INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH AND ANALYSIS

ISSN(print): 2643-9840, ISSN(online): 2643-9875

Volume 08 Issue 01 January 2025

DOI: 10.47191/ijmra/v8-i01-19, Impact Factor: 8.22

Page No. 148-155

Physicochemical Properties of Liquid Organic Fertilizer from a Mixture of Fish Waste and Coffee Grounds

Tatuk Tojibatus Sa'adah[1], Dwi Haryanta[2*]

[1]Faculty of Agriculture, Wijaya Kusuma University, Surabaya, Indonesia

[2]Faculty of Lecture Training and Education, Wijaya Kusuma University, Surabaya, Indonesia

ABSTRACT: Liquid fertilizer made from fish waste contains relatively high nutrients and effectively removes unpleasant odors during production. Coffee grounds are often used to remove unpleasant odors in rooms. This study aims to utilize coffee grounds to remove unpleasant odors in the production of liquid organic fertilizer from fish waste. The factorial experiment's first factor was the raw material for making liquid organic fertilizer (LOF), consisting of cow blood waste (P1) and fish waste (P2), while the second factor was the addition of coffee grounds at levels of 0% (K0), 10% (K1), 20% (K2), 30% (K3), and 40% (K4). The experiment was repeated three times using a completely randomized design (CRD). The results showed that adding coffee grounds at 20-30% of the total material could reduce the strong odor to a milder one, changing to a fermented smell at the end of the LOF production. Adding coffee grounds increased the macro and micronutrient content and reduced the C/N ratio in the resulting LOF. Adding 20-30% coffee grounds from the total raw materials is a solution to the problem of producing LOF from fish waste that remove unpleasant odors, while also utilizing coffee grounds that is usually discarded and can pollute the environment.

KEYWORDS: liquid organic fertilizer, fish waste, coffee grounds, unpleasant odor.

I. INTRODUCTION

The advancement of technology and industrialization in the fisheries sector has led to an increase in fish waste. Fish business operators dispose of waste in open areas, causing unpleasant odors that disturb the community (Jayvardhan & Arvind, 2020). Fish waste is rich in protein, organic carbon, flavonoids, magnesium, potassium, phosphate, and sulfate. Processing fish waste into organic fertilizer builds a utilization cycle for caught fish, where its waste is processed into fertilizer at a low cost in an environmentally friendly circular economy process (Coppola et al., 2021; Muscolo et al., 2022). Using organic fertilizer from fish waste mixed with manure effectively improves soil chemical properties (pH, organic carbon, and CEC) and the availability of N, P, and K in sandy soil. The effectiveness of increasing total soil N varies from 3242 to 7579%, available P varies from 1746 to 4069%, and K exchange value ranges from 87 to 2567% (Winarso et al., 2020). Liquid Organic Fertilizer from fish waste is used as a starter, and the resulting compost has organic C content of 5.17%; Nitrogen of 0.83%; Phosphorus of 0.48%; and Potassium of 0.16%, meeting SNI standards (Fahlivi, 2018; Kusuma et al., 2019).

Fish waste, consisting of heads, intestines, fins, bones, and uneaten fish, is a valuable resource for enhancing soil fertility and plant growth (Balraj et al., 2014). Fish waste extract at a concentration of 20 ml/l solution is the best treatment to increase cucumber growth, yield, and quality (Ellyzatul et al., 2018). LOF from blood waste and fish waste has higher nutrient content, improving the growth, yield, and nutrient content of eggplant, pakcoy, and mustard compared to POC from vegetable, fruit, sprout, and food waste (Haryanta et al., 2023). Catfish pond wastewater mixed with fish waste can be processed into LOF used as a medium for growing vegetables using an organic hydroponic system (Gustiar et al., 2022). Soil fertilization with fish waste fertilizer significantly increases nitrogen, phosphorus, potassium, sodium, calcium, and magnesium in lettuce and Chinese cabbage leaves (Radziemska et al., 2019; Thankachan & Chitra, 2021). Bokashi organic fertilizer from fish waste has organic C content of 13.98%-17.77%, total N of 3.23%-7.80%, C/N ratio of 16.9-55.0, total P of 1.46%-2.90%, and total K of 0.92%-1.46%, not yet meeting SNI standards (Ciptono & Khoir, 2022). Liquid organic fertilizer from fish waste has higher nutrient content than LOF from plant waste, but its production process emits an unpleasant odor (Haryanta et al., 2022).

