

GSJ: Volume 9, Issue 1, January 2021, Online: ISSN 2320-9186
www.globalscientificjournal.com

UTILIZATION OF FOOD WASTE AS RAW MATERIAL FOR FISH FEED (A REVIEW)

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KeyWords

Food Waste, Fish Feed, Nutrient of Food Waste, Food Waste Utilization, Regulation.

ABSTRACT

Indonesia is the 4th most populous country in the world, the increasing population also has an impact on increasing food waste production, so the best solution is needed to prevent the creation of new problems from waste piles. One way that can be used to overcome this problem is by utilizing food waste as a basic material for making fish feed, because food waste has a large enough protein content, ranging from 10-22%, and can be increased again by carrying out the fermentation process. Besides being able to overcome environmental problems, making recycling food waste into fish feed can also solve the problem of feed availability for aquaculture in Indonesia. This paper review aims to determine the conversion rate of food waste into animal feed (including fish feed) in Indonesia and compare it with other countries so that it can be an evaluation and provide solutions for food waste management in the future.

INTRODUCTION

Fish feed is the most important part of the aquaculture cycle, around 60-70% of the total cost spent in one production cycle is spent on feed procurement [1]. Currently, farmers only depend on the feed supply from the commercial feed, if the commercial feed has a high selling price, it will have an impact on the profits that will be obtained by farmers. Thus, it is necessary to make independent feed using alternative feed ingredients to reduce production costs. Several conditions must be met in the selection of alternative feed ingredients, including these ingredients that have sufficient nutritional content for fish growth, are relatively inexpensive, have large amounts of availability, are guaranteed their sustainability, and do not compete with humans in their use [2]. One of the alternative feed ingredients that can be used is organic food waste. Food waste will be directly proportional to population density in an area.

Indonesia has the 4th most populous population in the world. Based on statistical data released by BPS [3], the total population in Indonesia in 2018 has reached 265,015,300 people. The World Bank in 2012 stated that waste production was 1.2 kg/person/day with a world population of 3 billion people and it is predicted that it will continue to increase along with the increasing number of the world population [4]. This increase in population was followed by an increase in the production of organic waste leftovers, which would create new problems if the management was not good.

Organic waste is a production waste that can experience decay and decay [5]. Food waste is the amount of feed lost at the end of consumption activities (uneaten food waste), the production of food waste is related to consumer action [6]. Food waste is one of the problems that are still 'homework' for the Indonesian government and the international community in general. Based on data released by FAO (*Food and Agriculture Organization*) that 1/3 of food production will be wasted [6]. Apart from having an impact on food availability, *food loss and food waste* (FLW) has quite a large economic impact. FAO estimates that the losses incurred due to the FLW in 2012 amounted to USD 936 billion, which is slightly larger than Indonesia's GDP in the same year [7]. Meanwhile, from within the country, Indonesia was in the seventeenth rank as a country with the *Food Sustainable Index* (FSI) in 2018 with the indicator assessed as *food loss and waste* (FLW) [8].

The increase in the accumulation of organic waste will become a new problem for both the environment and the health of the community around the disposal site. Food waste is a serious problem and requires proper handling. Besides, proper handling of food waste can also assist in fulfilling SDG 12, namely Responsible Consumption and Production, so that proper handling is needed so as not to cause problems for environmental quality. One of the ways that can be done to reduce the problem of food waste is to use the waste into fish feed ingredients.

CURRENT CONDITION OF AQUACULTURE IN INDONESIA

Aquaculture is a sector that has a high enough production, based on published MPA data (Table 1) it can be seen that Indonesian aquaculture production has increased very significantly [9]. The increase in production which reached 9.31 million tons from 2011-2018 is a general description that aquaculture is one of the sectors that has the highest increasing trend of GDP value, which is 13.19% and higher than the National GDP of only 10.13% [10].

Table 1. Production of Aquaculture in Indonesia 2011-2018

Year	Production (Million Ton)	PDB (Billion Rupiah)
2011	7,93	163.484,0
2012	9,67	184.254,0
2013	13,30	210.670,8
2014	14,35	245.488,0
2015	15,63	288.916,6
2016	16	317.190,0
2017	16,11	348.853,8
2018	17,24	385.936,4

Aquaculture plays an important role in the high production of fisheries in Indonesia. In 2011, aquaculture only contributed 51% of total fishery production [9], however, there was a very significant increase in 2018, where aquaculture has succeeded in contributing 71% of total national fishery production [10]. Based on statistical data, seaweed is the most dominating commodity in cultivation, holding 69% of total production, followed by Tilapia with 7%, Catfish and Shrimp 5%, Milkfish 4% [10]. Based on the increasing trend from year to year, the KKP further targets that in 2021 there will be an increase in aquaculture production by 1.03 million tons from the production target in 2020 [11]. The increase in aquaculture production targets that have been set by the KKP has become a challenge for the availability of feed, so it is hoped that the use of food waste for fish feed ingredients will become a solution to the problem of feed availability.

