Journal of Fish Health
Volume 5, Issue 1, February 2025
https://doi.org/10.29303/jfh.v5i1.6312

Optimization of Local Feed Ingredient Composition to Achieve 30% Protein Levels in Cultivated Fish Feed Production

Ratna Dewi Zebua[1], Destriman Laoli[1], Betzy Victor Telaumbanua[1], Januari Dawolo[1], Okniel Zebua[1]

[1]Aquatic Resources Study Program, Faculty of Science and Technology, Nias University
Jalan Yos Sudarso Ujung No. 118/E-S, Ombolata Ulu, Gunungsitoli District, Gunungsitoli City, North Sumatra 22812

Correspondence:
ratnadewizebua1@gmail.com

Received:
January 2nd, 2025
Accepted:
February 9th, 2025

Keywords:
Feed Optimization, Fish Cultivation, Local Ingredients, Protein Content, Sustainability

ABSTRACT

Aquaculture plays a vital role in meeting the global demand for animal protein, yet the dependency on expensive imported feed ingredients remains a significant challenge. Optimizing the use of local feed ingredients is a strategic approach to enhance sustainability and cost-efficiency in fish farming. This research aims to optimize the composition of local feed ingredients to achieve 30% protein content in farmed fish feed. The formulation involves rice bran, corn bran, fish meal, and tofu dregs, selected based on local availability and protein content. The methodology includes analysis of the protein content of raw materials, formulation testing, and physical evaluation of feed. The results show that the pellets produced have nutritional quality that meets the target, good physical stability, and cost efficiency of up to 40% compared to commercial feed. This research makes a significant contribution in supporting the sustainability of the fish farming industry and reducing dependence on imported raw materials.

INTRODUCTION

According to Desta Sari & Khoirudin (2023), aquaculture is a strategic sector in the national food production system which has a fundamental role in meeting society's animal protein needs. As an archipelagic country with the longest coastline in the world, Indonesia has extraordinary potential in developing fisheries cultivation. However, this potential has not been fully exploited optimally, especially in the aspect of producing quality fish feed.

Significant population growth and increased awareness of animal protein consumption drive the need for sustainable innovation in fisheries food production. According to data from the Ministry of Maritime Affairs and Fisheries, per capita fish consumption in Indonesia has reached 54.45 kg per year in 2021, an increase compared to previous years. However, the main challenge remains the productivity and sustainability aspects of aquaculture.

Feed is a critical component in the success of aquaculture, with a cost contribution reaching 60-70% of total production costs (Salamah & Zulpikar, 2020). Protein is the main nutrient that determines the growth, metabolism and health of fish (Rahma *et al.*, 2024). Each fish species has different specific protein requirements, depending on growth phase, environmental conditions and physiological characteristics.

The standard protein requirements for cultivated fish generally range between 25-35%, with complex variations. Carnivorous fish such as salmon and trout require higher protein than herbivorous fish such as tilapia (Usman *et al*., 2020). However, it is not just quantity, but protein quality and amino acid balance that are key factors in the success of feed formulation. Indonesia faces structural challenges in fulfilling fish feed raw materials. High dependence on fishmeal imports creates vulnerabilities in the supply chain and significant price fluctuations. Imported fishmeal is not only expensive, but also causes sustainability problems due to overfishing practices.

The potential of local feed ingredients has not been fully exploited optimally. Some potential materials that are available in abundance are often considered waste or by-products of the agricultural and agro-industry industries. Rice bran with 11.35% protein, corn bran with 7.63%, fish meal with 62.65%, and tofu dregs with 23.55% protein are examples of local resources that have significant nutritional potential.

Thus, research on optimizing the composition of local feed ingredients does not just answer technical challenges, but rather contributes to the sustainable transformation of the Indonesian aquaculture industry, supports national food security, and opens up opportunities for sustainable innovation in the food production system.

METHODS

Research on fish feed formulation and testing was carried out at the Biology Laboratory, Nias University, over a period of one month. Starting on July 6, 2024, research activities are focused on fast and efficient processes starting from ingredient preparation, formulation, manufacturing, to testing fish feed.