Physicochemical Properties of Liquid Organic Fertilizer from a Mixture of Fish Waste and Coffee Grounds

The amount of coffee grounds produced annually worldwide reach 6 million tons, sourced from households, coffee shops, cafeterias, restaurants, and the instant coffee industry (Franca & Oliveira, 2022). Coffee grounds contain 2.28% nitrogen, 0.06% phosphorus, and 0.6% potassium, but liquid organic fertilizer made from coffee grounds alone without other materials does not meet Indonesian national standards for nitrogen, phosphorus, and potassium content (Febrian & Ismail, 2022). Coffee grounds are richer in C, N, P, and K elements, and when mixed with eggshell waste, increase Ca and Mg content (Tombarkiewicz et al., 2022). Coffee grounds can replace chemical fertilizers and have proven effective in enhancing plant growth, increasing nutrient content, and being environmentally friendly (Bomfim et al., 2022). Liquid organic fertilizer from coffee grounds, sheep manure, and banana peels has higher phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), and sodium (Na) content than compost tea, improving lettuce growth and yield (Bedhasa et al., 2020). Using coffee grounds for fertilizer allows waste management to increase agricultural productivity (Ciesielczuk et al., 2019). Applying composted coffee grounds increases the carotenoid, nitrogen, and potassium content in lettuce leaves compared to fresh coffee grounds application (Gomes et al., 2013). Coffee grounds processed into activated carbon can be used in the fertilizer and wastewater treatment industries (Mariana et al., 2018). Coffee grounds compost can increase soil pH, growth, and yield of mustard greens (Jumar et al., 2023). Coffee grounds are used to remove pollutants (Johnson et al., 2022). Coffee grounds are natural carbon that can be used as an adsorbent matrix in producing slow-release fertilizers (Setiawan et al., 2020).

The potential for processing fish waste into liquid organic fertilizer is very high, but the emergence of unpleasant odors during processing is an obstacle for the community. Coffee powder is utilized for odor removal, yet increasing coffee consumption results in significant coffee grounds waste. Coffee grounds can be utilized as a mixture in making liquid organic fertilizer from fish waste, expected to remove the unpleasant odor that has been a hindrance in making LOF from fish waste. This study aims to process fish waste and coffee grounds into organic fertilizer for urban agriculture development, find waste materials that can reduce unpleasant odors during LOF production from animal waste, and find appropriate technology formulas for processing fish or animal waste in general into LOF. The results of the study will recommend to the community the process of making liquid organic fertilizer from fish waste.

II. MATERIALS AND METHODS

A. Preparation of Raw Materials

The raw material for making liquid organic fertilizer consists of fish waste from fish traders in markets which is abundantly available in traditional markets in the city of Surabaya (figure 1.a). Coffee grounds were obtained from traditional coffee shops which are widely available in the city of Surabaya (figure 1.b).

a)

b)

Figure 1. Liquid Organic Fertilizer raw materials: a) Steamed fish waste; b) Coffee drinking waste (coffee grounds)

B. Experimental Design

A factorial experiment with two factors was conducted using a Completely Randomized Design. The first factor involved the type of raw material for liquid organic fertilizer (LOF), consisting of cattle blood waste (P1) and fish waste (P2), while the second factor included the addition of coffee grounds in the raw material, with additions of 10% (K1), 20% (K2), 30% (K3), 40% (K4), and 0% (K0) of the total raw materials. The experiment consisted of 8 treatment combinations, and the experimental units were arranged in a Completely Randomized Design. Each experimental unit consisted of one LOF production unit using 1 kg of raw materials in 5 L LOF production container.

