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S. Harini

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UTILIZATION OF FOOD WASTE AS FEED INGREDIENT

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S. Harini
Department of Aquaculture,
Dr.M.G.R.Fisheries College and research institute, Ponneri- 601 204, Tamilnadu
Dr.J.Jayalalitha Fisheries University, Tamilnadu, India

ABSTRACT

The amount of food waste generated by modern societies is increasing, putting tremendous strain on its treatment and disposal. Food waste should be treated as a valuable resource rather than a waste, and turning it into fish feed is a viable option. This paper examines the feasibility of converting food waste into fish feed using a variety of techniques such as bioconversion, enzyme addition, vitamin-mineral premix, probiotics, medicinal herbs, and prebiotics. It satisfies the lower trophic level species and are safer for consumption in comparison with the commercial feed pellets.

KEY WORDS: food waste, biotransformation, fish feed, probiotics.

INTRODUCTION

Food losses that occur at the final stages of the food supply chain, namely retail and final consumption, are referred to as "food waste," whereas food losses that occur during the production, post-harvest, and processing stages are referred to as "food loss." Food waste decomposition in landfills produces massive amounts of methane, a powerful greenhouse gas with a global warming potential 20 times that of carbon dioxide (Ishigaki et al., 2002). As a result, landfilling is an unsuitable method of disposing of food waste. Incineration is also not a viable option due to the low net caloric value of food waste due to its high moisture content (Liu et al., 2006). As a result, rather than being dumped or burned, food waste could be recycled. Incineration is also not a viable option due to the low net caloric value of food waste due to its high moisture content (Liu et al., 2006). As a result, rather than being dumped or burned, food waste could be recycled. Bioactive chemicals are molecules found in trace amounts in foods and other agricultural waste products that have the potential to provide health benefits. Bioactive substances include long-chain polyunsaturated fatty acids, vitamins, carotenoids, peptides, and polyphenols. The purpose of this article is to discuss the transformation of food waste to fish feed, with the idea that using food waste rather than disposing of it may be more beneficial.

TREATMENT OF FOOD WASTE

Processing technologies have the potential to transform food waste into safe animal feed products with added value and high-quality nutrients. Cooking, extrusion, pelletizing, dehydration, ensiling, and probiotic treatment are examples of food waste processing treatments. Extrusion, pelletizing, and dehydration, when compared to cooking and ensiling, increase the shelf life of the final food waste product.

BENEFITS AS FEED

- Highly digestible as feed
- Safe for consumption
- Highly nutritious
- Sustainable choice of feed.

FOOD WASTE AS FEED INGREDIENT

• Without proper separation at the source, producing fish feed with desirable composition and nutritional contents would be extremely difficult.

• To suit the feeding modes, different combinations of food wastes should be chosen. When compared to carnivorous fish, low-trophic level fish have lower protein and nutritional requirements (such as freshwater bass).

• Food waste pellets could be improved by adding enzymes and baker's yeast, resulting in faster growth rates.

METHODS OF UTILIZATION OF WASTE AS FEED

- Biotransformation of food wastes
- Solid state fermentation
- Bioconversion
- Lipid proportion maintenance
- Inclusion of medicinal herbs and enzymes
- Inclusion of prebiotics and probiotics
- Food wastes grown as algae for fish feed
- Dry heating or hydrothermal treatment coupled with fermentation

BIOTRANSFORMATION OF FOOD WASTES BY MICROBES

• Solid-state fermentation (SSF) is a method of growing microorganisms on solid substrates in the absence of free water (Lagemaat and Pyle, 2001) The use of brewer's yeast Saccharomyces cerevisiae in aerobic solid-state fermentation (SSF) can improve the protein composition of FW (Jannathulla et al., 2018).

• Proteins account for 40 to 45% of the dry mass of the microbe (Sacakli et al., 2013), and essential amino acids are abundant in yeast cells (Yamada and Sgarbieri, 2005).

• Additionally, the yeast cell wall is composed of polysaccharides, primarily - glucans, chitin, and mannoproteins, which have been shown to have pre-biotic properties, promoting fish growth and improving immune response (Bzducha-Wrobel et al., 2012). (Rawling et al., 2021).Although FW is high in lipids, it also has a low protein content and an unsuitable omega-3 fatty acid profile. Microorganisms with desaturases and elongases can theoretically be used to convert various fatty acids into EPA and DHA (Kennes, 2018), thereby increasing the omega-3 fatty acid content of FW used as an aquafeed ingredient.

