Fish waste as a resource: An approach to lessen the impact of improper solid waste management in the Philippines

Sheralyn, T. De Ungria, Lara Therese T. Fernandez, Sophia Ellise F. Sabado,
Jeano Paulo E. Santos, Allysa Rose B. Sararaña,
and Chona Camille V. Abeledo,
De La Salle University Integrated School, Manila

Abstract: Improper solid waste management of fish waste contributes to the pollution leading the Comprehensive National Fisheries Industry Development Plan to declare that the Philippine aquaculture industry is unsustainable. The utilization of waste promotes a circular economy, whereby products are reused indefinitely in order to eliminate waste and boost sustainability in the fish industry. This study consists of surveys and interviews with fish vendors to determine the most efficient methods of reusing and disposing fish waste, and which of these are feasible within the Philippines, specifically Metro Manila. The data gathered could be useful in the creation of policies recommending ways on repurposing fish waste and promoting a circular economy. From the responses gathered, wet market fish stalls in Metro Manila produce 1.8 tons of fish waste a year, wherein the majority claimed that it was managed by being collected by garbage collectors and segregated; however, the protocols and practices of the interviewed wet markets were inconsistent. As implementation of protocols are not strictly enforced, current waste management methods remain ineffective in reducing solid waste. Therefore, educating those in the fish industry, enacting methods to recycle fish waste, and recommending them to LGUs would prove effective in developing a circular economy while providing another source of income for the fish industry.

Key Words: fish waste; waste management; valorization; sustainability; wet market

1. INTRODUCTION

A circular economy follows the principle of reducing the usage of raw materials, reusing materials to create new products, and recycling existing ones; it minimizes hazardous impacts to the environment without stopping economic growth (Johansson & Henriksson, 2020). In the 35,000 tons of municipal solid waste being generated every day, 15 to 60% of the uncollected waste is found polluting bodies of water in the Philippines (Plaza, 2017). Despite the approval of RA 9003 or "Ecological Solid Waste Management Act of 2000" aimed to institute sustainable development by creating a comprehensive solid waste management (SWM) program; however, local government units (LGUs) have been unable to comply with the standards that the republic act requires (Castillo & Otoma, 2013). Due to improper waste disposal, the Comprehensive National Fisheries Industry Development Plan (CNFIDP) declared the Philippine aquaculture industry as unsustainable wherein fish waste such as bones, fins, skin, and scales, is one of the causes.

This study seeks to identify the actual amount of fish waste generated in the wet markets of Metro Manila, the existing SWM plans being implemented, and to find methods of converting fish waste into useful products to contribute to the development of a circular economy. The valorization of fish by-products play an essential role in conserving marine resources, and solutions should be implemented to avoid the pointless discarding of valuable biomass (Lopes et al., 2015). This will help alleviate excessive solid waste production, promote a circular economy, and provide new sources of useful material such as animal feed, fertilizer, biopolymer extracts, and collagen for the utilization and usage of other special fields within the food, medicinal, cosmetic, and agricultural industries.

2. METHODOLOGY

2.1 Sampling and Data Collection Methods

Purposive sampling was used in selecting the 40 fish vendors who manage stalls in the wet markets of Metro Manila. Their perspectives about the processes of waste disposal, their knowledge of SWM policies, and possible uses for fish waste byproducts were obtained from interviews and survey questionnaires, while the average of fish waste produced in the Philippines every year, along with the frequency of its valorization after disposal were

acquired through extensive literature from various studies using 71 books, academic journals, and theses, collectively. Interviews were conducted with the help of family members and friends, who are able to go outside following quarantine protocols, by way of face to face verbal surveys in Metro Manila wet markets. Php 50.00 of prepaid load was given to each participant days after conducting the interview. Guide questions were given to the participants a few minutes prior which had given them ample time to prepare their answers. The overall interview process lasted from late November to late December.

The interviewees were asked to provide personal information such as job position, job experience (e.g. years in current job), and province or city of origin. They were given the choice to provide their name or age as long as they were aware of the risks and confidentiality of the study. The participants were interviewed on the same day and their responses were recorded and transcribed.