LOF Production Process

The stages of the LOF production process are as follows:

- Make a starter solution by mixing 500 ml of EM4 solution with 500 g of sugar and 4 L of well water, stirring until the sugar dissolves, then incubating for 3-5 days.
- Drill a hole in the lid of the container wide enough for a small hose, insert the hose into the hole, and seal it with wax to make it airtight.

- Boil the cow blood waste by placing it in boiling water for 20-30 minutes or until the blood clots perfectly.
- Steam the fish waste (catfish entrails) for 30-60 minutes or until the fish waste is no longer oily.
- Drain the fish waste or cow blood waste until air-dry.
- Blend the raw materials according to the treatment, adding 500 ml of water.
- Add coffee grounds to the cow blood or fish waste according to the treatment, adding 200 g of bran, 250 ml of coconut water, 750 ml of starter solution, and 1000 ml of well water, so the total volume is 2-2.5 l, then place it in a 5 l container and stir until even.
- Place the lid on the container with the hose, ensuring the end of the hose does not enter the liquid in the container, while the other end of the hose is placed in a plastic bottle filled halfway with water, ensuring the end of the hose is submerged in water.
- Incubate the mixture for 4 weeks, and every week, open the lid and stir the mixture as needed, observing the physical condition, color, odor, temperature, and pH.
- Harvest the LOF after 4 weeks of incubation by opening the container lid, observing the physical condition, color, odor, temperature, and pH of the liquid, then filtering it in stages. The first filtration uses a coarse filter, and the second filtration uses a fine filter with cloth.

Store the harvested LOF from the second filtration in a light-proof plastic bottle and label it according to the treatment.

C. Experimental Variables and Data Analysis

During the LOF incubation period, the observed variables changed in the physical condition, color, odor, temperature, and pH of the LOF materials. The harvested POC was tested in the laboratory to determine the content of macro and micronutrients and organic C. The macro and micro nutrient content was measured using the Kjeldahl method for nitrogen content, the Atomic Absorption Spectrophotometer (AAS) method for P, K, CaO, MgO, and Fe content, and the spectrophotometer method for organic C content.

The data on changes in the physical condition, color, odor, temperature, and pH of the LOF materials were analyzed descriptively qualitatively. The data on the macro and micro nutrient content were analyzed using analysis of variance (ANOVA), and if there were significant differences between treatments, further tested with the 5% LSD test.

III. RESULTS AND DISCUSSION

A. Changes in the Physical Appearance of Materials

During the fermentation process of making LOF, the physical appearance of the raw materials changes, starting from the original appearance of the materials, which expand, foam, and have air bubbles, with white powdery substances appearing. The physical appearance changes were almost the same for all LOF material mixtures. Data on the changes in the physical appearance of the materials are presented in Table 1.

Table 1. Data on changes in the physical appearance of the mixture of fish waste and coffee grounds during the LOF production process

Treatment	Week I	Week II	Week III
K0 P1	Expands, foamy, white mass	Expands, foamy, white mass	Expands, foamy, white mass
K1 P1	Expands, foamy, white mass	Expands, foamy, white mass	Expands, foamy, white mass
K2 P1	Expands, foamy, white mass	Expands, foamy, white mass	Expands, foamy, white mass
K3 P1	Expands, foamy, white mass	Expands, foamy, white mass	Expands, foamy, white mass
K4 P1	Expands, foamy, white mass	Expands, foamy, white mass	Expands, foamy, white mass
K0 P2	Maggots present	Maggots present	Maggots present
K1 P2	Expands, foamy, white mass	Expands, foamy, white mass	Expands, foamy, white mass
K2 P2	Expands, foamy, white mass	Expands, foamy, white mass	Expands, foamy, white mass
K3 P2	Expands, foamy, white mass	Expands, foamy, white mass	Expands, foamy, white mass
K4 P2	Expands, foamy, white mass	Expands, foamy, white mass	Expands, foamy, white mass with mold

