INNSPUB

International Journal of Biosciences | IJB |
ISSN: 2220-6655 (Print) 2222-5234 (Online)
http://www.innspub.net
Vol. 24, No. 6, p. 147-153, 2024

RESEARCH PAPER OPEN ACCESS

The horticultural characteristics assessment of Pechay (*Brassica rapa*) using fish and fish waste based-organic fertilizer fermented with molasses

Sheenah N. Domingo, Hannah Jane Bendejo, Maria Danesa S. Rabia*

Bohol Island State University, Calape, Campus, Calape, Bohol, Philippines

Key words: Assessment, Fish and fish waste, Horticultural, Organic fertilizer

http://dx.doi.org/10.12692/ijb/24.6.147-153 Article published on June 10, 2024

Abstract

Nowadays, great amount of waste is being produce in the fish markets and processing industries. This study aims to find out the effect of using fish and fish waste as organic fertilizer on the growth of pechay. The study was arranged in a randomized setup with three (3) treatments and three (3) replications, each treatment has 30 samples. Among the treatments are T_1- 50g/5g, T_2-150g/10g and T_3- 200 g/15 g). The study uses the one-way ANOVA. Results showed that T_3 has the highest total mean growth of 16.4 cm and 15.77 cm in length compared to T_2 and T_1. The size of the leaves recorded with 14.37 cm and 7.96 cm wide. A 100% survival rate was obtained in all treatments. Significant difference was observed in the size of the leaves, other showed not significant results. The result is a good potential for adoption, especially it would benefit to the local farmers.

* **Corresponding Author:** Maria Danesa S. Rabia ✉ mariadanesa.rabia@bisu.edu.ph

Introduction

In recent years, the fish industry has generated a substantial amount of fish waste. Depending on the level of processing or type of fish, 30–70% of the original fish is fish waste. Circular economy and organic farming concepts were used to evaluate the potential of producing fertilizers from captured fish. Fertilizers produced from captured fish promote the recycling of nutrients from the sea and back to terrestrial environments. The nutritional composition of fish waste is assessed to determine the potential to supply plant nutrients such as nitrogen, or a combination of nitrogen and phosphorous, or to enrich a compost. In the research of Kenhudoy (2017) on the benefits of using fish and animal wastes as fertilizer, fish waste as soil fertilizer offers an organic solution and effectively provides nutrients to the soil for a blossom harvest. Even though some of the fish products have an unpleasant smell, they do have a lot of benefits for the crop, making them a healthy food source. Native Americans showed pilgrims how to use fish to fertilize their crops. From current findings, it is proven that the Native Americans were right about the benefits of using fish fertilizer.

Production and information about processing the fish waste were illustrated in the Organic Materials Review Institute (OMRI), indicating also the fish-based fertilizers industry and research in Europe. Converting fish waste like fish entrails into liquid fertilizer can be used to water or drench the plants. This liquid fertilizer could last for up to a year. The liquid produced in the fermentation process is called fish emulsion. The two main ingredients to make the emulsion are fish guts (entrails) and molasses. If molasses is not available, brown sugar is a good substitute. It is a sucrose product with a distinctive brown color due to the presence of molasses. The methods used in the processing of fish waste to produce fish emulsion, fish hydrolysate/fish silage, fish compost, and digestate from anaerobic digestion or co-digestion are presented in the study of Ahuja *et al.* (2020). The accumulation of fish waste should be a source of concern because it can pollute the water (Kusuma *et al.*, 2019). It can be turned into organic manure, which is beneficial to fish farmers and sellers who discard fish waste (Jayvardhan, 2020). It is essential to treat fish waste to minimize the environmental effects (Kusuma *et al.*, 2019). If we can properly dispose of it so that it can decompose, we can create jobs and make money by selling the manure.

On the other hand, the culture of pechay (*Brassica rapa*) in the Philippines is one of the fastest-growing vegetable industries. It is an important vegetable crop and has nutritional value as well as good commercial value. One of the most popular vegetables among consumers is always available in the market at any time of the year. It is known as one of the oldest vegetables in Asia; it therefore plays an important role in the Philippines' economy as well as in the nutrition of the Filipino people. Pechay is used mainly for its immature, but fully expanded, tender leaves. The succulent petioles are often the preferred part. It is used as the main ingredient for soups and stir-fried dishes. In Chinese cuisine, its green petioles and leaves are also used as a garnish (Gonzales *et al.* 2005). On the other hand, our government agencies like the Department of Agriculture encourage Filipino farmers to switch to an alternative and healthy way of marketing high-value crops to have a higher income. Several practices are being taught, like going back to basics and using organic fertilizers rather than inorganic or synthetic ones. Fermented fish entrails are another alternative medium used as a substitute for economically important and easy growing vegetables like pechay and sweet pepper in this study.

