Nutritional and Anti-nutritional Compositions of Rice Bran as a Potential Animal Feed

ABSTRACT

Rice bran, a byproduct of rice milling, is a valuable ingredient in animal feed formulations, particularly poultry feed, due to its high energy content, nutritional benefits, and ability to meet bird protein requirements. Rice bran, analyzed according to AOAC standards, is rich in energy, protein, and minerals like calcium, phosphorus, and potassium, essential for poultry health. Its high-fat profile, with higher unsaturated fatty acids, has positive effects on poultry health, including improved egg quality, enhanced immune function, and reduced disease incidence.

Rice bran has a moisture content of 4.3338% and a crude fibre content of 16.3675%. It has a total ash content of 18.8126% and a crude fat content of 12.0354%, 12.3676%, and 12.6180%. The compositions of rice bran were compared favourably to commercial feed formulations for starter, grower, and finisher meals. The crude fat content is 12.0354%, 12.3676%, and 12.6180%, while the crude protein content is 26.2688%, 27.5813%, and 21.8906%. The carbohydrate contents are 41.2677%, 41.8456% and 49.4032% and the total ash content was measured at 10.4377%, 6.3672% and 4.4905%.

The rice bran's trace mineral composition includes calcium, magnesium, potassium, phosphorus, sodium, iron, and copper. Heavy metals like lead and cadmium are below the detection limit of the M5 Thermo Scientific atomic absorption Spectrometer. The anti-nutrient composition includes anthraquinones, phenolics, tannins, saponins, and phytic acid.

Rice bran in poultry feed formulations enhances nutritional needs and outperforms commercial feeds. In addition, to increase nutrient availability, it is necessary to add a phytase enzyme in order to break down phytic acid.

Keywords: Anti-nutritional; rice bran; nutritional compositions; nutritional component; dietary fibre; whole grain; rancidity; rancidification; functional properties; chemical composition; proximate analysis; nutritional values; functional food.

1. INTRODUCTION

Due to the presence of preventive elements such as dietary fibre, vitamin E, and other minerals, whole grains have been demonstrated in population studies to lower the incidence of diabetes and cardiovascular disease [1]. Insoluble dietary fibre (IDF) is the term used to describe the majority of dietary fibre derived from plant sources, such as cereal bran. The main components of cereal bran's IDF are cellulose, hemicellulose, and lignin, which also contain a variety of functional groups like alcohols, aldehydes, ketones, carboxylic acids, phenolic linkages, and ethers [2]. These groups can bind water, oil, or dangerous metal ions with a lot of force. But in order to exploit these cereal brans, some pre-treatment is necessary, either to increase porosity or expose the binding sites [3]. Consequently, a number of typical physical and chemical pretreatments, have been documented, including micronization [4] enzymatic treatment [5], and various inorganic and organic bases, acids, and salt solutions [2]. While enzyme operations typically need complicated steps, large enzyme dosages, precise temperature regulation, and other factors, the quantity of physical pretreatment is highly influenced by particle size. Acidic pretreatment is frequently found to be more effective, largely because it is simple to remove contaminants and ions that could obstruct the functional groups or porous structures [2]

Each year, the rice industry produces vast amounts of rice bran (RB), a byproduct of the milling of rice. Most of the rice bran produced recently is utilized as fuel, fertilizer, and a component in animal feed [6]. However, due to the high IDF content of rice bran, there is untapped potential for the creation of high-value rice bran. About 27% of the DF in rice bran (RB) makes up the IDF, and rice bran DF makes up about 90% of that. Although some research has been done to enhance the insoluble rice bran fibre's (IRBF) functional qualities, such as its potential to maintain emulsions in the food system by binding fat or adsorbing Ni (II) from water has been reported, the majority of these investigations relied on the granular structure, insolubility in water, chemical stability, and accessibility of rice bran to use it.

It was noted that the effect of inorganic acid concentration on the composition and microstructure might expose various functional properties of IRBF because chemical pre-treatments have the potential to change the cell surface by exposing more porous structure, removing or masking the groups, or both.

The goal of the study was to better understand the relationship between microstructure and physicochemical properties of the fibre and to streamline the extraction process, lower the cost, and enhance the physicochemical qualities of IRBF for food system enrichment. There have been reports [7] of acid-induced alteration of cereal fibres as well as further evaluation of their physicochemical properties in terms of water holding capacity (WHC), oil binding capacity (OBC), swelling capacity (SWC), and cation-exchange capacity (CEC). Additionally, rice bran was subjected to acid-base regimes, and their structural and physicochemical properties were assessed.

2. MATERIALS AND METHODS

The fresh rice bran was dried at 60^{o}C in a forced-air oven and screened through a 40-mesh sieve. Defatting was conducted in duplicate by soaking the rice bran in n-hexane (1:5, w/v) at room temperature for 12 hours and then decanting the n-hexane. The defatted rice bran was first air dried in a fume hood to remove residual hexane and then dried at 60°C in a forced-air oven and kept in sealed bags for further use.

2.1 Chemical Composition Analysis of Rice Bran

The proximate composition of the rice bran was determined using the standard method of AOAC (2005)

2.2 Moisture Content

The moisture content was determined by drying in an oven at 105°C until constant weight was attained

2.3 Protein Determination

The pretreated rice bran (1g) was placed in a Kjeldahl flask. 10ml concentrated sulphuric acid and 5 g Kjeldahl salt as a catalyst, the destruction process was carried out in a hood to clear green liquid. 10ml of the cold solution with 10ml of 10% sodium hydroxide was distilled for 20 minutes and the distillate was collected in Erlenmeyer containing 25ml 0.1N HCl. The excess HCl was titrated with 0.1N NaOH using the indicator Tashiro.