B. Odor Changes

In the production of LOF from fish waste and cattle blood waste, an unpleasant odor resembling a strong, almost rotten smell was emitted. On the other hand, during the LOF production process, fermentation occurs, emitting a smell like fermented tape. Odor measurement of the LOF biomass materials used a scoring scale from the most unpleasant odor (scale 7) to a strong tape smell (scale 1). The odor measurement was conducted by a panel of 4 people, and the results were averaged. Data on the odor changes of the biomass materials during the LOF production process are presented in Table 2. Adding 30% coffee grounds (P3) could reduce the unpleasant odor in the fish waste raw materials (P2), even changing the unpleasant odor to a tape smell at the end of the LOF production (21 days of fermentation). Fish waste raw materials had a more unpleasant odor than cow blood waste raw materials. (Woo et al., 2017) concluded that activated carbon from coffee grounds could remove odors caused by acetaldehyde produced from a process or material. Coffee grounds can remove unpleasant odors around cattle pens from cow manure (Kim et al., 2021). Activated carbon from coffee grounds meets the quality standards specified in SNI No. 06-3730-1995, proving more efficient and effective in absorbing ammonia, a compound responsible for unpleasant odors (Mariana et al., 2018). (Fitriyanto et al., 2019) found that adding 30% chicken feces to liquid goat faces could remove unpleasant odors during the LOF production process.

Table 2. Data on odor changes of the mixture of fish waste and coffee grounds during the LOF production process

Treatment	Week 0	Week I	Week II
K0 P1	5.75	5.75	5.75
K1 P1	4.25	5.00	6.50
K2 P1	4.00	4.25	3.50
K3 P1	4.00	4.50	3.75
K4 P1	4.75	4.75	4.25
K0 P2	6.00	6.50	7.00
K1 P2	6.00	6.00	5.25
K2 P2	6.50	6.00	4.75
K3 P2	5.00	4.50	4.25
K4 P2	5.00	4.25	3.75

Note: Odor measurement used the following scoring scale: 7: very unpleasant odor; 6: very unpleasant odor; 5: unpleasant odor; 4: no odor/unpleasant odor; 3: slight tape aroma (noticeable with concentration); 2: tape smell (in normal conditions); 1: strong tape smell

C. Color

Table 3. Data on color changes of the mixture of fish waste and coffee grounds during the LOF production process

Treatment	Week 0	Week I	Week II	Week III
K0 P1 (100% cow blood waste)	Brown	Brown	Dark Brown	Dark Brown
K1 P1 (10% coffee grounds, 90% cow blood waste)	Brown	Dark Brown	Dark Brown	Dark Brown
K2 P1 (20% coffee grounds, 80% cow blood waste)	Dark Brown	Dark Brown	Dark Brown	Dark Brown
K3 P1 (30% coffee grounds, 70% cow blood waste)	Dark Brown	Dark Brown	Dark Brown	Dark Brown
K4 P1 (40% coffee grounds, 60% cow blood waste)	Dark Brown	Dark Brown	Dark Brown	Dark Brown
K0 P2 (10% coffee grounds, 90% cow blood waste)	Yellowish Brown	Yellowish Brown	Yellowish Brown	Yellowish Brown
K1 P2 (20% coffee grounds, 90% fish waste)	Yellowish Brown	Yellowish Brown	Brown	Brown
K2 P2 (10% coffee grounds, 80% cow blood waste)	Light Brown	Light Brown	Brown	Brown
K3 P2 (30% coffee grounds, 70% cow blood waste)	Light Brown	Light Brown	Brown	Brown
K4 P2 (40% coffee grounds, 60% cow blood waste)	Light Brown	Light Brown	Brown	Brown

Physicochemical Properties of Liquid Organic Fertilizer from a Mixture of Fish Waste and Coffee Grounds

The color changes from the original color of the materials, with cow blood being maroon, fish waste being yellowish-brown, and coffee grounds being black, to darker colors at the end of the process (harvest time). Data on color changes of the biomass materials during the LOF production process are presented in Table 3.

D. Temperature (°C)

During the LOF production process, temperature measurements indicated that there was no heat generation, with material temperatures remaining nearly equivalent to room temperature. The temperature of LOF materials remained stable throughout the fermentation process, and there were no significant differences observed among treatments. Detailed temperature data for biomass materials during LOF production are presented in Table 4.

