RESEARCH ARTICLE Asian Journal of Dairy and Food Research, Volume 42 Issue 1: 26-30 (March 2023)

Effect of Feeding Fermented Rice Bran by Rumen Liquor on the Growth Performance of Broiler Chickens

Muhammad Ashiqul Alam[1], Md. Shahidur Rahman Khan[2], Khan Md. Shaiful Islam[3]

10.18805/ajdfr.DRF-273

ABSTRACT

Background: Broiler feedstuff as Rice bran (RB) is a by-product of rice industry. Using RB in broiler chicken diets is not common, especially in broiler chicken production systems due to limitations like higher content of fiber and lower availability of micronutrients. Fermentation of RB by rumen inoculate would improve the nutritive value and further inclusion of urea as a non-protein nitrogenous substance would increase the microbial population using nitrogen generated from urea.

Methods: RB was fermented anaerobically without or with urea (2.0%) by rumen inoculates for 48 hours. Three isonitrogenous (22.75% CP) and isocaloric (3164 kcal/kg) diets contained 7.0% RB, 7.0% fermented RB (FRB) and 7.0% urea (2.0%) added fermented RB (UFRB) formulated. The total number of 90-day old unsexed broiler chicks distributed in 03 groups considering 30 replicate birds in each.

Result: True protein content increased in FRB (16.45%) and UFRB (16.85%) in comparison to RB group (16.27%). Final body weight of RB, FRB and UFRB groups 1129, 1152 and 1190 g/bird. Feed intake 1884, 1828 and 1924 g/bird respectively for RB, FRB and UFRB groups. Feed conversion ratio 1.75, 1.66 and 1.69 for RB, FRB and UFRB groups respectively. Dressing Percentage of Carcass yield is higher in UFRB (73%) than in FRB (70%). No mortality occurred in any groups during the experiment. So, it may be concluded that inclusion of fermented rice bran by rumen inoculate increase the performance of broiler but urea (2.0%) added to fermented rice bran by rumen inoculate shows better growth performance and carcass yield of broiler.

Key words: Broiler, Fermentation, Rice bran, Rumen inoculate, Urea.

INTRODUCTION

Rice bran (RB) is a byproduct of rice milling process which constitutes about 40.0% of paddy rice (Dafwang and Damang, 1995). It contains high levels of protein, lipids, vitamins B and E, trace minerals (Warren and Farrell, 1990) and good source of lysine and methionine (Gallardo *et al*., 2020). However, its utilization especially for monogastric animals is limited. The inclusion of rice bran at more than 7.5% (normal level) in broiler ration reduced performance (Tangendjaja, 1993). Nutritionally, several factors limit its use in poultry diet like presence of unavailable phosphorous as phytate and hull adulteration (Farrell, 1994; Warren and Farrell, 1990). Its high fibre content more than 13%. RB has been neglected as poultry feed and non-ruminant animals (Sharif *et al*., 2014; Taylor *et al*., 2021). But it would be a promising feed ingredient if those limitations would be eliminated by some processing technique. Fermentation of RB using rumen inoculates would be one of the most promising techniques, because it produce various enzymes such as α-amylase, α-acetolactate, decarboxylase, β-endoglucanase, hemicellulase, phytase, maltogenic amylase and xylanase which degrade fiber (Diaz, 2008; Wizna *et al*., 2009) and reduced crude fiber from RB (Wizna *et al*., 2012). The addition of inorganic source of nitrogen such as urea to the fermentation medium increase crude protein (Supriyati and Kompiang, 2002; Supriyati *et al*., 2015; Mu *et al*., 2011). Because treated RB has beneficial effect on growth performance, feed efficiency, protein digestibility, energy utilization and mineral retention of broiler chickens as a direct hydrolytic effect on phytate (Khan *et al*., 2013). *B. amyloliquefaciens* induced fermentation process increases the availability of nutrients in raw materials and their metabolic activity (Supriyati *et al*., 2015). The previous researchers had attempted to use fermentation technique (Wizna *et al*., 2012), enzymes supplementation (Tirajoh *et al*., 2010) and inclusion of the fermented product (Tangendjaja, 1993; Kompiang *et al*., 1995) in increasing RB utilization for poultry feed.

Rumen bacterial inoculum can be an alternative approach to optimize the use of RB in poultry feeding. Cellulolytic *Ruminococcus albus* can effectively reduce fiber and increase crude protein (CP) with the supplementation

[1]Department of Microbiology and Public Health, Khulna Agricultural University, Khulna, Bangladesh.
[2]Department of Microbiology and Hygiene, Bangladesh Agricultural University, Bangladesh.
[3]Department of Animal Nutrition, Bangladesh Agricultural University, Bangladesh.