There are several studies using fermented fish entrails mixed with fish molasses (Rabia, 2022), and even decomposed seaweeds and the bark of pine trees have been documented. In the study conducted by Diaz *et al.* (2011) on the growth and yield response of bell pepper to fish fertilizer and fermented fish juice as organic fertilizer, they found that fish gill emulsion fertilizer is comparable to commercial or synthetic fertilizers. It may be one of the best fertilizers to utilize for growing bell peppers. The compost made from fish waste has the added benefit of containing

potassium, calcium, and magnesium. Composting is a biotransformation process that involves microorganisms converting organic materials into stable and complex macromolecules. It can be used as a soil enhancement to increase the texture and fertility of the soil, reducing the need for synthetic fertilizers (Maja *et al.*, 2019). This waste can be helpful and valuable fertilizer in agriculture (Jayvardhan, 2020). No foul odors were detected in the fish waste fertilizer (Maja *et al.*, 2019).

Molasses is a primary by-product in the fermentation industry and can be used in the food industry, such as in distilleries, sugar production, and yeast production (Li *et al.*, 2020). It was high in calcium, magnesium, iron, and potassium. It also contains sulfur and a host of micronutrients (Susan Patterson and Master Gardener). Molasses has been used in the past as fertilizer on sandy soil and soil with poor structure (Pyakurel *et al.*, 2019). Using molasses as a fertilizer provides plants with a quick source of energy and encourages the growth of beneficial microorganisms. When molasses is added to organic fertilizers, it provides food for the healthy microbes in the soil (Susan Patterson, Master Gardener). Molasses supplies carbohydrates and alters the C:N ratio, which affects soil microbial ecology, lowers plant parasitic nematodes, and provides other favorable effects on plant growth (Hilty *et al.*, 2021). Molasses improves soil aggregation and reduces surface crusting in hard-setting soils (Wynne and Meyer, 2002). Molasses plant fertilizer is a great way to grow healthy plants, and as an added benefit, using molasses in gardens can help fend off pests. The fermentation process converts the solid substrates into simple molecules with the help of microbes. It is one of the promising technologies that converts fish waste into useful organic manure, an expensive resource for agriculture, without the formation of a fusty smell.

One of the problems encountered by some farmers nowadays is their inability to harvest crops on time and the low quality of the produce, particularly some leafy vegetables. Some fishermen also encountered challenges in the disposal of fish waste, which is very abundant in the locality. Many factors cause distractions in our world today, like pollution, inadequate solid waste disposal, global warming, climate change, and many others that affect our economic and environmental aspects. Our agricultural sector is widely affected by these problems. So, most of our farmers in the country use inorganic or synthetic fertilizers to boost plant resistance and improve or multiply their yield compared to the usual or natural cycle.

Fish are consumed as food in fresh conditions. Some of them are also utilized after the preservation. During preservation and processing, some materials from fish and prawns are discarded as waste. Similarly, some trash and distasteful fish are unsuitable for human consumption. These waste materials and the above fish become an important source for producing fish by-products, which in turn are used to produce different useful fish by-products. Organic agriculture or organic farming seeks to provide good quality and healthy foods while not harming the environment, maintaining soil fertility, and using synthetic materials. There is a growing demand for organic products in both local and global markets that is likely to be significant in the future. Fertilizers produced from captured fish promote the recycling of nutrients from the sea and back to terrestrial environments. The nutritional composition of fish waste is assessed to determine the potential to supply plant nutrients such as nitrogen, or a combination of nitrogen and phosphorous, or to enrich a compost. Methods used in the processing of fish waste to produce fish emulsion, fish hydrolysate/fish silage, fish compost, and digestate from anaerobic digestion or co-digestion are presented.