Table 4. Data on temperature (°C) changes of the mixture of fish waste and coffee grounds during the LOF production process

Treatment	Week 0	Week I	Week II	Week III
K0 P1 (100% cow blood waste)	29.50	28.50	27.50	28.50
K1 P1 (10% coffee grounds, 90% cow blood waste)	28.40	28.50	27.70	29.10
K2 P1 (20% coffee grounds, 80% cow blood waste)	29.70	28.50	27.70	29.30
K3 P1 (30% coffee grounds, 70% cow blood waste)	29.30	28.50	27.70	29.90
K4 P1 (40% coffee grounds, 60% cow blood waste)	28.80	28.70	27.90	28.10
K0 P2 (10% coffee grounds, 90% cow blood waste)	31.50	29.30	27.70	28.50
K1 P2 (20% coffee grounds, 90% fish waste)	31.40	28.70	27.90	29.30
K2 P2 (10% coffee grounds, 80% cow blood waste)	31.70	28.50	27.50	29.30
K3 P2 (30% coffee grounds, 70% cow blood waste)	31.90	28.70	27.70	29.20
K4 P2 (40% coffee grounds, 60% cow blood waste)	31.70	28.70	27.10	29.10

E. pH

During the LOF production process, organic materials are decomposed into inorganic materials, producing gaseous byproducts that affect the odor, color, and acidity levels in the LOF liquid. Data on pH changes of the biomass materials during the LOF production process are presented in Table 5. In general, pH decreased (acidic condition) in week I-II and increased back to neutral or slightly alkaline in week III. Adding coffee grounds to fish waste did not significantly affect the physical appearance, color, temperature, and pH during the LOF production process. The research data align with (Fitriyanto et al., 2019), who concluded that adding chicken manure to goat manure liquid did not significantly affect color, pH, temperature, organic N content, and NO3 levels in LOF.

Table 5. Data on pH changes of the mixture of fish waste and coffee grounds during the LOF production process

Treatment	Week 0	Week I	Week II	Week III
K0 P1 (100% cow blood waste)	7.0	5.5	7.5	7.3
K1 P1 (10% coffee grounds, 90% cow blood waste)	7.0	5.9	6.5	7.0
K2 P1 (20% coffee grounds, 80% cow blood waste)	7.0	6.0	6.5	7.0
K3 P1 (30% coffee grounds, 70% cow blood waste)	6.9	7.0	6.8	7.0
K4 P1 (40% coffee grounds, 60% cow blood waste)	6.0	6.5	7.0	7.5
K0 P2 (10% coffee grounds, 90% cow blood waste)	7.5	5.5	7.5	7.5
K1 P2 (20% coffee grounds, 90% fish waste)	7.0	5.5	7.0	7.8
K2 P2 (10% coffee grounds, 80% cow blood waste)	7.0	5.5	7.0	7.7
K3 P2 (30% coffee grounds, 70% cow blood waste)	7.0	5.0	7.0	7.5
K4 P2 (40% coffee grounds, 60% cow blood waste)	7.0	5.5	7.0	7.9

F. Macro Nutrient Content

The optimal nutrient levels in liquid organic fertilizer from a mixture of fish waste and coffee grounds include 30% total nitrogen ranging from 0.118% to 0.170%, optimal P2O5 ranging from 1.82% to 2.09% with 10% coffee grounds addition, optimal K2O ranging from 0.77% to 1.01% with 20% coffee grounds addition, optimal organic carbon ranging from 2.02% to 2.50% with 20% coffee grounds addition, and an optimal C/N ratio ranging from 14.99 to 17.92 with 30% coffee grounds addition. Data on the analysis of macro nutrient contents in the liquid organic fertilizer made from a mixture of fish waste and coffee grounds are presented in Table 6. Adding coffee grounds to fish waste generally increases macro nutrient content in LOF. According to (Ciesielczuk et al., 2015), coffee grounds-based fertilizers are rich in nitrogen, potassium, calcium, and organic matter, with low heavy metal content that decomposes slowly. Research by (Hepsibha & Geetha, 2019) concluded that organic fertilizers from fish waste contain macro and micro nutrients and essential amino acids.