2.2 Data Analysis Strategy

The Framework Method was the data analysis strategy used for this study (Gale et al., 2013). Firstly, the data collected were manually categorized and grouped based on the similarities of the responses. Secondly, the organized data were illustrated into a framework showing the full process of fish waste disposal and currently practiced valorization methods. The framework was then used for cross-referencing to identify loopholes in current disposal practices and policies such as where the unused fish waste ends up and how it is handled. Following the identification of these issues, methods of reusing fish waste that Southeast Asian industries can profit from were determined. These can serve as a basis for the creation of a policy paper which implements a circular economy through an improved solid waste management system by the Philippine fish industry.

3. RESULTS AND DISCUSSION

3.1 Results

The data from the surveys state that the majority of fish waste produced in the wet market are innards, gills, and scales that are produced on a daily basis (Fig. 4.3.1a and Fig. 4.3.1b).

The data from the surveys state that the majority of fish waste produced in the wet market are innards, gills, and scales that are produced on a daily basis (Fig. 4.3.1a and Fig. 4.3.1b).

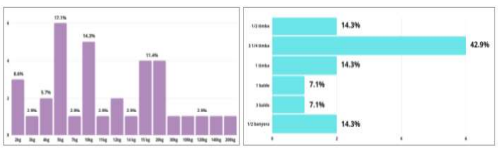

Fig. 4.3.1a *Weight of Fish Waste produced (kilograms), and b. Weight of Fish Waste produced (containers)*

With the amount of fish waste produced, 40% of respondents stated that their customers ask to acquire the fish waste for free, while some opt to buy it (22.5%). However, 37.5% of the respondents stated that fish waste isn't acquired from their stalls at all. In the stalls wherein fish waste is actually obtained, most customers buy around 1 to 2 kg of fish waste (Fig. 4.6.1a and Fig. 4.6.1b).

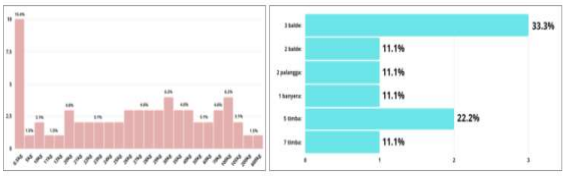

Fig. 4.6.1a. *Weight of Fish Waste thrown out (kilograms) and b. Weight of Fish Waste thrown out (containers)*

For fish waste that is thrown, 58.1% of the responses claim the waste is taken by garbage collectors or dump trucks, followed by the waste being given away (19.4%). Under SWM methods, the majority responded that waste produced by the vendors' stalls is collected by waste collectors (45%) and segregated (42.5%) while the rest stated it was maintained, unmanaged or given away, or that they did not know. Almost half of the respondents state that government units are responsible for managing wastes produced by vendors' stalls.

Most of the targeted wet markets implement policies like keeping the area clean (24.4%), placing waste proper containers (24.4%), and practicing proper disposal (15.6%) and segregation (13.3%). However, 20% claim that no such protocols are being implemented.

Regarding sanctions charged, the majority of the respondents (72.5%) stated that no penalties were imposed in their wet markets, while others (22.5%) claimed that penalties were given. These include being fined (55.6%), being given memos (22.2%), and other means of penalties accordingly.

The summary of responses for the possible uses for fish waste were animal food (63.6%) and fertilizer (11.4%). Several respondents also answered that there were no other uses for fish waste (9.1%) or that they did not know (9.1%).

3.2 Discussions

From the responses of the fish vendors, the specific parts of dead fish frequently being thrown were deemed as having little to no commercial value (Ahuja et al., 2020), hence being considered useless and labelled as "fish waste." This data supports the claim that the public market is the source that generates the most amount of solid waste (Environmental Management Bureau, 2016) as they produce fish waste on a daily basis, accumulating roughly 1.8 tons of fish waste a year. There are customers who obtain 1.5kg of fish waste everyday on

average, where 62.5% of them opt to utilize the fish waste, meaning each customer is able to repurpose around half a ton of fish waste annually and consequently reduce the amount of solid waste produced.

