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Evaluation of Physical and Organoleptic Characteristics of Rice Bran Fermented With 2% EM4 At Different Fermentation Durations

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Abstract
Rice bran is widely used as an animal feed ingredient due to its availability and relatively good nutrient content. Fermentation is commonly applied to improve its quality and stability. However, fermentation duration may influence the physical and organoleptic characteristics of the final product. This study aimed to evaluate the changes in physical and organoleptic characteristics (color, aroma, and texture) of rice bran fermented with 2% EM4 at different fermentation durations (2, 4, 6, 8, 10, and 12 days). This research employed a descriptive qualitative approach through direct visual and sensory observation. The observed parameters included color, aroma, and texture changes during the fermentation process. The results showed gradual and consistent changes over time. From day 4 to day 10, the rice bran exhibited a more homogeneous yellowish-brown color, a distinctive and stable fermented aroma, and a moist, smoother texture. On day 12, a slight decrease in moisture was observed, although the aroma and color remained stable. These findings indicate that fermentation duration influences the physical and organoleptic quality of rice bran, with day 8 to day 10 showing the most optimal characteristics. This study provides practical information regarding the appropriate fermentation duration to obtain physically stable and acceptable fermented rice bran as animal feed material

INTRODUCTION

Rice bran is a major by-product of rice *(Oryza sativa L.)* milling and is widely utilized as an animal feed ingredient due to its high availability and relatively valuable nutrient composition. However, raw rice bran has several limitations, particularly its susceptibility to lipid oxidation and rancidity caused by endogenous lipase activity, which can reduce storage stability and physical quality (Manlapig & Matsui, 2025). In practical feed applications, these stability issues often affect not only nutritional value but also the physical acceptability of the material.

Fermentation has been widely applied as a biological processing method to enhance the quality of agricultural by-products. Solid-state fermentation (SSF) is considered an effective approach for modifying rice bran because microbial metabolism can transform substrate characteristics under controlled moisture conditions (Wu et al., 2024). During fermentation, microorganisms metabolize carbohydrates and other components, producing organic acids and volatile compounds that influence the sensory profile of the material (Wang, 2025).

Previous studies have demonstrated that fermentation can alter the physical appearance, aroma, and structural characteristics of rice bran. Wu et al. (2024) reported that

solid-state fermentation affected the physical attributes of rice bran, including color changes and modifications in substrate texture due to microbial enzymatic activity. Similarly, Wang (2025) found that yeast fermentation significantly modified volatile compound profiles, resulting in distinctive aromatic characteristics. These changes are important because aroma is a primary indicator of fermentation success and product stability.

Research by Islam et al. (2022) showed that anaerobic fermentation of rice bran using rumen liquor resulted in desirable chemical and sensory changes, including the development of acidic aroma and structural softening. Likewise, Azizah et al. (2022) reported that fermentation using rumen microbial isolates influenced both physical and chemical properties of rice bran, including moisture characteristics and texture modifications. These findings indicate that microbial activity during fermentation directly affects observable quality parameters.

In addition, Surianti et al. (2024) observed that fermented rice bran exhibited improved physical characteristics when used as feed ingredients, particularly in terms of color uniformity and aroma stability. Yasa et al. (2025) further emphasized that physical quality evaluation—such as color consistency, odor, and texture—is essential in determining feed acceptability and handling characteristics. Texture changes during fermentation are commonly associated with enzymatic degradation of structural components, which may lead to softer and more homogeneous substrates (Ishaku et al., 2024).

Although many studies have focused on chemical and nutritional modifications of fermented rice bran, fewer investigations specifically evaluate systematic changes in physical and organoleptic characteristics over different fermentation durations without proximate nutrient analysis. According to Rosani et al. (2024), practical feed preparation at farm level often relies heavily on physical and sensory indicators to determine fermentation success. Therefore, understanding how fermentation duration influences observable parameters such as color, aroma, and texture is crucial for practical applications.

Furthermore, Putra et al. (2022) highlighted that fermentation duration significantly influences substrate characteristics and overall product acceptability, suggesting that optimal fermentation time must be determined based on quality indicators. However, limited information is available regarding descriptive evaluation of physical quality changes in rice bran fermented using commercial inoculants such as EM4 under different fermentation periods.

Therefore, this study aims to evaluate the changes in physical and organoleptic characteristics (color, aroma, and texture) of rice bran fermented with 2% EM4 at different fermentation durations and to determine the fermentation period that produces the most acceptable physical quality. This research provides practical insights into fermentation time optimization based on observable quality parameters for animal feed preparation.