NUTRITIONAL CONTENT OF FOOD WASTE

The selection of fish feed ingredients has several criteria that must be met, including that the material must have sufficient nutritional content to meet the nutritional needs of fish, feed must have low fiber content so that it is easily digested to increase feed efficiency, ingredients must not contain poison, this material is easily available and has a cheap economic value [12]. Several

studies have been conducted to determine the nutritional content of food waste (Table 2) so that it becomes the basis for feed formulation.

Tabel 2. Nutrient of Food Waste

Category	Food Waste				
	1	2	3	4	5*
Protein (%)	10.89	15.29	12.69	22.33	26.16
Crude Fiber (%)	9.13	7.73	6.42	4.59	3.71
Fat (%)	9.70	8.97	7,45	13.38	9.84

Information :

1. Agricultural Research and Development Agency (2000) [13]
2. Setiawan (2006) [14]
3. Soewarno (2007) [15]
4. Cahya *et al.* (2019) [16]
5. Andriani *et al.* (2020) [17] *(with fermentation)

The use of food waste to feed has long been used, based on Minkler's records in 1914 where food waste has begun to be used as animal feed (pigs) on farms in New Jersey [18]. In Indonesia, in 2000 the Agricultural Research and Development Agency (BPPP) conducted research to utilize food waste from Warung Tegal (warteg) around the city of DKI Jakarta as mixed feed for native chickens. Currently, the use of food waste is not only in the form of flour but also probiotics have been added to increase the nutrient content of the waste due to the fermentation process, besides the management of food waste by using maggot or larvae from *Black Soldier Fly* (BSF) which can become fish feed because having high protein content (> 40%).

The use of food waste into animal feed must be considered in the production process and its raw materials because food from food waste has the potential for disease transmission, so to prevent this the European Commission has banned the use of food waste as animal feed in 2002 by issuing a Regulation (EC) No. 1774/2002 [24]. Some of the diseases that have been identified include Foot and Mouth Disease, Swine Fever, Avian Influenza, and Transmissible Spongiform Encephalopathies (TSEs), these diseases, especially TSEs are caused by intraspecies recycling, which refer to feeding of animals with protein from the same species, fortunately, none of these diseases are related to fish, feeding food waste for fish does not raise any compliance with intraspecies recycling [24]. Thus, it is necessary to formulate regulations and standardize food waste used to prevent disease transmission.

UTILIZATION OF FOOD WASTE IN INDONESIA

Utilization of food waste in Indonesia is still not optimal, people only do waste disposal (7.5%) and compost (1.61%) [19], not many people use this waste to feed animals (farm or fish). However, some research and training continue to be able to reduce landfill waste and reduce the cost of livestock and fish production. Research conducted by BPPP in 2000 [13] by mixing food waste flour from Warung Tegal (warteg) around the city of Jakarta as broiler chicken feed gave good results. The use of 75% of restaurant waste flour mixed with feed does not have a negative effect, it can even reduce production costs by up to 35% so that it has an impact on breeders' income.

Another study was conducted by Setiawan in 2006 [14] by mixing rice bran and restaurant waste in broiler chicken feed. The results obtained were the addition of restaurant waste flour up to 12% did not have a negative effect on the conversion of chicken ration but for weight growth, the best addition of restaurant waste flour was found in the treatment with the addition of 6.2%.

In addition to the use of food waste as animal feed, there is also the use of food waste as fish feed. Research conducted by Cahya in 2019 [20], with a fermentation process in food waste. The fermentation process was chosen because fermentation can improve and improve the quality of feed ingredients due to changes in complex elements into simpler ones. The results of fermentation in food waste gave an increase in protein content of 50.83%, a decrease in crude fiber and fat by 30.74% and 7.72%. Fish feed is formulated to have a protein content of 30% with the addition of the best-fermented food waste flour at 20% treatment. The feed conversion value obtained was 1.95 with a daily growth rate of 1.63%. The use of fermented food waste flour in Tilapia feed carried out by Sandra in 2020 [21], gave the best results in adding food waste flour by 30% with a yield growth rate of 1.57%, feed conversion ratio 0.53, and survival rate of 90%.

Apart from being used as flour, food waste is also used in maggot cultivation. Fahmi in 2015 [21] conducted a study to determine the effect of the use of market waste, palm oil cake, and fish waste on the nutrient content of maggot which will be used as feed for carp. The results obtained, the maggot which was fed in the form of a mixture of market waste, oil palm cake, and fish waste had a protein content of 60.56% and 13.56% fat.