The tools and materials used are as follows:

1. Tools : Feed Printing Machine
2. Ingredients : Rice Bran 380 g
   Corn Bran 380 g
   Fish Meal 600 g
   Tofu Dregs 600 g
   Starch and enough water

Figure 1. Ingredients for making Feed

Feed Formulation:
Rice Bran 11.35%
Corn Bran 7.63%
Fish Meal 62.65 %
Tofu Dregs 23.55%

- The standard protein requirement in farmed fish feed ranges from 25-35%, depending on the species and growth phase of the fish (Word & Adipu, 2024). This formulation aims to achieve a protein content of 30%, which is within the optimal range for fish growth.
- Fish Meal (62.65%) was chosen as the main protein source because it has high protein content and essential amino acids that fish need (Safitri *et al*., 2023).
- Tofu dregs (23.55%) are used as an alternative vegetable protein that complements animal protein and provides good fiber content for the fish digestive system (Putri *et al*., 2022).
- Rice bran (11.35%) and corn bran (7.63%) act as additional sources of carbohydrates and protein and contain micronutrients that support fish metabolism (Kojo *et al*., 2015).

$$\text{Basalt: } \frac{\text{Rice Bran}}{\text{Corn Bran}} = \frac{11.35+7.63}{2} = 9.49$$

$$\text{Supplement: } \frac{\text{Fish Meal}}{\text{Tofu Dregs}} = \frac{62.65+23.55}{2} = 43.1$$

= 30% protein levels
= 43.1-30 = 13.1 x 100% = 19.49 %
= 30-9.49 = 20.51x 100% = 30.51 %
20.51 + 13.1 = 33.61

Rice Bran:	19.49 x 11.35 = 2.21 %
Corn Bran:	19.49 x 7.63 = 1.48 %
Fish Meal:	30.51 x 62.65 = 19.11 %
Tofu Dregs:	30.51 x 23.55 = 7.18 %

$$= \frac{30.51}{100}\ x\ 2\ \text{kg} = 0.61\ \text{kg} = 600\ \text{g}$$
$$= \frac{19.49}{100}\ x\ 2\ \text{kg} = 0.38\ \text{kg} = 380\ \text{g}$$

Total formulation: 30 %

RESULTS

Procurement of Raw Materials for Making Fish Feed

This research was conducted to optimize the composition of local feed ingredients to achieve 30% protein content in farmed fish feed. The initial stage involves procuring raw materials, namely fish meal, tofu dregs, rice bran and corn bran. All these ingredients are obtained from local sources with strict quality control.

Analysis of Protein Content of Raw Materials

The results of laboratory analysis of the protein content of raw materials are shown in Table 1.

Table 1. Raw Material Protein Content

Raw Material	Protein Content (%)
Fish Meal	62.65
Tofu Dregs	23.55
Rice Bran	11.35
Corn Bran	7.63

Fish Food Making Process

The process of making feed includes mixing the ingredients homogeneously, printing using a printing machine, and drying in the sun for 6-8 hours until the moisture content reaches 12%.

Evaluation of Fish Feed

The effectiveness of the feed was tested by giving it to the fish three times a day. Monitoring of fish response shows an average weight increase of 12-15% every two weeks with a feed conversion rate (FCR) of 1.6-1.8. Fig 1 shows the development of fish weight during the study.

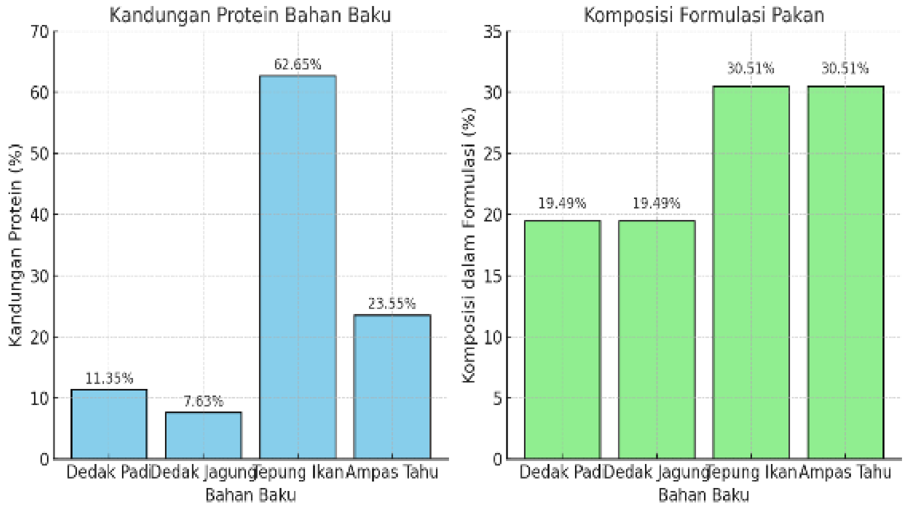

Figure 1. Absolute Growth Rate of Catfish (*Clarias* sp.)

