters (Agle *et al.*, 2010). This study focuses on the effects of free-choice roughage sources on ruminal fermentation, nutrient intake, utilization, and feed conversion efficiency in weaner lambs during the postweaning growth phase. Compared to rice bran, de-oiled rice bran (DORB) has higher protein and structural carbohydrates, lower fat, and improved digestibility (Kumar *et al.*, 2018). DORB is rich in cellulose, hemicellulose, lignin, crude fibers, and ashes. It contains crucial nutrients such as crude protein, fiber, fat, moisture, ash, sand silica, calcium, and phosphorus (Illankoon *et al.*, 2023). Additionally, it offers a superior assortment of amino acids, particularly lysine and methionine, compared to other cereal grains like maize and wheat (Perera *et al.*, 2022).

De-oiled rice bran stands out as a cost-effective nutrient source for livestock, boasting superior nutrient content compared to other supplement feedstuffs (Islam *et al.*, 2018). With its increasing availability in the market, this study aims to assess the effectiveness of de-oiled rice bran in promoting the growth, nutrition, and blood parameters of native sheep when used as a supplementary concentrate feed, replacing wheat bran (Bhatt *et al.*, 2013). The research aims to assess the effects of replacing wheat bran with de-oiled rice bran on the growth and nutrition of native sheep, while also exploring unconventional feed sources to reduce costs. Additionally, the study seeks to promote de-oiled rice bran as a concentrate feed supplement for wider adoption in enhancing sheep nutrition and growth.

Materials and Methods

Experimental site

The entire experiment took place at the Goat and Sheep Farm and Animal Science Laboratory within Bangladesh Agricultural University, Mymensingh, Bangladesh.

Animals and housing

A total of 12 lambs, with an average age of approximately 10 months and an average weight of 12.5±1.5 kg, were categorized into four groups based on their live weight. The experiment was conducted with the animals housed in well-ventilated enclosures.

Sources of feed

Green grass was supplied from the fodder plots of Goat and Sheep Farm, BAU, Mymensingh throughout the experimental period. Total amount of concentrates (De-oiled rice bran, Wheat bran, and common salt) were purchased from the feed dealer of Mymensingh town.

Ingredients used in ration and their amount

The study aimed to explore the impact of de-oiled rice bran by providing varying levels of both de-oiled rice bran and wheat bran to the sheep. The animals were fed twice daily in the morning and afternoon, with unrestricted access to water and green grass. The experimental design of the current study is presented in Table 1.

Table 1. Experimental design

	T_0 (1,2,3)	T_1 (4, 5, 6)	T_2 (7,8,9)	T_3 (10, 11, 12)
De-oiled Rice Bran(g)	0	50	100	150
Wheat Bran (g)	150	100	50	0
Salt (g)	3	3	3	3
Total(g)	153	153	153	153

Feeds were given in on clean bowl. Fresh and clean water was made available at all times.

Experimental design and layout of the experiment

The animals were blocked into A, B and C according to their body weight. Four dietary treatments (T_1, T_2, T_3 and T_4) were randomly distributed into each block (Table 2).

Table 2. Layout of experiment with initial weight of different dietary groups of animals.

Block	Dietary treatment initial live weight (kg)			
	T_0	T_1	T_2	T_3
A	12 (1)	11(4)	12.5(7)	11.5(10)
B	11.5 (2)	14(5)	11(8)	12(11)
C	10.5 (3)	11(6)	10.5(9)	10.5(12)
Average weight (kg)	11.3	12	11.3	11.3

Animal tag number is shown within the bracket of each dietary treatment.

Diet and method of feeding

The roughage and concentrate mix were administered separately, with the concentrate mixture comprising wheat bran, de-oiled rice bran, and common salt (Table 3). Each treatment group received a specific amount of de-oiled rice bran (0g, 50g, 100g, and 150g for T0, T1, T2, and T3, respectively) and wheat bran (150g, 100g, 50g, and 0g for T0, T1, T2, and T3, respectively). Animals in each treatment group were provided with de-oiled rice bran and wheat bran, in addition to grazing, twice a day at 9:00 AM and 5:00 PM. Adjustments to the supplemental diet were made based on live weight gain and feed consumption. Fresh, clean drinking water was available ad libitum, and the feeding trial continued for 75 days.

Table 3. Chemical composition of ingredients used for concentrates mixture.