Corresponding Author: Muhammad Ashiqul Alam, Department of Microbiology and Public Health, Khulna Agricultural University, Khulna, Bangladesh. Email: ashiq.alam@kau.edu.bd

How to cite this article: Alam, M.A., Khan, M.S.R. and Islam, K.M.S. (2023). Effect of Feeding Fermented Rice Bran by Rumen Liquor on the Growth Performance of Broiler Chickens. Asian Journal of Dairy and Food Research. 42(1): 26-30. doi: 10.18805/ajdfr.DRF-273.

Submitted: 06-03-2022 **Accepted:** 06-11-2022 **Online:** 12-11-2022

of urea (3.0% w/w) and molasses (5.0% w/w) (Bryant *et al*., 1961; Gado *et al*., 2007) that improves digestibility, weight gain and feed efficiency (Djibrillou *et al*., 1998). In the present study was designed to ferment RB by rumen inoculates with addition of 2.0% urea for desirable chemical changes which was confirmed by a feeding trial in broiler.

MATERIALS AND METHODS

The experiment was conducted in 2019-20 in the Department of Animal Nutrition, Bangladesh Agricultural University (BAU), Mymensingh.

Fermentation of rice bran and experimental diet

Rumen liquor was collected from a mature cow during slaughter and filtered using cheesecloth. Filtered rumen liquor was diluted 1:1 ratio with buffer (9.8 g $NaHCO_3$, 0.04 g $CaCO_3$, 0.47 g NaCl, 0.57 g KCl, 3.3 g Na_2HPO_4, 0.12 g $MgSO_4.7H_2O$ in 1 liter carbonated distilled water). The fluid was kept in a beaker where it continuously carbon di-oxide was flowed to maintain anaerobic conditions. One group considered only diluted rumen inoculates and in another group diluted rumen inoculate with 2% urea. The inoculated RB fermented for 48 hours anaerobically in a plastic container at 39°C. Fermented RB was dried under sunlight. CP, CF and Amino Acid were analyzed before and after fermentation by AOAC (2005). Three types of isocaloric and isonitrogenous experimental diets contained 7.0% rice bran (RB), 7.0% fermented rice bran (FRB) and 7.0% urea fermented rice bran (UFRB) were formulated (Table 1).

Management of birds

A total number of 90-day-old broiler chicks (Cobb 500) were assigned to the study. All the birds were divided into three groups (RB, FRB and UFRB) in a completely randomized design having 3 replications of 30 birds. Feed and water were available *ad libitum* throughout the experimental period. Chicks were housed in wire-netted battery cages with mesh grate floors above the excreta collection tray. Birds were vaccinated for Newcastle Disease-Infectious Bronchitis (ND-IB) at 7 days and Infectious Bursal Disease (IBD) at 14th day of age. All the birds have equal access to feed and water. Feed offered, feed left over and feed refusal recorded weekly.

Chemical analysis

The proximate analysis of ingredients and experimental feed were measured by AOAC (2005) and amino acid using HPLC at Bangladesh Council of Scientific and Industrial Research (BCSIR). The crude protein content was measured by macrokjehdahl digestion unit using Kjeltec 1030 Autoanalyzer.

Statistical analysis

Statistical analysis for fermented RB was compared by experimental data was performed by Duncan's multiple range test (DMRT) one-way analysis of variance (ANOVA) test (Duncan, 1955) using computer Excel program and SPSS and conducted to determine the differences among the treatment means (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

Chemical changes

UFRB (18.55%) and FRB (12.78%) contain higher Crude Protein than RB (13.48%) after fermentation (Fig 1). These results agreed with Supriyati *et al*. (2015), who described an increased CP content of RB from 12.1 to 13.4% due to microbial fermentation. A NPN compound urea is well known to improve the metabolism as well as to increase the CP contents of rice milling waste (Wizna *et al*., 2012). In this study, a significant increase in CP content of RB treated with rumen liquor in combination with 2% urea increased CP content of RB, which might have contributed to the increased growth and proliferation of Bacteria in the rumen liquor.