Table 6. Data on macro nutrient content in LOF from a mixture of fish waste and coffee grounds

Treatment	Organic material (%)	Total N (%)	P2O5 (%)	K2O (%)	Organic C (%)	C/N Ratio
K0	4.06 d	0.118 d	1.82 b	0.77 c	2.02 d	17.92 a
K1	4.69 c	0.135 c	2.06 a	0.82 b	2.30 c	16.99 b
K2	4.75 b	0.148 bc	2.04 a	0.99 a	2.50 a	16.66 c
K3	4.87 a	0.170 a	2.09 a	1.00 a	2.48 ab	15.05 d
K4	4.85 a	0.157 b	2.04 a	1.01 a	2.38 bc	14.99 d
LSD 5%	0.08	0.015	0.10	0.06	0.11	0.33
P1	4.04 b	0.154 a	1.59 b	0.74 b	2.44 a	15.96 b
P2	5.25 a	0.137 b	2.42 a	1.10 a	2.33 b	16.68 a
LSD 5%	0.05	0.009	0.07	0.04	0.07	0.21

Note: Numbers within the same column followed by the same letter are not significantly different based on the LSD test at 5%; NS = not significant.

$K_{0:}$: addition of 0% coffee grounds; K1: addition of 10% coffee grounds

$K_{2:}$: addition of 20% coffee grounds; K3: addition of 30% coffee grounds

$K_{4:}$: addition of 40% coffee grounds; P1: cattle blood waste; P2: fish waste

G. Micro Nutrient Content

Table 7. Data on micro nutrient content in LOF from a mixture of fish waste and coffee grounds

Treatment	Mg (%)	Ca (%)	Cu (ppm)	Zn (ppm)	Humic Acid (%)
K0	0,265	1,23 c	1,57 b	4,24 c	1,11 c
K1	0,268	1,28 bc	1,94 a	4,61 b	1,21 b
K2	0,270	1,33 abc	1,92 a	4,77 ab	1,33 a
K3	0,267	1,39 a	1,92 a	4,85 a	1,33 a
K4	0,265	1,37 ab	1,83 a	4,74 ab	1,35 a
LSD 5%	NS	0,10	0,19	0,21	0,09
P1	0,269	1,13 b	1,18 b	2,35 b	1,11 b
P2	0,265	1,51 a	2,49 a	6,93 a	1,42 a
LSD 5%	TN	0,06	0,12	0,13	0,05

Note: Numbers in the same column followed by the same letter are not significantly different based on the 5% LSD test; NS = not significant

$K_{0:}$: addition of 0% coffee grounds; K_1: addition of 10% coffee grounds

$K_{2:}$: addition of 20% coffee grounds; K_3: addition of 30% coffee grounds

$K_{4:}$: addition of 40% coffee grounds; P_1: cattle blood waste; P_2: fish waste

The Mg content ranges from 0.265 – 0.270%, not significantly different with coffee grounds addition. Ca content ranges from 1.23 – 1.39%, with the optimal value at 30% coffee grounds addition. Cu content ranges from 1.57 – 1.94 ppm, with the optimal value at 10% coffee grounds addition. Zn content ranges from 4.24 – 4.85 ppm, with the optimal value at 20% coffee grounds addition. Humic acid content ranges from 1.11 – 1.35%, with the optimal value at 20% coffee grounds addition. Adding coffee grounds to fish waste can increase the content of calcium, zinc, copper, and humic acid in LOF. Data on the micronutrient content analysis of liquid organic fertilizer made from a mixture of fish waste and coffee grounds are presented in Table 7.

