

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, 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 fiber 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 compared favorably 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 nutrients availability, it is necessary to add phytase enzyme in order to break down phytic acid.

INTRODUCTION

Due to the presence of preventive elements such as dietary fiber, vitamin E, and other minerals, whole grains have been demonstrated in population studies to lower the incidence

of diabetes and cardiovascular disease. (Mohd NA, Mohd SM, Lee LK. 2023) Insoluble dietary fiber (IDF) is the term used to describe the majority of dietary fiber 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. (Bhosale S. Vijayalakshmi D. 2015) 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 (Francisco H et al, 2021) Consequently, a number of typical physical and chemical pretreatments, have been documented, including micronization (Sijia et al. 2022) enzymatic treatment Gul K et al 2015), and various inorganic and organic bases, acids, and salt solutions (Bhosale S. Vijayalakshmi D. 2015). 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 (Bhosale S. Vijayalakshmi D. 2015)

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 (Anthina L., Costas G. Irakli M., 2021). 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 fiber's (IRBF) functional qualities, such as its potential to maintain emulsions in the food system by binding fat or adsorbing Ni (II) from water have 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 fiber and to streamline the extraction process, lower the cost, and enhance the physicochemical qualities of IRBF for food system enrichment. There have been reports (Yilmaz NT 2023) of acid-induced alteration of cereal fibers 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.

Materials and Methods

The fresh rice bran was dried at 60°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

Chemical composition analysis of rice bran

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

Moisture content

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

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 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 collected in Erlenmeyer containing 25ml 0.1N HCl. The excess HCl was titrated with 0.1N NaOH using indicator Tashiro.

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 is acid-free. Washed with 100ml 0.313 N

boiled NaOH and reflux for 30 minutes. The residue was filtered with Buchner funnel and washed with K₂SO₄ 10%, distilled water and ethanol 95%, respectively. The residue was transferred to weight porcelain container and dried at 105 °C and 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 (w₁) into 1 dm³ conical flask water (100ml) and (20ml) of 20% sulphuric acid were 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 were 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 and twice with ethanol and finally three times with petroleum ether. It was allowed to dry and scrapped into crucible and allowed to dry overnight at 105⁰C in an air oven, it was then removed and cooled in a desiccator the sample was weighed (w₁) and dried at 550⁰C for 90 minutes in a Lento Muffle furnace, it was finally cooled in a desiccator and weighed again (w₂) . The percentage crude fiber was calculated using the equation.

$$\text{Crude fiber (\%)} = \frac{w_1 - w_2}{w} \times 100$$

Where, w is weight of the sample in grams

w₁ is weight of the dried sample = w_a – w₀

w₂ is weight of the ashed sample = w_b – w₀

w₀ is weight of the empty crucible

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

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.

RESULTS AND DISCUSSION

The result in table1 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 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 |

PROXIMATE ANALYSIS OF COMMERCIALY AVAILABLE POULTRY FEEDS (ULTIMA FEED) MANUFACTURED BY CROWN FEEDS LIMITED

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 |
| | | | | 8.4552 |

Moisture content % 4.3338 5.6804 8.1933

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 grower meal had the highest protein content which had 27.5813 followed by starter meal with 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 moisture content rice bran was marginally lower than the commercial feed meal analysed in this study. The low 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 |

Conclusion

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

REFERENCEES

1. Mohd NA, Mohd S, Lee L. World Journal of Diabetes. (2023) Vol.14 (5) 606 – 616 Efficacy of Multigram Supplementation in Type 2 Diabetes Mellitus: A Pilot Study for a Randomized Intervention trial.
<https://doi.org/10.4239/wjd.v14.5.606>.
2. Bhosale S., Vijayalakshmi D. Current Research in Nutrition and Food Science. (2015) Vol. 3(1) Processing and Nutritional Composition of Rice Bran.
<https://doi.org/10.12944/CRNFSJ3.1.08>
3. Francisco H et al. International Journal of Food Science and Technology (2021) Vol 56 (11) 5445 – 5451. Enzymatic and Extrusion Pretreatments of Defatted Rice Bran to Improve Functional Properties of Protein Concentrates.

<https://doi.org/10.1111/ijfs.15017>.