DISCUSSION

Procurement of Raw Materials for Making Fish Feed

Research on optimizing the composition of local feed ingredients to achieve 30% protein content in cultivated fish feed production has been carried out in a series of systematic and measurable stages. The initial stage begins with the procurement of raw materials with an emphasis on quality and sustainability of supply. Fishmeal, which is the main source of protein, is obtained through collaboration with local fish processors who apply strict processing standards. The fish meal processing process is carried out using controlled drying and grinding methods to maintain protein quality. This is important considering that fish meal contributes significantly to the final protein content in feed formulations.

Tofu dregs as a component of vegetable protein are obtained through strategic partnerships with the tofu processing industry around the research location. The collaboration system that has been built ensures a sustainable supply of fresh and quality tofu dregs. Initial processing of tofu dregs includes pressing to reduce water content and controlled drying to prevent spoilage. According to Urland & Sudarma, (2023) rice and corn bran which function as additional sources of carbohydrates and protein are taken directly from local mills with an adequate quality control system. All raw materials are stored in a special warehouse with controlled temperature and humidity settings to prevent mold growth and microorganism contamination (Karlida & Musfiroh, 2020).

Analysis of Protein Content of Raw Materials

Laboratory analysis of the protein content of the raw materials showed promising results. Local fishmeal has a protein content of up to 62.65% with a complete amino acid profile, making it an ideal raw material for achieving feed protein targets (Amin *et al*., 2020). This high protein content is supported by proper processing and the selection of quality fish raw materials. Tofu dregs with a protein content of 23.55% provide a significant contribution of vegetable protein, complemented by fiber which is beneficial for fish digestion (Putri *et al*., 2022). Vegetable protein from tofu dregs has good digestibility and an amino acid profile that complements animal protein from fish meal (Putri *et al*., 2022).

Rice bran and corn bran, with protein contents of 11.35% and 7.63% respectively, not only contribute to total protein but also provide other important nutrients. Rice bran is rich in B complex vitamins which are essential for fish metabolism, while corn bran contributes carotene and xanthophyll which play a role in pigmentation and the fish immune system (Nuraeni, 2022). The combination of these four raw ingredients produces a balanced and complementary nutritional profile.

Fish Food Making Process

The process of optimizing the composition of local feed ingredients to achieve 30% protein content in fish feed production was carried out through a series of research and tests. The initial stage begins with the preparation of raw materials which include fish meal (600 g) with a protein content of 62.65%, tofu dregs (600 g) with 23.55% protein, rice bran (380 g) containing 11.35% protein, and corn bran (380 g) with a protein content of 7.63%. The choice of this composition was based on the need to achieve the 30% protein target while considering the availability and sustainability of local raw materials.

The process of making feed begins with grinding all the ingredients until they reach a uniform level of fineness. Proper grinding is the main key to ensuring the homogeneity of the mixture and the stability of the feed in water. Fish meal as the main source of protein is specially ground to maximize digestibility, while tofu dregs are dried first to prevent clumping in the dough (Anggraeni *et al*., 2019).

The method of mixing ingredients is carried out in stages to ensure even distribution of nutrients (Mulya, 2024). Rice bran and corn are mixed first, followed by adding tofu dregs, and finally fish meal. The adhesive solution is made separately by dissolving starch in warm water (60-70 °C) in a ratio of 1:10. The adhesive is added slowly while continuing to stir until it reaches the ideal consistency, characterized by a dough that can be formed but is not too wet.

Feed printing uses a printing machine with a diameter adjusted to the needs of the target fish (2-3 mm). The molding process requires precise speed settings to produce feed with optimal density. The feed that comes out of the machine is immediately cut into 3-4 mm lengths to make it easier for fish to consume. Fresh feed is then drained before entering the drying stage.