In this study, amino acid contents were significantly increased by 5% and 44% in FRB and UFRB groups, respectively, indicating an absolute increase in the amino acid contents, either urea was added or not. The amino acid profile was sharply higher in the UFRB group. Oshoma *et al*., (2005) agreed that fermented RB contains high protein value and a balanced amino acid composition. Stevenson (1978) observed that the amino acids were excreted during the active growth of the rumen Bacteria. Ranjan *et al*., (2018) found that deoiled RB fermented with *Rhizopus oryzae* resulted in a nearly six-fold increase in lysine content and saturated fatty acid content. Itou *et al*. (2000) and Chang *et al*. (1992) found increase the composition of free amino acids in fermented RB. In this study, it was observed that fermentation resulted in an increase in the amounts of glutamic acid, aspartic acid, glycine, alanine, valine and leucine and low molecular peptides in comparison to unfermented RB (Fig 2). Khin *et al*., (2011); Yunus *et al*., (2015) supported that major component cellulose in the RB is the best for the growth of microorganisms. Sukaryana, (2001) found that the production of single cell protein biomass increases the crude protein of rice bran with the addition of urea in the UFRB using bacteria. Wizna *et al*. (2012) found that *B. amyloliquefaciens* as an inoculum improved fermentation and its microbial population. Supriyati and Kompiang, (2002) agreed with the results of the present experiment as protein content increased when urea was added.

Growth performance

In this study, live weight gain and feed consumption of broiler in UFRB were significantly increased ($p \leq 0.05$) but feed

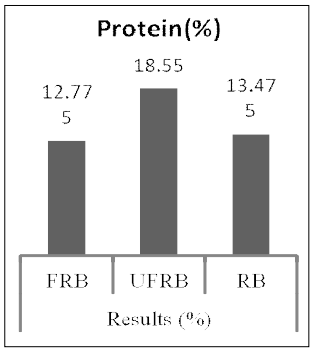


Fig 1: Crude protein changes.

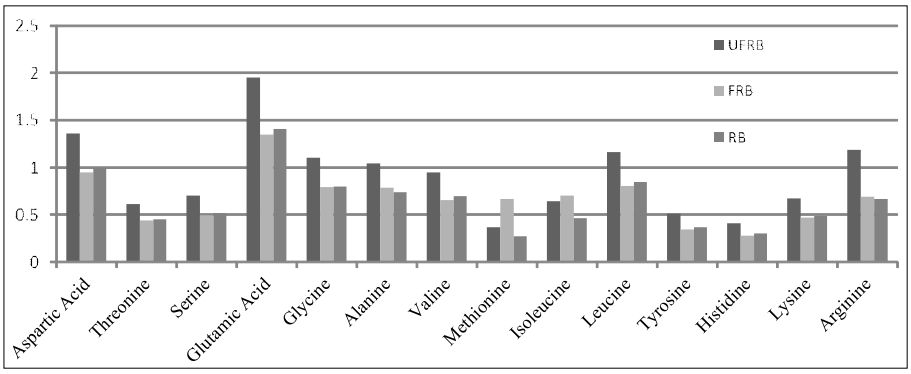


Fig 2: Changes of amino acids (%) content.

N.B: RB-Rice bran; FRB-Fermented rice bran; UFRB-Urea fermented rice bran.

Table 1: Formulation of feed and composition of experimental diets.

Ingredients (%)		Dietary groups			
		Components	RB	FRB	UFRB
Maize	50.50	DM (%)	89.12	89.12	89.12
Protein concentrate	12.50	ME (kcal/kg)	3164	3164	3164
RB/FRB/UFRB	7.00	CP (%)	22.75	22.63	22.70
Soybean meal	23.00	TP (%)	16.27	16.45	16.85
Soybean oil	4.50	CF (%)	4.12	4.05	3.76
Salt	0.50				
DL-Methionine	0.15				
Choline chloride	0.05				
Mineral mixture[1]	0.05				
Vitamin[2]	0.25				
Total	100.00				

[1]Vitamin contains in the following per kg: Vitamin A: 2400000 IU, Vitamin D: 1000000 IU, Vitamin E: 16000 IU, Vitamin K: 800 mg, Vitamin B1: 600 mg, Vitamin B_2: 1600 mg, Vitamin B_6: 1000 mg, Vitamin B_{12}: 6 mg, Niacin: 8000 mg, Folic acid: 400 mg, Pantothenic acid: 3000 mg, Biotin: 40 mg and Antioxidant: 3000 mg.[2]Mineral mixture contains in the following per kg: Cobalt: 80 mg, Copper: 2000 mg, Iodine: 400, Iron: 1200 mg, Manganese: 18000 mg, Selenium: 60 mg and zinc: 14000 mg.

Table 2: Live weight (g/bird), live weight gain (g/bird) performance feed intake (g/bird) and feed conversion ratio of birds.

