ALLIANCE™
(https://www.globalseafood.org)

Responsible Seafood ADVOCATE

Aquafeeds

Solid-state fermentation converts rice bran into a high-protein feed ingredient for black tiger shrimp

3 February 2025

By Fredson H. Huervana, M.S.

Results showed that fermentation increased the protein, decreased the fiber contents, enhanced the amino acid profile, and improved the digestibility coefficient of rice bran

Study evaluated fermented rice bran (FRB) as an alternative protein source to soybean meal (SBM) in practical diets for juvenile black tiger shrimp (*Penaeus monodon*). Results showed that fermentation increased the protein, decreased the fiber contents, enhanced the amino acid profile and improved the digestibility coefficient of rice bran. Photo by Darryl Jory.

Feed ingredients used in commercial diets for black tiger shrimp (*Penaeus monodon*) in many developing countries in Asia are mostly imported. Among the imported feed ingredients, soybean meal (SBM) is the most important feed-protein source used in shrimp feeds. However, livestock and aquaculture industries compete in the use of SBM. There is currently great interest in reducing feed costs using locally available feed ingredients. One locally available feed ingredient is rice bran, which is inexpensive and available in large quantities. This material is produced as a byproduct of the rice milling process and is mainly used as an energy source in animal feed.

The Philippines is the seventh largest rice producer in the world and contributes 2.5 percent of global rice production. Since rice bran accounts for about 8 to 11 percent of the grain, approximately **87 million metric tons (https://doi.org/10.4060/cc8166en)** are produced annually and could be a cheaper source of feed protein in shrimp diets. However, rice products are not normally used in shrimp feeds because they are similarly priced with wheat products but have no feed-binding properties. The limitation of its use is also attributed to its high fiber content (12.4–27.8 percent), low protein (7.8 percent), and the presence of anti-nutritional factors.

Several studies have been conducted to improve the quality of rice bran and increase its utilization as a feed ingredient. Biomass transformation through solid-state fermentation (SSF) is one such technique. Fermentation of rice bran increases its nutrient availability through changes arising from microorganisms' metabolic activity, **increasing protein and soluble sugars** (https://doi.org/10.5897/AJB2004.000-2032), and reducing complex carbohydrates. However, to this date, there are no published reports on the use of fermented rice bran (FRB) in shrimp feeds.

This article – **summarized** (https://creativecommons.org/licenses/by/4.0/) from the **original publication** (https://doi.org/10.3389/fmars.2024.1384492) (Huervana F.H. et al. 2024. Solid-state fermentation converts rice bran into a high-protein feed ingredient for *Penaeus monodon*. *Front. Mar. Sci.* 11: 1384492) – reports on a study that evaluated the feed value of SSF rice bran as a replacement for soybean meal in the diet of juvenile *P. monodon*.

Study setup

The study was conducted at the hatchery complex of the Institute of Aquaculture, College of Fisheries and Ocean Sciences, University of the Philippines Visayas in Miagao, Iloilo, Philippines. Good quality and disease-free *P. monodon* postlarvae (PL15) were obtained from a private hatchery in Guimbal, Iloilo, Philippines.

The postlarvae were acclimated and stocked in a 50-ton canvas pond for 30 days. At the end of the nursery phase, juveniles were transferred to the experimental setup. The juveniles were randomly distributed into 20 units of 60-liter plastic tanks with a recirculating seawater system, with 15 shrimp per tank and were acclimated for seven days.

Fermented rice bran (FRB) was evaluated as an alternative protein source to soybean meal (SBM) in practical diets for the juvenile black tiger shrimp. FRB was tested in a feeding trial to replace SBM in *P. monodon* diets at 0 (T0), 12.5 (T12.5), 25 (T25), 37.5 (T37.5) and 50 percent (T50). Five iso-nitrogenous and iso-caloric experimental diets containing 44 percent crude protein were fed to groups of juvenile shrimp randomly assigned to twenty 60-liter rectangular tanks equipped. Each dietary treatment was run in four replicates and the feeding trial lasted 50 days.

For detailed information on the experimental design, animal husbandry, feed formulation and sample and data collection and analyses, refer to the original publication.

Robins McIntosh on everything you need to know about EHP and shrimp farming, part 1

Shrimp farming expert Robins McIntosh details a decade of learning about the microsporidian EHP and how to mitigate its impact.

Global Seafood Alliance

Results and discussion

Results of this study showed that fermentation decreased the fiber content of rice bran by about sevenfold compared to the unfermented rice bran. The content of total dietary fiber (TDF) in rice bran is approximately 20–30 percent, and nearly 90 percent of that content consists of insoluble dietary fiber (IDF). The high content of these IDF in rice bran is responsible for the low nutritional value and limited use of this biomass in feeds.

The solid-state fermentation (SSF) technique used in this research increased the protein content of rice bran about threefold compared to the raw material. The quantity of total amino acids in FRB was also increased as compared to the unfermented rice bran, indicating an improvement in the quality of protein. Similar improvements in the protein content and amino acid profile have been observed by other researchers. This improvement in protein content and quality has been associated with the **microbial biomass** (https://doi.org/10.1016/j.foodchem.2013.07.105) known as natural protein concentrate as it contains highly digestible proteins with complete essential amino acids.