Drying is done by drying in the sun for 6-8 hours or until the water content reaches a maximum of 12% (Soekarno *et al*., 2023). Turning the feed is carried out periodically to ensure even drying. The final result shows good physical characteristics, including a hard and compact texture, a buoyancy of 15-20 minutes in water, and adequate stability when in water media. Evaluation of feed effectiveness is carried out by giving it to farmed fish three times a day

(08.00, 12.00 and 16.00) with a dose of 3-5% of the biomass weight. Monitoring the fish's response showed positive results in terms of appetite, growth rate and feed conversion rate. Production cost analysis indicates savings of 30-40% compared to commercial feed, while maintaining equivalent nutritional quality.

Optimization of this manufacturing process produces feed with a high level of homogeneity, ensuring uniform nutritional content in each grain of feed (Dilaga *et al*., 2022). The production method developed not only produces quality feed but also supports efficient use of raw materials and minimizes production waste. This research provides a strong foundation for the development of a fish feed industry based on sustainable local raw materials.

Product Packaging and Feeding to Fish

According to Afiqah *et al*., (2024) packaging fish feed is an important stage to maintain quality and extend the shelf life of the product. Before packaging, completely dry feed is cooled at room temperature for 30-45 minutes to prevent condensation in the packaging (Maryani *et al*., 2018). The packaging process uses double-layer plastic with a minimum thickness of 0.8 mm to provide optimal protection against moisture and physical damage.

Each package is labeled with important information including production date, raw material composition, protein content (30%), and storage instructions. According to (Mustajib *et al*., 2018) the packaging method is carried out using a double sealing system using a plastic pressing machine to prevent leaks and contamination of outside air. Feed sacks are arranged on wooden pallets with a maximum height of 5 stacks to facilitate air circulation and prevent feed compaction due to excessive pressure.

The feeding protocol is implemented by considering aspects of efficiency and effectiveness of fish growth. The frequency of feeding is three times a day at regular times:

- Morning (08.00): 40% of total daily feed
- Afternoon (12.00): 30% of total daily feed
- Afternoon (16.00): 30% of total daily feed

The feeding dose is adjusted to the fish biomass, ranging from 3-5% of the total weight of the fish in the pond. Dose adjustments are made every two weeks through fish weight sampling to ensure feeding efficiency. Food is spread evenly at several points in the pond to avoid competition and ensure that all fish have access to the same food (Mustajib *et al*., 2018).

Monitoring the fish's response to feeding is carried out through observation:

1. Appetite: observed through the fish's response when feeding and the remaining feed after 15-20 minutes
2. Growth speed: sampling measurements of fish weight and length every two weeks
3. Feed conversion rate (FCR): calculation of the ratio of the amount of feed given to the weight gain of the fish

Observation results show optimal feed consumption levels with an average FCR of 1.6-1.8. Fish growth shows a positive trend with an average weight increase of 12-15% every two weeks. The quality of the pond water is maintained well because the stability of the food in the water prevents pollution due to uneaten food (Pradana *et al*., 2024).

In extreme weather conditions or less than optimal water quality, the feeding dose is reduced by 25-30% to prevent decreased appetite and wastage of feed (Scabra *et al*., 2022). Feeding adjustments are also made when fish show symptoms of stress or disease, with a focus on restoring the fish's condition before returning to normal doses (Sari *et al*. 2022). According to Kurniawan *et al.*, (2020) a detailed daily recording system is implemented to monitor feeding, including the amount of feed given, fish response, and water quality parameters. These data are important for evaluating the effectiveness of feeding programs and adapting cultivation strategies on an ongoing basis. This systematic approach to feeding has proven effective in optimizing fish growth and efficient use of feed.

CONCLUSION

This research succeeded in optimizing local ingredients for the production of fish feed with a protein content of 30%. This formulation offers cost efficiency, high nutritional quality, and supports the sustainability of the fish farming sector. The results of this research have the potential to be a practical solution for aquaculture industry players in reducing dependence on imported materials.