• Gayathri et al. (2010) demonstrated soilborne Trichoderma spp. and Aspergillus niger's ability to bio-convert oleic acid (OA) into EPA and DHA. Trichoderma spp. is soil-dwelling filamentous fungi that secrete multiple exoenzymes and are thought to convert short fatty acids into longer omega-3 fatty acids. The extraction of lipids from restaurant waste using solvents would allow for the formulation of diets with better lipid proportions and, most likely, better yeast fermentation.

BIOCONVERSION

- According to Yang et al. (2006), lactic acid fermentation of food waste can break down fibre and increase water-soluble carbohydrates in the fermentation product. According to Liu (2014), carbohydrate-rich foods account for a large portion of food waste.
- The high carbohydrate content of food waste may be especially beneficial for the growth of herbivores and carnivorous fish. Nonetheless, information on various methods of processing food waste as feed is limited, and more research is required.

LIPID REMOVAL

- High lipid content in feed containing meat products was also a possible cause of growth inhibition and high body lipid. It is suggested that lipid be removed during the preparation of food waste feed or that further research be conducted by incorporating supplements, such as enzymes in feed, to improve lipid or protein utilisation by fish.

USE OF PREBIOTICS AND PROBIOTICS

- Prebiotics such as inulin, an oligosaccharide; mannanoligosaccharides (MOS), a glucomannoprotein complex derived from yeast cell wall; fructo oligosaccharides (FOS); and galactooligosaccharides (GOS) could be used to improve aquatic animal health instead of antibiotics which enhances feed digestibility, growth and non-specific immunity of fish
- "Probiotics" referred to "a live microbial feed supplement which beneficially affects the host animal by improving its intestinal balance" (Fuller, 1989) The positive effects provided by addition of yeasts is mainly due to the adhesion of yeast cells to the intestinal wall, and their amylase enzymes would increase the digestibility (Scholz et al., 1999) of the food waste based pellets. Furthermore, yeast cells attached on the intestinal wall could also stimulate innate immune responses, protecting fish against infections (Esteban et al., 2001). This is due to B-glucans, mannan oligosaccharides and nucleic acid contained in the yeast, serving as immune-stimulants (White et al., 2002).

USE OF ENZYMES

Proteases such as papain(from papaya) and bromelain (from pineapple) which increases the feed conversion ratio, digestibility and immunoglobulin content. And the commercial enzyme, Ronozyme TM VP which is known to promote growth performance and protein utilization could be added to upgrade the food waste based feeds.

VITAMIN-MINERAL PREMIX

Addition of vitamin- mineral premix increase the nutritional qualities in feed. Vitamins and minerals are one of the key nutrition for the larval development and addition of it prevents the skeletal abnormalities and defects in growth. It also increases the protein digestibility of the feeds.

USAGE OF MEDICINAL HERBS

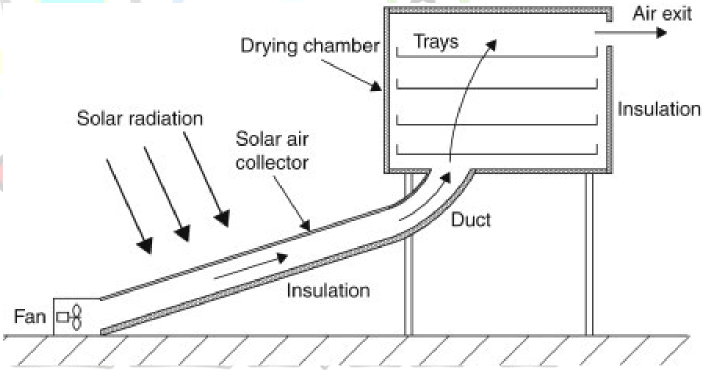
Medicinal herbs have been used for human therapeutic purposes as medicines and immune builders. They have also been used in aquaculture which replaces the commercial antibiotics. The commonly used herbs include *Cinnamomum cassia, Achyranthes aspera, Allium sativum, Eupatorium fortune, Punica granatum* which are used as a feed additive to upgrade the qulity of the feed.