The essential amino acid index of FRB was found to be high at 84 percent, rated as a good quality protein material, and comparable to soybean meal. The chemical score index of FRB showed tryptophan as the limiting amino acid. The **amino acid profile**

(https://doi.org/10.1080/19476337.2017.1359676) of the fermented material is dictated by the microbial species and substrate used in the fermentation

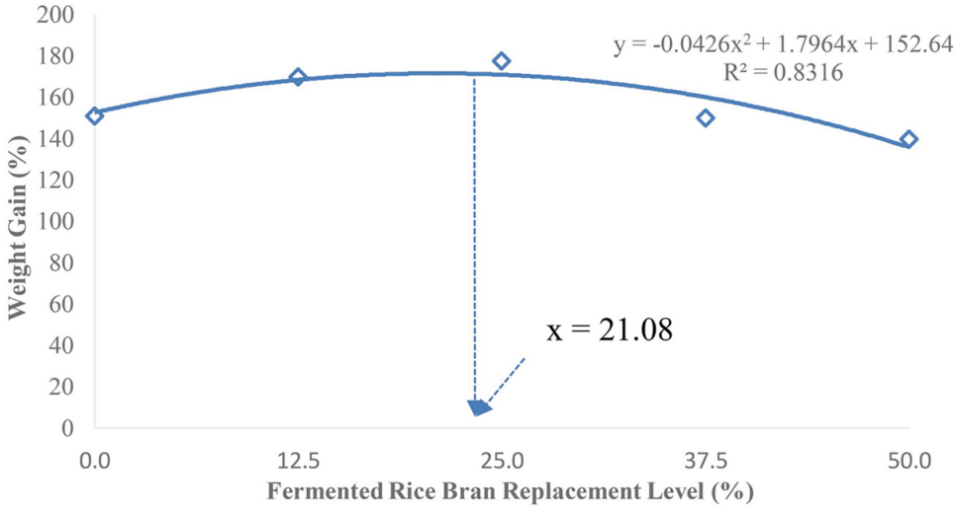

Fig 1: Optimum soybean meal replacement level of fermented rice bran (FRB) to achieve maximum growth in *P. monodon*.

The use of SBM as a major plant protein source is considered a standard in aquatic animal nutrition. The results of the present study confirm the viability of FRB in replacing SBM in diets for juvenile *P. monodon*. FRB substitution of 25 percent soybean meal showed significant improvement in weight gain, specific growth rate, feed conversion ratio and protein efficiency ratio. However, no significant effect on growth performance was observed when replacing soybean meal at higher levels. This indicates that fermentation can improve the nutritional value of rice bran and be used as a partial replacement for SBM in *P. monodon* diets.

The results of this study also showed higher replacement levels of FRB where possible when compared to another study where only 20 percent of SBM was replaced by FRB in catfish diets. And other studies have also reported the positive effects of replacing SBM with fermented agro-industrial wastes on shrimp growth. For example, *L. vannamei* exhibited **improved growth** (http://hdl.handle.net/10524/62926)when fed diets containing fermented sweet potato meal. Moreover, our results align with previous studies on terrestrial animals, which have demonstrated enhancements in growth performance across various species, including growth of broiler chickens, higher egg production in layers and reduced feed cost in swine.

Results on the carcass composition indicate no negative influence of FRB in the nutritional composition of *P. monodon*. Furthermore, the protein retention in shrimp was improved when SBM was replaced by up to 25 percent. However, higher SBM replacement showed retention levels similar to the control. This could be explained by the increased essential amino acids in the diets with FRB, which led to more efficient protein retention. This result is in contrast to other studies where partial replacement of SBM by fermented agro-industrial wastes showed no significant effect on the **protein retention** (http://hdl.handle.net/10524/54931) of shrimp.

Fig 2: Nutrient retention of *P. monodon* fed with different levels of fermented rice bran (FRB).

The amino acid analysis of *P. monodon* juveniles after the feeding trial showed that lysine levels in shrimp fed with 50 percent FRB replacement of SBM was significantly higher than the control. Lysine, along with various other amino acids, is important in shrimp taste. An increase in these amino acids would further enhance a desirable flavor, and a decline can cause changes in the sensory characteristics of shrimp. Furthermore, the **glutamic acid** (https://doi.org/10.1081/FRI-100000515) – a substance responsible for the umami (savory) taste in seafood products – of 50 percent FRB-fed *P. monodon*, was higher than the control. These results suggest that FRB could improve the sensory characteristics of *P. monodon*, as shown by an increase in the amount of amino acids important to shrimp taste.

Perspectives

The present study demonstrates that solid-state fermentation can improve the nutritional value of rice bran into a high-protein feed ingredient for *P. monodon.* The process increased the protein, decreased the fiber contents, enhanced the amino acid profile and improved the digestibility coefficient of this feed ingredient.

Results show that FRB can partially replace dietary SBM without affecting the growth performance and biochemical composition of black tiger shrimp. A 25 percent replacement of SMB by FRB improved shrimp growth and a 50 percent replacement of FRB could replace SBM without affecting shrimp growth. However, further research is required to evaluate the complete substitution of SBM with FRB.

Author

FREDSON H. HUERVANA, M.S.

Corresponding author
Institute of Aquaculture, College of Fisheries and Ocean Sciences, University of the Philippines Visayas, Miagao, Iloilo, Philippines

fhhuervana@up.edu.ph (mailto:fhhuervana@up.edu.ph)