RESEARCH METHODS

This study employed a descriptive experimental approach to evaluate changes in the physical and organoleptic characteristics of rice bran during fermentation. The experiment was conducted in March 2025 at the Ruminant Animal Feed Testing Laboratory, Faculty of Animal Science, Hasanuddin University. Fresh rice bran was mixed with 2% EM4 inoculant (based on bran weight) diluted in clean water. The mixture was homogenized until slightly moist and then

stored in airtight plastic containers under anaerobic conditions at room temperature (27–30°C). Fermentation durations were set at 2, 4, 6, 8, 10, and 12 days. Physical and organoleptic parameters observed included color, aroma, and texture. These parameters were selected as practical indicators of fermentation progress and feed acceptability (Yasa et al., 2025; Surianti et al., 2024). Observations were conducted directly through visual, olfactory, and tactile assessment at each fermentation period. To reduce subjectivity, a semi-quantitative descriptive scoring system (scale 1–3) was applied for each parameter. Color was classified from light brown (score 1) to uniform yellowish-brown (score 3); aroma ranged from mild fermentation odor (score 1) to stable and pleasant fermented aroma without foul smell (score 3); and texture ranged from rough and dry (score 1) to moist and smooth (score 3). Similar structured sensory evaluation approaches have been recommended in fermented substrate assessment (Wang, 2025; Wu et al., 2024). Data were analyzed descriptively by comparing score progression across fermentation durations. The most acceptable fermentation period was determined based on stability of color, pleasant fermentation aroma, and optimal moist-smooth texture without signs of spoilage.

RESULTS AND DISCUSSION

The physical and organoleptic characteristics of rice bran fermented with 2% EM4 at different fermentation durations are presented in Table 1. Gradual changes in color, aroma, and texture were observed from day 2 to day 12 of fermentation.

Table 1. Physical and Organoleptic Score of Fermented Rice Bran

Fermentation Day	Color Score	Aroma Score	Texture Score
Day 2	1	1	1
Day 4	2	2	2
Day 6	2	3	3
Day 8	3	3	3
Day 10	3	3	3
Day 12	3	2	2

Source: Primary Data, 2025

Table 1, physical changes were evident as fermentation progressed. On day 2, rice bran exhibited a light brown color (score 1), mild fermentation odor (score 1), and rough, dry texture (score 1). This indicates that fermentation had initiated but had not yet produced significant physical modifications.

By day 4, improvements were observed in all parameters, with color shifting to slightly yellowish brown (score 2), aroma becoming more distinct (score 2), and texture turning moist (score 2). Further enhancement was evident on day 6, where aroma and texture reached score 3, indicating a stable and pleasant fermentation odor and a moist-smooth texture.

The most stable and desirable physical characteristics were observed on days 8 and 10. During this period, rice bran exhibited uniform yellowish-brown color (score 3), stable pleasant fermented aroma (score 3), and moist-smooth texture (score 3). No signs of foul odor or visible spoilage were detected.

On day 12, although the color remained stable (score 3), a slight decline in aroma intensity and moisture condition was observed, with aroma and texture decreasing to score 2. This suggests a possible reduction in optimal physical quality beyond day 10.

Overall, the results demonstrate that fermentation duration influenced the physical and organoleptic characteristics of rice bran. Based on the scoring system, days 8 to 10 represented the most acceptable fermentation period in terms of color uniformity, aroma stability, and texture quality.

The gradual improvement in color uniformity, aroma stability, and texture softness observed during fermentation reflects typical physical transformations that occur in solid-state fermentation processes. Similar trends in physical modification of rice bran during fermentation have been reported by Wu et al. (2024), who observed structural and appearance changes due to microbial activity, and by Wang (2025), who highlighted that fermentation time significantly influences aroma development and sensory stability. These findings support the pattern observed in the present study.

The present study demonstrates that fermentation duration significantly influenced the physical and organoleptic characteristics of rice bran. Progressive changes in color, aroma, and texture were clearly observed from day 2 to day 10, indicating active microbial metabolism during the fermentation process. Similar temporal effects of fermentation duration on substrate transformation have been reported in cereal by-products and feed materials (Adeyemi & Sani, 2018; Jha & Das, 2019; Oluwafemi & Adeyemi, 2021).

The gradual shift in color from light brown to uniform yellowish-brown reflects biochemical transformations occurring during solid-state fermentation. Color modification in cereal substrates is commonly associated with enzymatic degradation of complex compounds and mild non-enzymatic browning reactions (Feng et al., 2022; Wu et al., 2024). Park et al. (2024) further explained that optimal fermentation duration promotes uniform pigment distribution, which is often interpreted as an indicator of homogeneous microbial growth. The uniform coloration observed on days 8 and 10 in this study suggests stable fermentation activity.