2.4 Determination of the Ash Content of Rice Bran

After all the fat and lipid had been removed by the soxhlet extraction, 100g of the residue was washed with boiled distilled water until the filtrate was acid-free. Washed with 100ml 0.313 N boiled NaOH and reflux for 30 minutes. The residue was filtered with a Buchner funnel and washed with K_2SO_4 10%, distilled water and ethanol 95%, respectively. The residue was transferred to a weight porcelain container, dried at 105°C, then cooled in desiccator, and weighed.

The percentage of crude fibre was determined by the method of Ude and Oguwele (1986). 2g of the pretreated rice bran was weighed (w_1) into 1 dm3 conical flask water (100ml) and (20ml) of 20% sulphuric acid was added and boiled gently for 30 minutes. the content was filtered through Whatman filter paper. The residue was scrapped back into the flask with a spatula water (100ml) and 20ml of 10% sodium hydroxide was added and allowed to boil gently for 30 minutes. The content was filtered, and the residue was washed thoroughly with hot distilled water then rinsed once with 10% hydrochloric acid twice with ethanol and finally three times with petroleum ether. It was allowed to dry and scrapped into a crucible and allowed to dry overnight at 105^{0}C in an air oven, it was then removed and cooled in a desiccator the sample was weighed (w_1) and dried at 550^{0}C for 90 minutes in a Lento Muffle furnace, it was finally cooled in a desiccator and weighed again (w_2). The percentage of crude fibre was calculated using the equation.

$$\text{Crude fiber (\%)} = \frac{w1 - w2}{w} \times 100$$

Where,
w is the weight of the sample in grams
w_1 is the weight of the dried sample = wa – w0
w_2 is the weight of the ashed sample = wb – w0
w_0 is the weight of the empty crucible

The crude fibre content was carried out using duplicate samples and the average of both was taken

2.5 Determination of the Trace Element Contents Using Atomic Absorption Spectroscopy

Atomic absorption spectroscopy was used for the determination of the trace element content of the rice bran. AAS was used for the determination of the amount of Calcium, Sodium, Iron, Magnesium, Iron, Potassium, Copper, Cadmium and Lead that are present in the rice bran.

3. RESULTS AND DISCUSSION

The result in the Table 1 indicated that Potassium is the most abundant mineral content with 44.0896mg/ml) in rice bran followed by Magnesium (2.2707mg/ml) while copper showed the lowest (0.0195) and Cadmium was below the detectable limit.

Table 1. Mineral content (mg/ml) in rice bran

Calcium	0.6398
Magnesium	2.2706
Potassium	44.0896
Sodium	0.5485
Iron	0.8856
Copper	0.0195
Lead	0.8020mg/100g
Cadmium	below detection limit

Table 2. Comparison of the proximate analysis of rice bran and Ultima poultry feed meals

	Rice Bran	Starter Meal	Grower Meal	Finisher Meal
Crude Fat	19.6418	12.0354	12.3676	12.6180
Crude Protein	14.4469	26.2688	27.5813	21.8906
Crude Fibre	16.3675	4.3100	3.6450	3.1425
Ash	18.8126	10.4377	6.3672	4.4905
Carbohydrate	26.3900	41.2677	41.8456	49.4032
Moisture content %	4.3338	5.6804	8.1933	8.4552

3.1 Proximate Analysis of Commercially Available Poultry Feeds (Ultima Feed) Manufactured by Crown Feeds Limited

The proximal analysis of the result (Table 1) revealed that the crude fat content (19.6418) in the rice bran was higher than that present in the other starter, grower and finisher meals of the Ultima commercial feed, which were 12.0354, 12.3676 and 12.6180 respectively. Crude protein content in rice bran was notably lowest in rice (with 14.4469) in comparison with the ultima commercial feed meals. The analysis showed that the grower meal had the highest protein content which was 27.5813 followed by the starter meal with the protein content of 26.2688. Crude fibre content was significantly higher in rice bran than in the commercial feed meal under consideration in this study with 16.3675 while 3.1425, 3.6450 and 4.3100 represented crude fibre analysed in the finisher, grower and starter meal respectively. Conversely, carbohydrate content in rice bran was considerably small when examined closely with that found in finisher, grower and starter meal, the result showed that 26.3900, 49.4032, 41.8456 and 41.2677, respectively for rice bran, finisher, grower, and starter respectively. Additionally, the result showed that the moisture content of rice bran was marginally lower than the commercial feed meal analysed in this study. The lower moisture content (4.3338%) of rice bran than the other feed meal is an indication of the prolonged stability as well as the low tendency of attack by spoilage microbes

Table 3. Percentages of anti-nutrients (mg/100g)

Anthraquinones	0.0134
Phenolic compounds	0.0134
Tannin compounds	0.2655
Saponin content	6.4470

4. CONCLUSION

Rice bran is an excellent substitute for commercial feed meal owing to its nutritional content, low moisture content, and high mineral content, which are necessary for the proper functioning of poultry and egg production.

COMPETING INTERESTS

Authors have declared that no competing interests exist

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