4. Sijia Y. et al. Journal on Food Research International (2022) Vol 157 (1-2): 111328 Journal on Food Research International. Improvement Effect of Micronization on Morphology, Functional and Nutritional Attributes of Stabilized Rice Bran.
<http://doi.org/10.1016/j.foodres.2022.111328>
5. Anthina L, Costas B, Irakli M. Foods (2021) Vol. 10(1) 57. Comparative Evaluation of the Nutritional, Antinutritional, Functional and Bioactive Attributes of Rice Bran Stabilized by Different Heat Treatments.

<https://doi.org/10.3390/foods10010057>

6. Yilmaz NT Foods (2023) Vol.12 (9) 1924. Stabilization of Rice Bran: A Review
<https://doi.org/10.3390/foods12091924>
7. Artiwan S., Phannipha D. LWT-Food Science and Technology (2020) Vol 134. Recovery of γ – Oryzanol from Rice Bran Oil Soapstock Derived Calcium Soap: Consideration of Hansen Solubility Parameters and Preferential extractability in Various Solvents.
<https://doi.org/10.1016/j.lwt.2020.11028>
8. Lavanya et al. Springer International Publishing AG (2017). 79 – 90 Brown Rice. Physicochemical Characteristics of Rice Bran
doi 10.1007/978-3-319-59011-0_5
9. Gul K et al. Bioactive Carbohydrate and Dietary Fiber (2015) Vol. 6 (1) 24 – 30 Rice Bran: Nutritional Values and its Emerging Potential for Development of Functional Food – A Review.
<https://doi.org/10.1016/j.bcdf.2015.06.002>

10. Alauddin MD. et al. Rice Bran and Rice Bran Oil Chemistry Processing and Utilization (2019) 183 – 206. Development of Rice Bran Functional Food and Evaluation of its Healthful Properties
<https://doi.org/10.1016/B978-0-12-812828-2-00008-1>
11. Riantong S., Umar G. Rice Bran and Rice Bran Oil Chemistry Processing and Utilization (2019) 125 – 158. Rice Bran and Rice Bran Oil
<https://doi.org/10.1016/B978-0-12-812828-2.00005-6>
12. Yan Z. et al. Rice Bran and Rice Bran Oil Chemistry Processing and Utilization (2019) 271 – 293 Rice Bran Protein: Extraction, Nutraceutical Properties and Potential Application
<https://doi.org/10.1016/B978-0-12-812828-2-00011-1>
13. Ali Akbar Z et al Journal on Animal Science and Technology(2015)
Effect of Extrusion of Rice Bran on Performance and Phosphorus Bioactivity in Broiler Chickens.
<https://doi.org/10.1186/s40781-015-0059-z>
14. Sharif M.K et al. Critical Review in Food Science and Nutrition (2014)Vol.54 (6), 807 – 816. Rice Bran a Novel Functional Ingredient.
<https://doi.org/10.1080/10408398.2011.608586>.
15. Lamid M et al. Journal of Applied Environmental and Biological Sciences (2014) Vol.4(3) 377 – 380. Potential of Phytase Enzymes as Biocatalyst for Improved Nutritional Value of Rice Bran for Broiler Feed.
16. . Chinwa C.E et al. Nigerian Food Journal(2014) Vol. 32(1). 126 - 132 Optimization of Rice Bran Fermentation Conditions Enhanced by Baker's Yeast for Extraction of Protein Concentrate
[https://doi.org/10.1016/S0189-7241\(15\)30105-3](https://doi.org/10.1016/S0189-7241(15)30105-3)
17. Zhenhua W et al. Journal on Food Chemistry and Technology (2022) Vol. 11(23) 3849 Optimization of Oil Extraction from Rice Bran with mixed Solvent using Response Surface Methodology.
<https://doi.org/10.3390/foods11233849>
18. Khanita R. Journal on Food Process Engineering(2021) Vol. 44(5) Optimization of Rice Bran Stabilization by Infrared – Vacuum Process and Storage Stability.
DOI:10.1111/jfpe.13668
19. Sumaya A et al. Journal on Food Processing and Preservation(2021) Vol. 45(7) Microwave Stabilization and Process Optimization of Rice Bran Cultivar Jhehue.
DOI:10.1111/jfpp.15659
20. Cheng – wei et al. (2020) Journal of Food Processing and Preservation Vol. 44(4) Comparison of 11 Rice Bran Stabilization Methods by Analyzing Lipase Activities.