Ingredients	Amount (gm)	Chemical composition (g/100g DM)					
		CP	CF	EE	Ash	NFE	OM
Wheat bran	100	14.63	10.41	4.75	5.64	64.57	94.36
De-oiled rice bran	100	12.09	11.52	0.4	8.38	38.12	89.37

Deworming

Sheep were administered deworming treatment, involving the use of an anthelmintic drug, every 14 days. This practice aimed to eliminate helminth parasites, including roundworms, flukes, and tapeworms, from the sheep.

Nutritional status parameters

Blood samples from each sheep were analyzed at 15-day intervals throughout the experimental period to assess glucose levels, albumin, serum urea, serum calcium, and serum phosphorus.

Chemical analysis for determination of blood parameters

Blood was collected from healthy sheep using a 10 ml falcon tube directly from the jugular vein. After collection, the blood samples were placed in a rack at room temperature. Subsequently, the collected blood was centrifuged at 10,100 rpm for 10 minutes to obtain plasma, which was then transferred into sterile 1.5 ml Eppendorf tubes. The plasma was preserved in a deep freezer, and each tube was appropriately marked with a permanent marker for easy identification during blood analysis.

The plasma glucose level was determined using the Enzymatic Colorimetric Test, specifically the CHOD-PAP method (Corso *et al.*, 2016). The concentration of blood serum albumin was determined using a quantitative colorimetric kit for albumin, employing the Bromcresol green method (Vivia Biotech S.L., Ctra. Santa Coloma, Spain) (Moreira *et al.*, 2018). The concentration of blood serum urea was determined using a quantitative colorimetric kit for urea, specifically the urease-GLDH kinetic liquid method (CHEMELEX, S.A., Pol. Ind. Can Castells, Barcelona, Spain) (Afroz *et al.*, 2020). The blood urea nitrogen level was determined by the procedure described by the study of Seki *et al.* (2019). The total protein level was determined by the procedure described by the study of Rogatsky (2021).

Data collection and record keeping

The sheep's initial body weight (IBW) was recorded on the first day of the experiment, and subsequent weekly weigh-ins were conducted for all sheep within each replication.

Measurement of growth changes

Growth parameters were assessed by measuring the height, weight changes, and body length of the animals. At the experiment's outset, animals were weighed for two consecutive days, and the average weight was considered the initial weight. Subsequently, regular weighing occurred every 15 days, conducted in the morning before feeding at a fixed time. Additionally, height, heart girth, and body length were measured at the beginning and end of the experiment using a measuring tape. At the conclusion of the experimental period, animals were weighed for two consecutive days, and the average served as the final weight. An animal weighing balance facilitated weight measurements. Live weight gain was calculated by subtracting the initial weight from the final weight, and the average daily gain was determined by dividing the total weight gain by the total number of days. Final height and body length measurements were taken to assess growth changes at the conclusion of the experiment.

Statistical analysis

The data collected for various parameters were analyzed using the "SPSS 25" statistical program (SPSS 25, 2016). Analysis of variance (ANOVA) was employed in a completely randomized design at a 5% level of probability.

Results and Discussions

Growth performance of lamb replacing wheat bran with de-oiled rice bran

The de-oiled rice bran quantities supplied to the four dietary groups (T1, T2, T3, and T4) were 0, 50, 100, and 150 g/day, respectively, exhibiting significant differences ($P<0.01$) among the groups. Although the initial live weights of the lambs did not differ significantly, the live weight, especially in T2, was higher in groups fed de-oiled rice bran. The live weight changes over the 75-day experiment revealed significant differences ($P<0.01$) among the dietary groups, with average initial live weights ranging from 11.33 to 12.00 kg. By the experiment's end, the animals reached live weights of 15.16, 17.91, 15.66, and 15.33 kg in T1, T2, T3, and T4, respectively, indicating significant differences ($P<0.01$). At the experiment's conclusion, average live weight gains were 3.50, 5.77, 4.33, and 4.23 kg in T1, T2, T3, and T4 groups, respectively. The results demonstrated significant differences ($P<0.01$) in live weight gain attributable to varying dietary de-oiled rice bran and wheat bran. Specifically, the average live weight gains significantly increased with the replacement of wheat bran with higher levels of de-oiled rice bran. Group T2 exhibited higher significance than T1, with slight differences between T2 and T3, T4 due to potential aversion to some round particles in de-oiled rice bran. The study suggests that incorporating 50 g and 100 g of de-oiled rice bran is both significant and cost-effective, as higher quantities may impact digestibility (Table 4). The study results suggest a significant improvement in the growth performance of sheep in various treatment groups by substituting wheat bran with de-oiled rice bran. A significant ($P<0.01$) difference was observed among the dietary treatments for growth, indicating a trend of increased growth rates with higher levels of de-oiled rice bran.