UTILIZATION OF FOOD WASTE AND REGULATION IN OTHER COUNTRIES

Westendorf [18], stated that in New Jersey, US has been using food waste as feed for farmed pigs since 1914. The food waste was obtained from New York, Newark, and New Jersey, then in 1919 the New Jersey Agricultural Experiment Station (NJAES) where the results of the research are then used as the basis for making regulations for food-waste feeding or what is known as the Swine health protection act garbage feeding final rules [18; 23]. Another study was conducted by Mourad [22], in his paper explaining that the United States and France are both preventing increased food waste production by using the "Food Recovery Hierarchy" cam-

paign, by implementing prevention (optimizing process for reducing waste from source), recovery (redistributing food for people who needed) and recycling (converting food waste to animal feed, produce energy or compost). Several regulations and supporting infrastructure have begun to be placed alongside roads in big cities to increase public awareness of collecting food scraps and composting food waste, this is because the collection of leftovers will be used as animal feed and partly used as compost, both solutions it is the best way to reduce food waste buildup and is the safest and healthiest way for major cities in the United States and France.

Apart from countries in Europe and America, several countries in Asia such as South Korea, Japan, and China are also recycling food waste. In 1995, South Korea implemented a Volume-Based Waste Fee System program, this system was successful to increase the waste recycling rate to 40.9% in 2005 [27] and most recently, in 2013, regulations for people to collect food waste into biodegradable bags and each household will be charged the cost of the food waste produced [28]. Those few regulations making South Korea as a country that manages food waste well, they can reuse food waste with a percentage of 94.7%, 40.55% of the waste is used as animal feed, 49.52% as compost and 9.93% processed into other products [24]. The treatment for food waste before it is processed into animal feed is heated for 30 minutes with a minimum temperature of 80°C [23].

Japan is one of the countries that can manage food waste well, in the 1990s the concept of the Sound Material-Cycle Society was developed for waste management and policy of recycling [25]. Japan has introduced the Food Waste Recycling Law in 2011, this law used to regulate the collection, transport, and storage of food waste [23]. With these concepts and regulations, Japan was successful in recycling 24.58% of total food waste and 47% has been recycled into animal feed [24]. Ecofeed is the name of the product of animal feed made from recycled food waste in Japan, the treatment before processing food waste into animal feed is heated for 30 minutes at 70°C or 3 minutes at 80°C and does not use ingredients of mammal, poultry and fish protein for ruminants [26].

China is one of the countries that has started to utilize food waste and most of the waste is processed into compost, but other solutions are needed in managing food waste. One solution is to use it as animal feed, including fish [23]. China has no rules or established a system to collecting waste, that food waste is mixed with other waste [29], based on research reported that food waste separation from other waste only 15% [30] this is the reason for the use of food waste in China not maximal. Treatment carried out on waste before it is managed is by heat drying for feed safety because heat exposure inactivates most pathogenic viruses, besides processing by bioconversion using Black soldier fly is also chosen because it has safety in terms of health and does not disturb humans [24].

IMPLEMENTATION CHALLENGES IN INDONESIA

There are several challenges in managing food waste in Indonesia, the first is that no regulations are governing the collection and management of food waste, even in Indonesia, there is no specific definition of food waste [31] so that in managing food waste it is still mixed with other ingredients. Besides, based on other research, it was found that only 40% of the total waste entered the TPA, the rest was processed by the community by burning (35%), buried in the ground (7.5%), and composting (1.61%) [19]. This explains that the Indonesian people are still not aware of the importance of sorting and processing waste including food waste, this problem needs to be handled properly, considering that waste is one of the problems in Indonesia. In addition, no regulations are governing the processing of food waste into animal feeds (including fish feed), so there are no references, initial treatment that must be carried out, and standardization of food waste that is suitable for use in its manufacture.

CONCLUSION

The increasing population density in Indonesia has an impact on the production of food waste which also increases, so there is a need for a solution so that this waste does not become a new problem. Utilization of food waste into fish feed is one way that can be used, apart from overcoming environmental and health problems, the conversion of food waste into fish feed will also be a solution for the availability of feed for aquaculture activities in Indonesia. South Korea, the USA, Japan, and China can be used as examples in managing food waste into fish feed, this is because these countries can be said to have succeeded in using food waste into other products such as animal feed, energy, and compost. It is necessary to make regulations governing food waste management in Indonesia so that it becomes the main reference in making fish feeds and there is also a need for increasing public awareness in sorting waste and continuing to strive to carry out the 3R (Recycle, Reuse and Reduce) campaign.

Acknowledgment

The author would like to thank Dr. Yuli Andriani, S.Pi., MP as the promoter in research on the utilization of organic waste to fish feed and also to all of the people who help the author in compiling this review paper.

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