Among the 10 wet markets, five had inconsistent practices as there were varying practices in each, even though responses show that there were existing implementations in these markets. On the other hand, two among these have inconsistent practices and implementations as responses exhibit that only some practice them while a few are not aware or claim that there are none. While responses from one market were consistently observing one practice showing consistent presence of implementation, responses from another were consistently claiming there were no implementations. SWM methods in these markets correspond to the SWM program under RA 9003 where waste segregation and collection of solid waste are listed to manage solid waste (Aquino et al., 2013). Aligned with this is the assistance of LGUs in implementing SWM systems (Castillo & Otoma, 2013). Since more than half of the respondents gave the responsibility to market management or the store owner, it can be said that the LGUs have failed in leading the implementation of this program.

Although penalties are supposed to be imposed according to RA 9003 and Presidential Act No. 825, the majority of respondents claimed that there are none or were found to be unaware of the penalties. This proves that SWM is ineffective due to insufficient efforts by government agencies in implementing such penalties (Ngoc & Schnitzer, 2009). Despite the consequences per violation, this data implies that there is inadequate cooperation from citizens or fish vendors in waste collection methods (Environmental Management Bureau, 2018).

While a smaller percentage of fish vendors are unfamiliar with the alternate uses of fish waste or believe they have no uses, a significant portion managed to offer their knowledge related to repurposing their waste. Regarding utilization processes, results of this study show that 8 out of 10 fish vendors within Metro Manila have knowledge on repurposing fish waste as feed, fertilizer, leftovers, and clothing designs as their method of reducing the waste they produce.

Amongst the given alternative uses of fish waste obtained from the interview data, other unmentioned uses such as sources for biofuels and biopolymer extracts were found through extensive research. In this case, the methods of creating animal feed, fertilizer, leftovers, clothing designs, biofuels, and biopolymer extracts from fish wastes were further investigated. First, there are two types of animal feed that can be reprocessed from fish waste — fish silage, a wet by-product liquefied by enzymes and acids (Zynudheen & Binsi, 2018), and fish meal, a by-product that is minced, cooked, and pressed to separate the solid cake from the liquid phase (Plazzota & Manzocco, 2019). Second, seeing that fish waste is rich in nutritive soil elements, decomposes rapidly, and is compatible with organic production systems, fish waste is a suitable material as fertilizer (López-Mosquera et al., 2011; Illera-Vives et al., 2015). Third, leftover fish parts can be used in meals such as chowder, stew, stock and more. Fourth, clothing such as leather can be produced from fish skin, an ancient tradition practiced by indigenous Arctic groups (Palomino et al., 2019). Fifth, through the method of fish waste conversion with transesterification — wherein the biomass reacts with alcohol — a nontoxic, pollution-free, and biodegradable biofuel can be created (Knothe et al., 2015). Lastly, since seafood by-products are a great source of biopolymers, certain extracts like chitin, chitosan, and collagen can be obtained depending on the method of extraction on a specific type of fish waste (Diez-Pascual, 2019). The methods to extract chitin, chitosan, and collagen include centrifugation, N-deacetylation and deacytylation, and demineralization, respectively (Korma et al., 2016; Majekodunmi, 2016).

4. CONCLUSIONS

Throughout the research, the following objectives were accomplished:

The current state of fish waste management within the wet markets of the Philippines was observed by identifying the amount and frequency of waste produced, SWM practices, and the extent of the fish vendors' knowledge in fish waste valorization methods.

Methods of repurposing fish waste produced by wet markets were compiled and practices feasible in the Philippines and Southeast Asia were determined.

5. ACKNOWLEDGMENTS

We wish to extend our sincerest gratitude to our families, for their love, patience, unwavering support, and helpful participation, especially in providing the funds for our research and help in conducting interviews with the fish vendors. Together with the fish vendors, for participating in our study and sharing their time during their work hours to help us obtain data for our research.

6. REFERENCES

Ahuja, I., Dauksas, E., Remme, J. F., Richardsen R., & Løes, A. (2020). Fish and fish waste-based fertilizers in organic farming—with status in Norway: A review.

Waste Management, 115, 95-112. https://doi.org/10.1016/j.wasman.2020.07.025

Aquino, A. P., Derequito, J. A. P., Festejo-Abeleda, M. A. (2013, December 9). Ecological solid waste management act: Environmental protection through proper solid waste practice. https://ap.fftc.org.tw/article/588#:~:text=Waste%20mismanagement%20has%20serious%20environmental,garbage%20problems%20in%20the%20country.