With these, siganids are the most abundant fish in the locality; with the common name of rabbitfishes, they are essential to reef herbivores that browse individually or in schools over the reef or feed on plankton within the water column (Nelson, 1994; Kenhudoy, 2017). Siganids' fish waste weighs from 10

to 20 grams per fish, depending on the size of the fish. It contains the nutritional contents found in rabbit fish, which are amino acids, fatty acids, protein, vitamins, and other essential minerals. According to the International Food Research Journal in Indonesia, samples of fish filleted without skin contained 77.79% moisture, 15.93% protein, 1.01% ash, and 0.93% fat. Rabbit fish also contained nine (9) essential and seven non-essential amino acids. Glutamic acid was the most abundant amino acid with a level of 1.983 mg/100 g. The eicosatetraenoic acid (EPA), docosahexaenoic acid (DHA), and arachidonic acid (ARA) quantities were 0.54%, 6.45%, and 1.21%, respectively. So, these ideas trigger the researchers to use the fish waste as fertilizer in the culture of vegetables, particularly the pechay, which is considered an economically important crop because it is easy to grow, is available throughout the year, and is both an excellent source of different nutrients. This research study aims to determine the performance of pechay (*Brassica rapa*) grown in a container using fermented siganid entrails as organic fertilizer. This study also aims to determine the effects of using fish waste as organic fertilizer on the productivity of vegetable production. These could also have the potential for the replacement of other dried poultry manure from conventional farming in organic farming.

Materials and methods

Research design

The researchers used experimental research methods. A factor design was used and laid out in a randomized complete block design (RCBD). There are three treatments T_1- 50 g/5 g, $T_{2:\ 150\ g/10\ g,}$ and T_3- 200 g/15 g) with three replications and 90 samples per treatment. The data was subjected to a one-way ANOVA to determine if there was a significant effect among the treatments.

Research materials

The following research includes 180 identically sized pots for growing pechay—90 pots per treatment per replication. In fermented entrails, muscovado sugar was used for the molasses solution, and vacuum-sealed containers were used during the fermentation period.

Research procedure

Soil preparation

The ten kilos of garden soil were mixed with five kilos of carbonized rice hull and five kilos of cow manure. The ratio is 2:1:1. Filling the pots with an equal amount of soil. After this, it was watered regularly to maintain its moisture.

Planting

The seeds of pechay were obtained from the Department of Agriculture office. The seed were sown in the seed box, after two weeks, seedlings are ready for pricking and a week after transplanting was done in treated pots with culture media. The plant was set 1 inch below the surface and was covered with soil and watered.

Fertilizer formulation

The fish and fish waste based organic fertilizer was formulated. The fish entrails were collected from the market using Siganid fish. The fish waste was then cleaned, including the guts (entrails), and placed in a container or a basin. Chopping of other fish entrails was also done using the food processor. The chopped and collected fish entrails were placed in the container. The container is tightly sealed with a lid. The following treatment mixture was followed, for treatment 1: 50 grams of fish entrails are added with 1 tablespoon of sugar; treatment 2: 150 grams of fish entrails are added with 2 tablespoons of sugar; and treatment 3: 200 grams of fish entrails are added with 3 tablespoons of sugar. Then, it was mixed for 5 minutes and stored at room temperature away from direct sunlight. The mixture was open every other day. The microbes in the concoction release gases during the fermentation process. The mixture was left out for two weeks (Fig. 1).

Water dilution

After two weeks, the fermented mixture was filtered to remove the undecomposed fish waste. A measure of 200 ml per treatment was diluted with

1 liter of rainwater and was used as daily fertilizer for the plant.

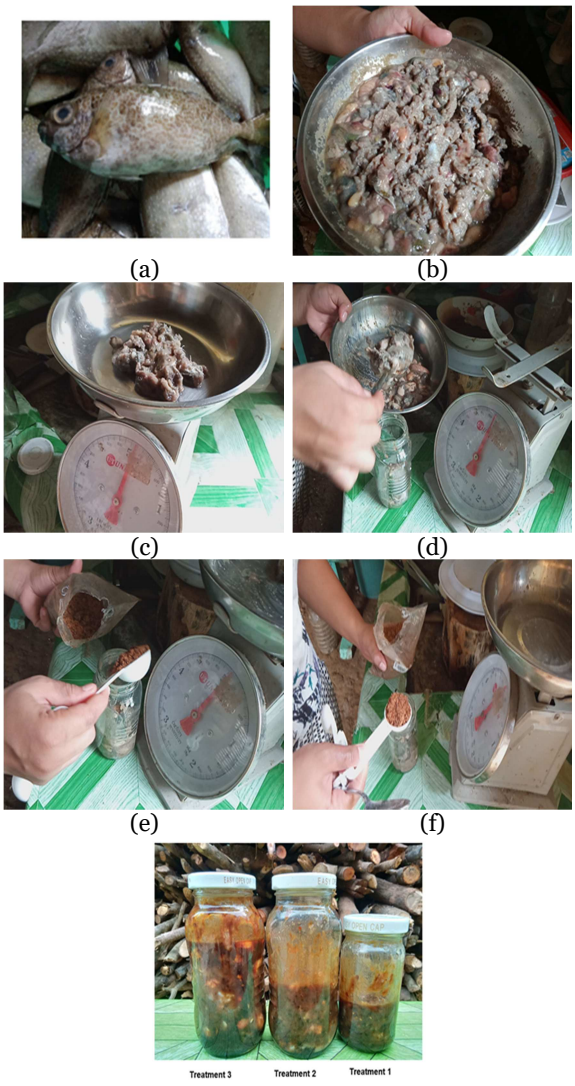

Fig. 1. Preparation of Fish and Fish-Waste Based Organic Fertilizer (steps-by-steps)