Parameter	Dietary groups		
	RB	FRB	UFRB
Initial weight	*55^{a}±1.19	56^{a}±1.34	55^{a}±1.12
Final weight	1129^{b}±24	1155^{ab}±30	1241^{a}±83
Total live weight gain	1074^{b}±24	1100^{ab}±33	1187^{a}±84
Total feed intake	1884^{a}±109	1828^{a}±140	2010^{a}±172
Feed conversion ratio	1.75^{a}±0.10	1.66^{a}±0.15	1.69^{a}±0.15

N.B: RB-Rice bran; FRB-Fermented rice bran; UFRB-Urea fermented rice bran.

*Mean±SD; ^{abc} Means with dissimilar superscripts are significantly different ($p<0.05$).

conversion ratio was low in FRB group of birds (Table 2). Kubad *et al*., (1997) reported that fermented products were more palatable compared to the original materials because fermentation produces some good flavors and water-soluble vitamins such as B_1, B_2 and B_{12} and minerals that also support the results of the present experiment as feed consumption was maximum in UFRB group than RB group. Kang *et al*., (2015) also found the same result using 10.0% FRB in broiler diet.

In Table 1, CP and metabolizable energy (ME) contents in the diets were equalized. The difference in ME content between all diets would not affect the performances of broiler chickens during this feeding trial. Olomu and Offiong (1980) found that the different protein (20% and 23%) and energy levels (3,000 and 3,200 kcal/kg) in the diets did not affect the performance of broiler chickens.

The fermented RB diets gave different levels of CF among all diets (Table 1), resulting in different CF consumption. Gonzalez-Alvarado *et al*. (2007) reported that the feed consumption of broiler chicks fed with diets containing different levels of CF (2.5% up to 3.4%) differed significantly during the 14 to 21 days. Mateos *et al*. (2002) reported that the inclusion of fiber in the diet (below 5%) might be of benefit in terms of nutrient digestibility and growth performance in broilers. In this study, the increased feed consumption in the presence of UFRB with decrease CF (3.76%) in the diets compared to the control RB (4.12%) and FRB (4.05%) diet, might also be due to a more acceptable flavor after fermentation.

Table 3: Carcass characteristics of birds.

Parameter	Dietary groups		
	RB	FRB	UFRB
Heart (%)	*0.51±0.05	0.51±0.03	0.58±0.08
Liver (%)	1.80±0.23	1.66±0.34	1.93±0.19
Gizzard (%)	1.83±0.22	1.73±0.39	1.62±0.16
Kidney (%)	0.16±0.03	0.15±0.02	0.11±0.01
Dressing percentage (%)	71.00^{b}±2.52	70.00^{b}±1.95	73.00^{a}±2.51

N.B: RB-Control; FRB-7% Fermented rice bran; UFRB-Urea treated 7% fermented rice bran.

*Mean±SD; ^{abc} Means with dissimilar superscripts are significantly different ($p<0.05$).

According to Kahlon *et al*. (2009) and Ryan *et al*. (2011), improved growth performance (live weight gain and feed conversion ratio) of broiler may be due to high concentrations of protein, vitamin, minerals, phospholipids, essential fatty acids and more than 120 antioxidants are present in fermented RB. *Lactobacillus*, *Saccharomyces* and *Bacillus* are present in rumen inoculate. This fermented RB are used as feed ingredients all the microbes get access to enter the digestive tract of broiler and serve as a probiotic that enhances the live weight gain in broiler (Nakphaichit *et al*., 2011, Salim *et al*., 2013, Jeong and Kim, 2014) that supports the result of the present experiment as live weight was high in both fermented rice bran (FRB and UFRB) group supplemented with or without urea in the fermentation process (Table 2).

Carcass traits

Carcass traits are not affected by the addition of FRB and RB. Only dressing percentage (carcass yield) was high in UFRB (73%) of birds than another group of bird (Table 3). Lesson *et al*., 2000 reported that physiological condition and content of nutrients in feed and genetic factors are affecting the carcass weight of broiler. Mujahid *et al*., (2003) reported that RB containing feed increases in organ weights of broiler chicks.

CONCLUSION

RB was fermented by rumen inoculum increased live weight gain and feed conversion efficiency of the broiler, which was further increased when urea was added during fermentation. But this study needs to repeat for confirmation in other species and different sources of RB. Based on this research work, it might be helpful if future works are continued on the industry-scale production of fermented RB by rumen liquor.

ACKNOWLEDGEMENT

The author acknowledged the Alexander von Humboldt Foundation, Germany for financial support to conduct the study under the Research Group Linkage program. This study was carried out in the Department of Animal Nutrition, Bangladesh Agricultural University (BAU), Mymensingh.

Conflict of interest: None.

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