Castillo, A., & Otoma, S. (2013). Status of solid waste management in the Philippines. https://www.jstage.jst.go.jp/article/jsmcwm/24/0/24_677/_pdf.

Diez-Pascual, A. M. (2019). Synthesis and applications of biopolymer composites. International Journal of Molecular Sciences, 20(9), 1-7. https://doi.org/10.3390/ijms20092321

Environmental Management Bureau. (2016). National Solid Waste Management Strategy 2012-2016. https://nswmc.emb.gov.ph/wp-content/uploads/2016/07/NSWM-Strategy-2012-2016.pdf

Environmental Management Bureau. (2018). National solid waste management report. https://emb.gov.ph/wp-content/uploads/2019/08/National-Solid-Waste-Management-Status-Report-2008-2018.pdf

Gale, N.K., Heath, G., Cameron, E., Rashid, S., & Redwood, S. (2013). Using the framework method for the analysis of qualitative data in multi-disciplinary health research. BMC Medical Research Methodology, 13(117), 1-8. https://doi.org/10.1186/1471-2288-13-117

Illera-Vives, M., Seoane Labandeira, S., Brito, L.M., López-Fabal, a., López-Mosquera, M.E. (2015). Evaluation of compost from seaweed and fish waste as a fertilizer for horticultural use. Scientia Horticulturae, 186, 101-107. https://doi.org/10.1016/j.scienta.2015.02.008

Johansson, N. & Henriksson, M. (2020). Circular economy running in circles? A discourse analysis of shifts in ideas of circularity in Swedish environmental policy. Sustainable Consumption and Production, 23, 148-156. https://doi.org/10.1016/j.spc.2020.05.005

Knothe, G., Krahl, J., & Van Gerpen, J. (Eds.). (2015). The biodiesel handbook. Elsevier.

Korma, S. A., Kamal-Alahmad, Niazi, S., Ammar, A., & Alyousef, H. (2016). Production, classification, properties and application of chitosan. International Journal of Research in Agricultural Sciences, 3(3), 2348-3997.

Lopes, C., Antelo L. T., Franco-Uria, A., Alonso, A. A., & Pérez-Martín, R. (2015). Valorisation of fish by-products against waste management treatments – Comparison of environmental impacts. Waste Management, 46, 103-112. https://doi.org/10.1016/j.wasman.2015.08.017

López-Mosquera, E., Fernández-Lema, E., Villares, R., Corral, R., Alonso, B., & Blanco, C. (2011). Composting fish waste and seaweed to produce a fertilizer for use in organic agriculture. Procedia Environmental Sciences, 9, 113–117. https://doi.org/10.1016/j.proenv.2011.11.018

Majekodunmi, S. O. (2016). Current development of extraction, characterization and evaluation of properties of chitosan and its use in medicine and pharmaceutical industry. American Journal of Polymer Science, 6(3), 86-91. http://article.sapub.org/10.5923.j.ajps.20160603.04.html

Ngoc, U. N., & Schnitzer, H. (2009). Sustainable solutions for solid waste management in Southeast Asian countries. Waste Management, 29(6), 1982-1995. https://doi.org/10.1016/j.wasman.2008.08.031

Palomino, E., Káradóttir, K., Rhame, L., & Boon, J. (2019). Indigenous arctic fish skin clothing traditions: Cultural and ecological impacts on fashion higher education. https://www.researchgate.net/publication/334224302_Indigenous_Arctic_Fishskin_clothing_traditions-_Cultural_and_ecological_impacts_on_Fashion_Higher_Education_Cumulus-Rovaniemi

Plaza, A. B. (2017, October 13). Ditch NIMBY to fix Philippines' municipal solid waste problem. https://blogs.adb.org/blog/ditch-nimby-fix-philippines-municipal-solid-waste-problem

Plazzota, S. & Manzocco, L. (2019). 10 - food waste valorization. Saving Food: Production, Supply Chain, Food Waste, and Food Consumption, 279-313. https://doi.org/10.1016/B978-0-12-815357-4.00010-9

Zynudheen, A. A. & Binsi, P. K. (2018). Fish processing waste: Valuable raw material for silage, foliar spray and animal feed preparation. http://drs.cift.res.in/bitstream/handle/123456789/4486/Fish%20processing%20waste.pdf?sequence=1