(a) Collection of fresh fish entrails (FE); (b) collecting and sorting of fish entrails; (c) set-up and weighing of FE according to treatment; (d) preparing the glass and pouring the FE; (e) putting of muscovado sugar as molasses; (f) continue the preparation per treatment; and (g) the set up.

Application of treatment

The solution was used as fertilizer and applied using drench method. Since the solution is organic, it was applied twice a day, early in the morning and late in the afternoon.

Collection of data

The growth characteristics, including the plant height, number of leaves, size of pechay leaves (length), and size of pechay leaves (width), were collected weekly. In determining the plant's height, it is measured in centimeters using a ruler; the same is true for the size of the leaves, which are measured by their length. In determining the width of the plants, measuring their diameter is usually good only for about a month after they are planted to achieve their fresh stage and not exceed their maturity. This was done for every plant under every treatment. The data were subjected to statistical treatment.

Research environment

The study was conducted in Barangay Cabayugan, Calape, Bohol. Cabayugan is a mountain barangay in the municipality of Calape, on the boundary of almost four (4) municipalities, namely, Antequera, San Isidro, Loon, and Calape, in the province of Bohol. The coordinates are 9.8388 and 123.032 on Bohol Island, and the elevation at these coordinates is estimated to be 288.2 meters. The area is very nice and known as the "vegetable basket" of the town.

Results and discussion

The percentage of survival of the pechay was recorded during the termination period. All samples, regardless of treatment, had a 100% survival rate. Pechay with treatment 3 (200 g/3 tbsp) was found to obtain the highest total mean growth of 16.4 cm in terms of height, 15.77 cm in terms of the number of leaves, 14.37 cm in terms of the size of leaves (length), and 7.96 cm in terms of the size of leaves (width) (Table 1). On the other hand, it is followed by pechay, with treatment 1 (50 g/1 tbsp) obtaining the growth of 15.98 cm in terms of height, 5.93 in terms of the number of leaves, 14.48 cm in terms of the length of leaves, and 6.74 cm in terms of the width of leaves. Pechay with treatment 2 (100 g/2 tbsp) obtains 15.97 in terms of plant height, 5.9 in terms of the number of leaves, and a total mean of 14.03 cm in terms of leaf length and 7.36 cm in terms of leaf width.

Table 1. The growth characteristics (plant height, number of leaves, size (length), size (width) of the potted pechay (*Brassica rapa*) using fermented fish entrails molasses as fertilizer

Treat.	Replication												Mean			
	1				2				3							
	Plant height	No. of leaves	Size (L)	Size (w)	Plant height	No. of leaves	Size (L)	Size (w)	Plant height	No. of Leaves	Size (L)	Size (w)	Plant height	No. of leaves	Size (L)	Size (w)
T_1-50g/5g	14.71	5.8	13.38	7.02	15.7	5.7	14.21	6.47	17.53	6.3	15.86	6.72	15.98	5.93	14.48	6.74
T_2-150g/10g	15.03	5.7	13.22	7.39	15.86	6.2	14.03	7.21	17.02	5.8	14.83	7.49	15.97	5.9	14.03	7.36
T_3-200 g/15g	15.39	6.1	13.73	8.05	16.35	5.6	14.18	7.91	17.46	5.6	15.2	7.92	16.4	5.77	14.37	7.96
CV	2.26	3.54	1.94	6.97	2.12	5.51	0.68	10.01	1.59	6.11	3.41	8.24	1.52	1.45	1.64	8.30

Treat. = Treatment, @ 0.05 level of significance

In terms of plant height, there is a significant difference in using the fish entrails with sugar as fertilizer applied to the pechay plants. In terms of the number of leaves, no significant difference was observed among the treatments. The leaf count is almost the same for the different treatments being used. In terms of the size of the leaves and the length of the leaves, there is a significant difference in using fish entrails with sugar as fertilizer applied to the pechay plant. Fish fertilizers are a good source of nitrogen, phosphorus, and potassium, which are essential for the growth of plants, especially leafy vegetables. In the width of the leaves, there is no significant difference between plants applied with different treatments.