ACKNOWLEDGEMENT

This research successfully optimized local ingredients for fish feed production, achieving a protein content of 30% while maintaining good physical stability and cost efficiency of up to 40% compared to commercial feed. The formulated feed demonstrated positive results in fish growth performance, with an average weight increase of 12-15% every two weeks and a feed conversion ratio (FCR) of 1.6-1.8. These findings support the sustainability of the aquaculture sector by reducing dependency on imported raw materials and promoting the use of locally available resources. This study provides a practical and cost-effective solution for fish farmers, contributing to the long-term development of sustainable aquaculture.

REFERENCES

Afiqah, N., Hartanti, L., & Rahayuni, T. (2024). Kajian Lama Penyimpanan Asam Pedas Ikan Lele Menggunakan Standing Pouch Aluminium Foil. *Jurnal Teknologi Dan Industri Pertanian Indonesia*, *16*(1), 36–43. https://doi.org/10.17969/jtipi.v16i1.32205

Amin, M., Taqwa, F. H., Yulisman, Y., Mukti, R. C., Rarassari, M. A., & Antika, R. M. (2020). Efektivitas Pemanfaatan Bahan Baku Lokal Sebagai Pakan Ikan Terhadap Peningkatan Produktivitas Budidaya Ikan Lele (*Clarias* sp.) di Desa Sakatiga, Kecamatan Indralaya, Kabupaten Ogan Ilir, Sumatera Selatan. *Journal of Aquaculture and Fish Health*, *9*(3), 222. https://doi.org/10.20473/jafh.v9i3.17969

Anggraeni, Nur, D., & Rahmiati, R. (2019). Pemanfaatan Ampas Tahu Sebagai Pakan Ikan Lele (*Clarias batrachus*) Organik. *Biogenesis: Jurnal Ilmiah Biologi*, *4*(1), 53–57. https://doi.org/10.24252/bio.v4i1.1469

Dilaga, S. H., Sofyan, Amin, M., Mastur, & Dahlanudin. (2022). Pengamatan Organoleptik, Homogenitas, Dan Daya Simpan Pakan Konsentrat Yang Diproses Dengan Teknik Pencampuran Berbeda. *Prosiding SAINTEK LPPM Universitas Mataram*, *4*(November 2021), 185–190. syamsulhdilaga@unram.ac.id

Karlida, I., & Musfiroh, I. (2020). Suhu Penyimpanan Bahan Baku Dan Produk Farmasi Di Gudang Industri Farmasi. *Farmaka*, *15*(4), 58–67.

Kojo, R. M., Rustandi, D., Tulung, Y. R. L., & Malalantang, S. S. (2015). Pengaruh Penambahan Dedak Padi Dan Tepung Jagung Terhadap Kualitas Fisik Silase Rumput Gajah (*Pennisetum purpureum*cv.Hawaii). *Zootec*, *35*(1), 21. https://doi.org/10.35792/zot.35.1.2015.6426

Kurniawan, C. M. A., Sahertian, J., & Sanjaya, A. (2020). Sistem Monitoring dan Pemberian Pakan Otomatis pada Budidaya Ikan Lele Berbasis Internet of Things. *Seminar Nasional*

Inovasi Teknologi, *09*(02), 224–228.

Maryani, M., Efendi, E., & Utom, D. S. C. (2018). Efektivitas Ekstrak Bunga Kenanga (*Cananga odorata*) Sebagai Bahan Anestesi Pada Transportasi Benih Nila Merah (*Oreochromis* sp.) Tanpa Media Air (The Effectiveness of Cananga Flower (*Cananga odorata*) as an Anesthetic Material On Trnsportation Red Tilapia F. *SAINTEK PERIKANAN : Indonesian Journal of Fisheries Science and Technology*, *14*(1), 8. https://doi.org/10.14710/ijfst.14.1.8-15

Mulya, K. P. (2024). Pelatihan Pembuatan Media Tanam untuk Mendukung Ketahanan Pangan Mandiri Rumah Tangga Kelompok PKK 1. *Jurnal Unsur*, *5*(1), 34–40.

Mustajib, M., Elfitasari, T., & Chilmawati, D. (2018). Catfish (*Clarias* sp) Farming Development Prospects In Wonosari Village, Bonang District, Demak Regency. *Jurnal Sains Akuakultur Tropis*, *2*(1), 38–48. https://ejournal2.undip.ac.id/index.php/sat/article/view/2476

Nuraeni, A. (2022). Substitusi Jagung (*Zea Mays* L.) Dalam Pembuatan Bakpao Sebagai Pangan Fungsional. *Jurnal Sain Boga*, *5*(2), 88–99.