FOOD WASTE IN PRIMARY PRODUCTIVITY

- Due to the expensive culture medium used to maintain the algal culture, it has been estimated that investment in culturing microalgae could represent 30% of a hatchery's operating cost (Coutteau and Sorgeloos, 1992).
- However, the use of food waste hydrolysate may help to reduce costs. Pleissner et al. (2013) discovered that a fungal hydrolysate of food waste (derived from a cafeteria) could be used as a culture medium for rearing Schizochytrium mangrovei and Chlorella pyrenoidosa, with higher concentrations of protein (S. mangrovei: 259.8 mg; C. pyrenoidosa: 130.6 mg) and lipids (S. mangrovei: 164.9 mg; C. pyren (protein and lipids: S. mangrovei: 82.1 mg and 124.9 mg; C. pyrenoidosa: 69.4 mg and 48.6 mg, respectively)
- Food waste, like fish waste and okara, would require pre-treatment to reduce moisture before further processing because both fresh and cooked food contain more moisture than uncooked food and thus promote microbial growth. Heat treatment of food waste at 65 °C for 20 minutes would be sufficient to kill most harmful microorganisms, including Enterobacteria, Clostridium, and Staphylococcus aureus, with no loss of nutritional quality (Sancho et al., 2004).

DRY HEATING

Drying FW is an effective method for storing and extending its shelf life. Other benefits of drying include: easy and inexpensive transportation and packaging of dried FW, less storage space required than for other processed FW, lower environmental load, and reduced greenhouse gas emissions. Some drying techniques are not suitable or cost-effective for drying food waste. Among the drying methods, radiactive-convective drying appears to be the most effective method for food waste drying; however, due to their high energy requirements, convective dryers must be connected to a low-cost energy source, such as solar energy, for the drying process to be economically and environmentally acceptable and to meet sustainability criteria.



USE AS FEED

Bake *et al.* (2013) **NILE TILAPIA** (no significant differences in growth performance to the control group (fed a	Used recycled food waste (including **soy sauce waste, leftover food from convenience stores, food waste residues discharged during processing, hotel waste, restaurant cooking waste, tofu waste and bread production waste)**

diet without food waste)	
Mo *et al.* (2014)	Food waste-based diets contained satisfactory levels of **essential amino acids, crude proteins, crude carbohydrates, crude lipids and phosphates**; such diets were suitable for growing low-trophic level fish, including grass carp, grey mullet, bighead carp and tilapia.
Cheng *et al.*, 2015	Fish fed food waste based pellets had **lower levels of contaminants (such as DDT and mercury) than those fed commercial feed pellets**

CONCLUSION

Food waste is a renewable source of nutrients that could be used as an aquafeed ingredient to reduce aquaculture production costs. FW, on the other hand, has a low protein content. Using food waste to make fish feed pellets appears to be a viable option. Different food waste combinations should be chosen to suit the feeding modes of various fish species, particularly freshwater fish associated with low-trophic levels, such as herbivores (such as grass carp) and omnivores (such as grey mullet). This is because the protein and nutritional requirements of these low-trophic level fish are lower than those of carnivorous fish (such as freshwater bass). Food waste pellets could be improved by adding enzymes and baker's yeast, resulting in faster growth rates and improved quality. The addition of Chinese medical herbs would also aid in the replacement of certain antibiotics used in aquaculture. In general, fish fed food waste diets are safer for human consumption than fish fed commercial diets, owing to higher contaminant concentrations in fishmeal contained in commercial diets. Further research should focus on the feasibility of incorporating various Chinese medicinal herbs, enzymes, or other additives to improve the quality and efficacy of fish feeds.

REFERENCES :

1. Bake, G.G., Endo, M., Satoh, S., Sadiku, S.O.E. and Takeuchi, T., 2013. Nitrogen and mineral budget of Nile tilapia fry fed recycled food wastes materials supplemented with lysine and methionine in a closed recirculating fish culture system.
2. Bzducha-Wróbel, A., Błażejak, S. and Tkacz, K., 2012. Cell wall structure of selected yeast species as a factor of magnesium binding ability. European Food Research and Technology, 235(2), pp.355-366.
3. Cheng, J.Y. and Lo, I., 2016. Investigation of the available technologies and their feasibility for the conversion of food waste into fish feed in Hong Kong. Environmental Science and Pollution Research, 23(8), pp.7169-7177.
4. Coutteau, P. and Sorgeloos, P., 1992. The use of algal substitutes and the requirement for live algae in the hatchery and nursery rearing of bivalve molluscs: an international survey. Journal of Shellfish Research, 11, pp.467-467.
5. Esteban MA, Cuesta A, Ortuno J, Meseguer J (2001). Immunomodulatory effects of dietary intake of chitin in