The by-product utilization that can be proposed is the use of siganids' entrails with sugar as an alternative fertilizer. Conclusion Based on the findings, researchers made the following conclusion: During termination, the plants in all treatments survived with no mortalities. Pechay fertilized with siganid entrails and sugar shows that the said treatments could be an alternative fertilizer source for pechay. The result of the test in hypothesis on the growth performance of pechay cultured in identically sized pots with the three treatments in terms of height, number of leaves, and size of leaves would be beneficial to the farmers in terms of being able to fertilize.

Conclusion

There is a greater potential for adoption and replication of using fish and fish waste as organic fertilizer for pechay, as indicated in the horticultural assessment results of the plant.

References

Ahuja I, Dauksas E, Remme J, Richardsen R, Løes A-K. 2020. Fish and fish waste-based fertilizers in organic farming – With status in Norway: A review. Waste Management **115**. 95-112. DOI: 10.1016/j.wasman.2020.07.025.

Diaz FA, Baladjay MJS, Tadle FC. 2011. The Growth and Yield Response of Bell Pepper (*Capsicum annum* L.) to Fish Fertilizer and Fermented Fruit Juice as Organic Fertilizer. https://www.scribd.com/doc/51372857/The-Growth-and-Yield-Response-of-Bell-Pepper-to-Fermented-Fruit-Juice-and-Fish-Fertilizer

Gonzales LM, Caralde R, Aban M. 2015. Response of Pechay (*Brassica napus* L.) to Different Levels of Compost Fertilizer. International Journal of Scientific and Research Publications **5,** 1-2250.

Jayvardhan VB. 2020. Devising of Organic Fertilizer from Fish and Crab Wastes: Waste to Best Technology. International Journal of Fisheries and Aquatic Studies **8(2)**, 01-05.

Hilty J, Muller B, Pantin F, Leuzinger S. 2021. Plant growth: the What, the How, and the Why. New Phytologist **232**, 25–41. DOI: 10.1111/nph.17610

Kenhudoy. 2017. Benefits of using fish and waste as fertilizer. Retrieved from https://steemit.com/gardening/@kenhudoy/benefits-of-using-fish-and-fish-waste-as-fertilizer-a-must-read. Accessed on September 2020.

Kusuma I, Syafrudin S, Yulianto, B. 2019. Utilization of Fish Waste Processing as Compost Raw Material in Tambak Lorok Market. E3S Web of Conferences **125**. 07004.
DOI: 10.1051/e3sconf/201912507004.

Maja R, Magdalena DV, Dana A, Martin B, Zbigniew M. 2019. Valorization of Fish Waste Compost as a Fertilizer for Agricultural Use. Waste and Biomass Valorization.
DOI: 10.1007/s12649-018-0288-8.

Nelson JS. 1994. Fishes of the World–Third Edition. New York, NY: John Wiley and Sons. Retrieved from https://www.cambridge.org/core/journals/journal-of-the-marine-biological-association-of-the-united-kingdom/article/js-nelson-fishes-of-the-world-3rd-edition-xvii-600p-john-wiley-and-sons-1994-price-6600/D29EA27EA193D17C458552ACF3EC29C0. Accessed on October 09, 2019.

Li S, Zhao X, Ye X, Zhang L, Shi L, Xu F, Ding G. 2020. The Effects of Condensed Molasses Soluble on the Growth and Development of *Brassica napus* through Seed Germination, Hydroponics and Field Trials. Agriculture **10(7), 260.**
https://doi.org/10.3390/agriculture10070260**.**

Pyakurel, Anish, Dahal BR, Rijal S. 2019. Effect of Molasses and Organic Fertilizer in Soil fertility and Yield of Spinach in Khotang, Nepal. Int. J. Appl. Sci. Biotechnol. **7(1)**, 49-53.
DOI: 10.3126/ijasbt.v7i1.23301.

Rabia MDS. 2022. Fish molasses as indigenous nutrient source in the growth and yield of economically important vegetables in simple nutrient addition program (SNAP) hydroponics system. International Journal of Biosciences **2(1)**, 155-162.

Waynne A. Meyer J. 2002. An Economic Assessment of Using Molasses and Condensed Molasses Solids as a Fertilizer in the South African Sugar Industry. Accessed on July 18, 2024 from https://www.semanticscholar.org/paper/AN-ECONOMIC-ASSESSMENT-OF-USING-MOLASSES-AND-SOLIDS-Wynne-Meyer/aab884d2b839f91b33c95496f74d219e3d92c0d7