Pradana, E. S., Ch, S., & Suksmadana, I. M. B. (2024). Rancang Bangun Sistem Kontrol pH Air dan Pemberian Pakan Ikan Otomatis Pada Akuaponik Berbasis Mikrokontroler. *6*(1), 649–658. https://doi.org/10.47065/josh.v6i1.6122

Putri, D. K. Y., Sudrajat, H., Susanti, A., Susilowati, & Batuthoh, M. W. I. (2022). Utilization of Tofu Dregs in the Making of High-Fiber and Low-Fat Flours As Alternative Functional Food Ingredients. *Jurnal Hasil Pengabdian Kepada Masyarakat Universitas Jember*, *1*(1), 27–35. https://doi.org/10.19184/jpmunej.v1i1.72

Rahma, A. A., Nurlaela, R. S., Meilani, A., Saryono, Z. P., & Pajrin, A. D. (2024). Ikan Sebagai Sumber Protein dan Gizi Berkualitas Tinggi Bagi Kesehatan Tubuh Manusia. *Karimah Tauhid*, *3*(3), 3132–3142. https://doi.org/10.30997/karimahtauhid.v3i3.12341

Safitri, E., Anggo, A. D., & Rianingsih, L. (2023). Pengaruh Penambahan Tepung Ikan Nila (*Oreochromis niloticus*) Terhadap Kualitas dan Daya Terima Fish Flakes. *Jurnal Ilmu Dan Teknologi Perikanan*, *5*(1), 10–27. https://medium.com/@arifwicaksanaa/pengertian-use-case-a7e576e1b6bf

Salamah, S., & Zulpikar, Z. (2020). Pemberian probiotik pada pakan komersil dengan protein yang berbeda terhadap kinerja ikan lele (*Clarias* sp.) menggunakan sistem bioflok. *Acta Aquatica: Aquatic Sciences Journal*, *7*(1), 21. https://doi.org/10.29103/aa.v7i1.2388

Sari, C. D., Khoirudin, R., & Dahlan, U. A. (2023). Pengaruh sektor perikanan terhadap pdb indonesia. *3*, 10–22.

Sari, M. P., Helmizuryani, H., Adjie, S., & Khotimah, K. (2022). Influence of Feed Satisfaction Interval on Survival and Growth of Patin (*Pangasius hypopthalmus*). *Journal of Global Sustainable Agriculture*, *2*(2), 36. https://doi.org/10.32502/jgsa.v2i2.4489

Scabra, A. R., Afriadin, A., & Marzuki, M. (2022). Efektivitas Peningkatan Oksigen Terlarut Menggunakan Perangkat Microbubble Terhadap Produktivitas Ikan Nila (*Oreochromis niloticus*). *Jurnal Perikanan Unram*, *12*(1), 13–21. https://doi.org/10.29303/jp.v12i1.269

Soekarno, S., Nadzirah, R., Indarto, I., Lestari, N. P., Bahariawan, A., & Karimah, N. (2023). Pengendalian Suhu Ruang Pada Mesin Pengering Vertikal Tipe Rak (Vertical Tray Dryer) Dalam Pengeringan Biji Jagung (*Zea mays* L.). *Jurnal Ilmiah Rekayasa Pertanian Dan Biosistem*, *11*(1), 113–124. https://doi.org/10.29303/jrpb.v11i1.454

Urland, A. C., & Sudarma, I. M. A. (2023). Uji Kualitas Fisik Dan Kimiawi Dedak Padi Penggilingan Di Kecamatan Umbu Ratu Nggai Kabupaten Sumba Tengah. *Jurnal Peternakan Sabana*, *2*(1), 19. https://doi.org/10.58300/jps.v2i1.454

Usman, Asda Laining, E. S. (2020). Suplementasi crude enzim papain dalam pakan pembesaran ikan beronang, *Siganus guttatus*. *Jurnal Perikanan (J. Fish. Sci.)*, *XVI*(1), 10–16.

Word, L. E., & Adipu, Y. (2024). Kualitas Pakan Pelet Ikan Dari Limbah Ternak. *Gorontalo Fisheries Journal*, *6*(1), 1. https://doi.org/10.32662/gfj.v6i1.3316