<https://doi.org/10.1111/jfpp.14370>

21. Lemessa et al *Frontiers in Food Science and Technology*(2022) Vol. 2 Physicochemical Characterization of Microwave Stabilized Rice Bran Oil from Ethiopian Small – Scale Rice Processing Plants.
DOI:10.3389/frfst2022.1011445
22. Shi – Wen L.V. *Czech Journal of Food Sciences* (2018)Vol. 36(1) Pp 57 – 65 Effect of Different Stabilization Treatment on Preparation and Functional Properties of Rice Bran Protein.
DOI:10.17221/100/2017-CJFS
23. Bollinedi H et al *Critical Review on Food Science and Nutrition* (2021) Vol. 61(1) Pp 75 – 84 Genetic and Genomic Approaches to Address Rapid Rancidity of Rice Bran.
DOI: 10.1080/10408398.2020.1718598
24. B Li et al. *Quality Assurance and Safety of Crops and Foods* (2017) Vol. 10(1) Pp 25 – 34 Rice Bran Real – Time Stabilization Technology with Flowing Microwave Radiation: its impact on Rancidity and Some Bioactive Compound.
<https://doi.org/10.3920/QAS2016.0982>
25. Ling Bo et al.*Lebensmittel – Wissenschaft* (2018) Vol. 91(2) Pp 453 – 459 Effect of Hot Air – Assisted Radio Frequency Heating on Enzyme Inactivation, Lipid Stability and Product Quality of Rice Bran.
DOI:[10.1016/j.lwt.2018.01.084](https://doi.org/10.1016/j.lwt.2018.01.084)
26. Erturk B, Meral R. *Journal of Cereal Science* (2019) Vol. 88(4) Pp 71 – 78 Impact of Stabilization on Functional, Molecular and Thermal Properties of Rice Bran.
DOI: <https://doi.org/10.4491/eer.2019.409>.
27. Gregor M., Mitja K *Molecules* (2021) Vol. 26(1) Pp 174 Bioactivity of Inositol Phosphate: Analytical Method for Determination of Phytic Acid and other Inositol Phosphate.
<https://doi.org/10.3390/molecules26010174>
28. Koomson D.A et al. *Journal of Pharmacognosy* (2018) Vol. 10 (5) Pp 946 – 950 Phytochemical Constituents, Total Saponins, Alkaloids, Flavonoids and Vitamin C Contents of Ethanol Extracts of Five *Solanum Torvum* Fruits.
DOI:[10.5530/pj.2018.5.160](https://doi.org/10.5530/pj.2018.5.160)
29. Wu J. et al. *Journal of Cereal Science* (2016) Vol.71 Pp 130 – 137. Improvement in Storage Stability of Lightly Milled Rice Using Superheated Steam Processing.
<https://doi.org/10.1016/j.jcs.2016.08.006>.
30. Hu Y. et al. *LWT-Food Science and Technology* (2018) Vol. 91 Pp 446 – 452. Superheated Steam Treatment on Wheat Bran: Enzymes Inactivation and Nutritional Attributes Retention.

<https://doi.org/10.1016/j.lwt.2018.01.086>

31. Kim S, Chung S. Journal of Cereal Science (2014) Vol. 60 Pp 243 – 248. Effect of Various Heat Treatments on Rancidity and some Bioactive Compound of Rice Bran.
<https://doi.org/10.1016/j.jcs.2014.04.001>
32. Khalid K, Ohm J, Simsek S. Journal of Cereal Science (2017) Vol. 78 Pp 48 – 56 Whole Wheat Bread: Effect of Bran Fractions on Dough and End Product Quality.
<https://doi.org/10.1016/j.jcs.2017.03.011>
33. Ahmad F. International Journal of Food Science and Technology (2014) Vol. 54 Pp 1206 – 1214. Antioxidant Profiling of Native and Modified Cereal Brans.
<https://doi.org/10.1111/ijfs.14046>