Aroma development followed a typical fermentation pattern, characterized by progressive formation of mild acidic and alcoholic notes. Volatile compound production during fermentation is strongly influenced by microbial metabolism and fermentation time (Li et al., 2023; Wang et al., 2025). Islam et al. (2022) reported that rice bran fermented under controlled conditions exhibited improved sensory aroma due to organic acid production and reduction of undesirable compounds. The stable and pleasant aroma observed on days 8 and 10 indicates balanced microbial activity, whereas the slight decline on day 12 may reflect metabolic slowdown or moisture changes, as described by Zhao et al. (2022).

Texture modification observed in this study, transitioning from coarse and dry (day 2) to moist and smooth (days 6–10), is consistent with structural degradation of fiber components during fermentation. Enzymatic activities such as cellulase and protease production contribute to substrate softening (Zhang et al., 2021; Bhat & Ahmad, 2021). Similar improvements in physical softness of fermented rice bran were documented by Liu et al. (2018) and Hidayat &

Wina (2020). Moreover, fermented feed materials generally exhibit improved physical stability and palatability compared to untreated substrates (Kumar et al., 2021; Santos & Dalloul, 2020).

From a practical standpoint, physical and organoleptic evaluation plays an important role in small-scale feed production systems. Farmers often rely on visual appearance, odor, and texture to assess fermentation success (Widodo & Agustono, 2019; Utami & Prasetyo, 2022). Lestari & Wahyuni (2024) and Putra & Yulianti (2023) emphasized that uniform color, absence of foul odor, and stable moisture are key indicators of acceptable fermented feed quality. Therefore, identifying optimal fermentation duration based on observable parameters provides valuable applied implications.

Although this study did not include proximate analysis, previous research has shown that fermentation of rice bran may improve protein availability, reduce anti-nutritional factors, and enhance digestibility (Gao et al., 2023; Zulkarnain & Hidayat, 2023; Dawood et al., 2019). The consistent physical transformation observed in this study supports the likelihood of concurrent biochemical modifications, as similarly reported in solid-state fermentation systems (Agustono et al., 2022; Arief et al., 2019).

Overall, fermentation duration of 8–10 days produced the most desirable physical and organoleptic characteristics under the experimental conditions applied. However, future research incorporating proximate composition, microbial population analysis, and pH monitoring is recommended to strengthen the scientific validation of fermented rice bran quality (Ningsih & Sutrisno, 2022; Alagawany et al., 2020).

CONCLUSION

This study demonstrated that fermentation duration significantly influenced the physical and organoleptic characteristics of rice bran under solid-state fermentation conditions. Progressive changes in color, aroma, and texture were observed throughout the fermentation period, indicating active microbial transformation of the substrate. The findings clearly show that fermentation duration plays a critical role in determining the observable quality of fermented rice bran. Based on the evaluation results, fermentation for 8–10 days produced the most desirable characteristics, characterized by uniform yellowish-brown color, stable and pleasant fermentation aroma, and moist yet stable texture. In contrast, shorter fermentation periods (2–4 days) resulted in incomplete transformation, while prolonged fermentation (12 days) showed slight decline in stability. These results suggest that fermentation duration beyond the optimal period may reduce physical quality consistency.

Although chemical composition was not analyzed in this study, the consistent physical and sensory improvements observed support the assumption that controlled fermentation enhances substrate quality. Therefore, determining optimal fermentation time based on observable parameters provides practical value, particularly for small-scale or farm-level feed production systems where laboratory analysis is limited. In conclusion, fermentation duration of 8–10 days can be recommended as the optimal period for producing physically stable and organoleptically acceptable fermented rice bran under the applied experimental conditions. Future studies incorporating proximate analysis, microbial profiling, and pH measurement are recommended to provide a more comprehensive evaluation of nutritional improvement.

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DECLARATIONS

Author Contributions

W and MAH contributed to the conceptualization and design of the study, as well as supervision of the research. RA, MZPR and MRPJ carried out data collection and experimental activities. All authors contributed to data analysis, manuscript preparation, and critical revision of the manuscript. All authors have read and approved the final version of the manuscript.

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Ethical Statement

This study did not involve human participants or live animals. The organoleptic evaluation was conducted through direct sensory observation by the research team without involving human subjects as panelists. Therefore, ethical approval from an institutional review board or ethics committee was not required. All procedures were conducted in accordance with standard scientific and laboratory practices.

Declaration of Interest

The authors declare that there are no competing interests or conflicts of interest related to this study.

Data Sharing Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request. The data are not publicly available due to their use in an ongoing research project.

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