Additionally, there was a significant reduction in dry matter intake (DMI) with increasing levels of wheat bran in the sheep's diet. Study of Garg *et al.* (2004) found no adverse effect on DMI when grains were replaced with wheat bran or de-oiled rice bran. Lambs, owing to their rapid growth, demand elevated energy levels for optimal development (Bhatt *et al.*, 2013). Increasing the concentration of feed provided to lambs resulted in higher feed intake and live weight gain (Bhatt *et al.*, 2013). Lambs receiving a high-energy diet exhibited significantly higher live weights (ranging from $P<0.05$ to $P<0.01$) throughout all growth intervals spanning 0-75 days of the experiment compared to those on a low-energy diet. This aligns with findings indicating that local sheep, when grazing on natural grasses, experience a growth rate of only 15.7 g/d, while those provided with grazing along with 300 g of concentrate can achieve a significantly higher growth rate of 40.5 g/d, supporting the outcomes of the present study. The concordance in results could be attributed to factors such as breed, feed composition, stage of growth, and environmental conditions (Beckman, 2011). The growth performance is enhanced under a cafeteria system of feeding management compared to grazing with either 1.5% or 2.5% of body weight concentrate supplementation (Rodríguez *et al.*, 2007). The cafeteria system of feeding management not only improves feed conversion efficiency but also ensures that carcass fat content remains well within the acceptable limit of 9% (Chaudhary *et al.*, 2015).

Table 4. Effect of de-oiled rice bran and wheat bran on body weight gain.

Treatments	Initial weight (kg)	Final weight (kg)	Gain (kg)	Mean±SD	P value
T_1 (control)	12	15	3	3.50^a±.87	0.013
	11.5	16	4.5		
	10.5	14.5	3		
T_2 (50g DORB)	11	16.5	5	5.77^b±.86	
	14	19.6	5.6		
	11	17.7	6.7		
T_3 (100g DORB)	12.5	17	4.5	4.33^{ab}±.29	
	11	15	4		
	10.5	15	4.5		
T_4 (150g DORB)	11.5	15	3.5	4.23^a±.76	
	12	16	4		
	12.5	15	2.5		

Live weight gain at different treatment levels supplemented de-oiled rice bran

The body length of animals exhibited a significant increase ($P<0.01$) with the gradual rise in de-oiled rice bran. Notably, animals in Group T4 showed a higher increase in body length compared to those in Groups T1, T2, and T3. The inclusion of de-oiled rice bran also led to a significant increase in the heart girth length of animals across different treatment groups, with Group T3 animals having higher heart girth lengths than others. However, the data in Table 5 indicates no significant difference ($P>0.05$) in height with the varying levels of de-oiled rice bran in the animals' feed.

Table 5. Effect of de-oiled rice bran and wheat bran on body length, height and heart girth length difference of animal.

Parameter	T_1	T_2	T_3	T_4	P value	Sig. level
Length (inch)	0.83^b±0.28	1.66^{ab}±0.57	3.33^a±1.52	3.83^a±0.28	0.001	**
Heart girth(inch)	1.00^b±0.00	2.50^{ab}±0.50	3.66^a±1.52	4.00^{ab}±1.00	0.018	*
Height(inch)	0.83^a±0.28	1.66^a±0.28	3.16^a±1.75	3.20^a±1.47	0.094	NS

Data presented in the table are Mean±SD; **= 1% level of significance; *= 5% level of significance; NS= Non-significant.

Glucose, total protein, albumin, Calcium and Phosphorus

A significant difference in glucose levels was observed among the treatments ($P<0.05$), and a slight decrease in glucose levels was noted with the increase of de-oiled rice bran in some replications. Regarding total protein, there was a significant decrease ($P<0.01$) with the replacement of wheat bran by de-oiled rice bran, falling below the normal range of 6.0-6.5 g/dL in the blood serum of sheep (Table 6).

Table 6. Glucose level, total protein, Albumin, Calcium, and Phosphorus in blood.