gilthead seabream (Sparus aurata L.) innate immune response. Fish Shellfish Immunol 11:305-15.
6. Fuller R (1989). Probiotics in man and animals. J Appl Bacteriol 66: 365- 78
7. Gayathri, S., Prabhu, S., Mitra, A., Kumar, V., Sheela, J.S., Rajani, G., Sundar, N. and Sivvaswamy, S.N., 2010. Soil microorganisms produce omega-3 fatty acids. Indian Journal of Science and Technology, 3(5), pp.499-503.
8. Ishigaki, T., Sugano, W., Nakanishi, A., Tateda, M., Ike, M. and Fujita, M., 2004. The degradability of biodegradable plastics in aerobic and anaerobic waste landfill model reactors. Chemosphere, 54(3), pp.225-233.
9. Jannathulla, R., Rajaram, V., Kalanjiam, R., Ambasankar, K., Muralidhar, M. and Dayal, J.S., 2019. Fishmeal availability in the scenarios of climate change: Inevitability of fishmeal replacement in aquafeeds and approaches for the utilization of plant protein sources. Aquaculture Research, 50(12), pp.3493-3506.
10. Kennes, C., 2018. Bioconversion processes. Fermentation, 4(2), p.21.
11. Liu, G., 2014. Food losses and food waste in China: a first estimate.
12. Liu, Z., Liu, Z. and Li, X., 2006. Status and prospect of the application of municipal solid waste incineration in China. Applied Thermal Engineering, 26(11-12), pp.1193-1197.
13. Mo, W.Y., Cheng, Z., Choi, W.M., Lun, C.H., Man, Y.B., Wong, J.T., Chen, X.W., Lau, S.C. and Wong, M.H., 2015. Use of food waste as fish feeds: effects of prebiotic fibers (inulin and mannanoligosaccharide) on growth and non-specific immunity of grass carp (Ctenopharyngodon idella). Environmental Science and Pollution Research, 22(22), pp.17663-17671.
14. Mo, W.Y., Man, Y.B. and Wong, M.H., 2018. Use of food waste, fish waste and food processing waste for China's aquaculture industry: Needs and challenge. Science of the Total Environment, 613, pp.635-643.
15. Pleissner, D., Lam, W.C., Sun, Z. and Lin, C.S.K., 2013. Food waste as nutrient source in heterotrophic microalgae cultivation. Bioresource technology, 137, pp.139-146.
16. Rawling, M.D., Pontefract, N., Rodiles, A., Anagnostara, I., Leclercq, E., Schiavone, M., Castex, M. and Merrifield, D.L., 2019. The effect of feeding a novel multistrain yeast fraction on European seabass (Dicentrachus labrax) intestinal health and growth performance. Journal of the World Aquaculture Society, 50(6), pp.1108-1122.
17. Sacakli, P., Koksal, B. H., Ergun, A., & Ozsoy, B. (2013). Usage of brewer's yeast (Saccharomyces cerevisiae) as a replacement of vitamin and trace mineral premix in broiler diets. Revue de Médecine Vétérinaire, 164(1), 39–44.
18. Sancho, P., Pinacho, A., Ramos, P. and Tejedor, C., 2004. Microbiological characterization of food residues for animal feeding. Waste Management, 24(9), pp.919-926.
19. Scholz U, GarciaDiaz D, Ricque L, Latchford J (1999). Enhancement of Vibriosis resistance in juvenile Penaeus vannamal by supplementation of diets with different yeast products. Aquaculture 176:271-83.
20. Van de Lagemaat, J. and Pyle, D.L., 2001. Solid-state fermentation and bioremediation: development of a continuous process for the production of fungal tannase. Chemical Engineering Journal, 84(2), pp.115-123.
21. White L A, Newman MC, Cromwell GL, Lindemann MD (2002). Brewers dried yeast as a source of mannan oligosaccharides for weanling pigs. J Animal Sci 80:2619-28.