Parameters	T1	T2	T3	T4	P value	Sig. level
Glucose (mmol/L)	2.43^a±0.11	2.25^{ab}±0.05	2.28^{ab}±0.10	2.08^b±0.07	0.008	**
Total Protein (g/dL)	6.52^a±0.18	6.48^a±0.08	6.42^a±0.10	6.34^a±0.12	0.388	NS
Albumin (g/dL)	4.21^b±0.09	4.23^{ab}±0.03	4.75^a±0.10	4.25^{ab}±0.37	0.030	*
Calcium	1.4^b±0.44	1.77^{ab}±0.15	2.42^b±0.07	2.17^b±0.21	0.006	*
Phosphorus	0.65^b±0.05	0.74^{ab}±0.06	0.93^a±0.06	0.79^{ab}±0.17	0.052	**

Data presented in the table are Mean±SD; **= 1% level of significance; *= 5% level of significance; NS= Non-significant

The blood glucose level results indicate that there is no significant difference ($P>0.05$) when wheat bran is replaced with de-oiled rice bran in the lamb feed. However, a slight increase in blood glucose levels was observed in some cases, though this increase is not statistically significant. It's worth noting that all results fell within the reported normal range (Wang *et al.*, 2020). Observations on albumin, calcium, and phosphorus indicate slight changes in T1 and T2, but in T3, the values are higher than in T4. The supply of 100g de-oiled rice bran with 50g wheat bran shows greater significance than supplying only de-oiled rice bran. In monogastric animals, insulin secretion is influenced by plasma glucose concentration, specific amino acids (arginine, lysine, and leucine), fatty acids, and ketones (Newsholme and Krause, 2012). As ruminants primarily derive metabolizable energy from volatile fatty acid production in the rumen, glucose absorption from their digestive tracts is limited (Ungerfeld, 2020). Consequently, propionate and butyrate play insulinogenic roles in ruminants. Significant differences ($P<0.01$) were identified among the groups in terms of total protein and albumin levels. A gradual increase in total protein, calcium, phosphorus, and albumin levels was observed with the corresponding rise in de-oiled rice bran (DORB) levels. The lower phosphorus content in the sheep's blood is attributed to its lower concentration in their diet (Ademi *et al.*, 2017). Plasma protein concentration, particularly total proteins, serves as an indicator for assessing ruminant nutrition (Urushihara *et al.*, 2016). Across all experimental groups, total proteins fell within the normal range of 6-8 g/dl. It's noteworthy that higher protein intake has been associated with an increase in serum albumin levels. This underscores the importance of monitoring these blood parameters as indicators of nutritional status in ruminants.

Blood urea and Blood Urea Nitrogen (BUN)

In both cases, the levels of urea and BUN increased with the rise in de-oiled rice bran among the treatment groups, progressing from T1 to T3, but exhibited a drastic change in T4. The increase in blood urea and BUN was found to be statistically significant among the groups from T1 to T3 (P<0.01) (Table 7).

Table 7. Urea (mg/dL) and BUN (mg/dL) in blood.

Parameters	T1	T2	T3	T4	P value	Sig. Level
Urea (mg/dL)	33.00^a±3.60	34.33^a±8.02	36.67^a±1.53	30.33^a±0.16	0.494	NS
BUN (mg/dL)	15.44^a±1.65	16.05^a±3.75	17.14^a±0.71	16.35^a±2.64	0.493	NS

Data presented in the table are Mean±SD; **= 1% level of significance; *= 5% level of significance; NS= Non-significant

No significant increase (P>0.05) in blood urea and BUN levels was noted among the treatment groups with the progressive substitution of wheat bran with de-oiled rice bran. Serum urea concentrations are intricately influenced by various factors such as dietary protein intake and rumen degradability, amino acid composition, protein intake relative to requirements, liver and kidney function, muscle tissue breakdown, and dietary carbohydrate amount, along with effective rumen degradable protein intake (Massini *et al.*, 2023; Prahl *et al.*, 2022). In sheep, the normal range for blood urea is 25-35 mg/dL, and for BUN, it is 7-20 mg/dL (Beier *et al.*, 2011). The growth performance of lambs exhibited a consistent correlation with nutrient intake, utilization, and nitrogen balance (Bhatt *et al.*, 2013; Zeng *et al.*, 2023). Each treatment group demonstrated a distinct pattern, showcasing the incremental increase in urea and BUN levels with the progressive replacement of wheat bran with de-oiled rice bran. Notably, in the case of T4, where only de-oiled rice bran was supplied, there was a decrease in both urea and BUN values. The highest values for blood urea and BUN were found in the T3 treatment group, while the lowest values were observed in the T4 group, reinforcing the impact of dietary composition on these blood parameters in sheep.

Conclusions

Replacing wheat bran with DORB enhances lamb growth performance. Group T3 and T4 animals showed similar body weights, indicating that supplementing with 100 g DORB and 50 g wheat bran or 150g DORB without wheat bran were equally effective. This suggests that providing 50 g and 100g of DORB can significantly improve the growth performance of native lambs under semi-intensive conditions, maintaining blood parameters within normal levels and proving economically viable in the prevailing socio-economic context.

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