Physicochemical Properties of Liquid Organic Fertilizer from a Mixture of Fish Waste and Coffee Grounds

Liquid organic fertilizer from coffee grounds and banana peels through aerobic fermentation shows higher phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), and sodium (Na) content compared to compost tea solution (used as a control) (Bedhasa et al., 2020). Heavy metal content is very low, far below the allowable threshold. According to (Bomfim et al., 2022), coffee grounds show excellent performance when applied to soil and composting because they are nutrient-rich organic waste without heavy metals.

V. CONCLUSIONS

The addition of coffee grounds to fish and blood waste does not affect the physical properties of the biomass materials but significantly reduces unpleasant odors during the production of liquid organic fertilizer (LOF). Adding 20-30% coffee grounds from the total materials can remove the strong unpleasant odor, changing to a mild smell and eventually a fermented tape at the end of the LOF production. Adding coffee grounds to the LOF production from fish waste and cow blood waste can increase macro and micro nutrient content and reduce the C/N ratio in the resulting LOF. Adding 20-30% coffee grounds from the total raw materials provides a solution to the problem of unpleasant odors in the LOF production from fish waste and cow blood waste, while also utilizing coffee drinking waste that is usually discarded and can pollute the environment.

ACKNOWLEDGMENT

We would like to thank the Rector of Universitas Wijaya Kusuma Surabaya for approving the funding of this research activity under the budget in 2024. We also extend our thanks to the students of the 2019 Agrotechnology program for their assistance in sourcing research materials.

REFERENCES

1) Balraj, T. H., Palani, S., & Arumugam, G. 2014. Influence of Gunapaselam, a liquid fermented fish waste on the growth characteristics of Solanum melongena. Available Online Www.Jocpr.Com Journal of Chemical and Pharmaceutical Research, 6(12), 58–66. www.jocpr.com
2) Bedhasa, T., Zekeria, Y., & Misrak, K. 2020. Production of Bioorganic Liquid Fertilizer from Coffee Ground and Banana Peels Biological Activities of Oil Extracts from Fruit Wastes and Traditional Medicinal Plants View project Production of Bioorganic Liquid Fertilizer from Coffee Ground and Banana Peels. Advanced Research Journal of Biotechnology, 4(4), 91–97. www.advancedscholarsjournals.org
3) Bomfim, A. S. C. de, de Oliveira, D. M., Walling, E., Babin, A., Hersant, G., Vaneeckhaute, C., Dumont, M.-J., & Rodrigue, D. 2022. Spent Coffee Grounds Characterization and Reuse in Composting and Soil Amendment. Waste, 1(1), 2–20. https://doi.org/10.3390/waste1010002
4) Ciesielczuk, T., Rosik-Dulewska, C., Poluszynska, J., & Slezak, E. 2019. Assessment of effectiveness of organo-mineral fertilizer made of coffee spent grounds and biomass ash. Journal of Ecological Engineering, 20(2), 73–78. https://doi.org/10.12911/22998993/96269
5) Ciesielczuk, T., Rosik-Dulewska, C., & Wiśniewska, E. 2015. Possibilities of Coffee Spent Ground Use as a Slow Action Organo-mineral Fertilizer Annual Set The Environment Protection Rocznik Ochrona Środowiska Possibilities of Coffee Spent Ground Use as a Slow Action Organo-mineral Fertilizer. Rocznik Ochrona Środowiska, 7, 422–437. https://www.researchgate.net/publication/282741309
6) Ciptono, E. B., & Khoir, M. 2022. Composition Analysis of Bokashi Organic Fertilizer from Fish Flour Fishery Waste. AGARICUS: Advances Agriculture Science & Farming, 2(1), 14–23.
7) Coppola, D., Lauritano, C., Esposito, F. P., Riccio, G., Rizzo, C., & de Pascale, D. 2021. Fish Waste: From Problem to Valuable Resource. In Marine Drugs 19(2). https://doi.org/10.3390/MD19020116
8) Ellyzatul, A. B., Yusoff, N., Mat, N., & Khandaker, M. M. 2018. Effects of Fish Waste Extract on the Growth, Yield and Quality of Cucumis sativus L. J. Agrobiotech, 9(1S), 250–259.
9) Fahlivi, M. R. 2018. Physicochemical characteristics of liquid fertilizer from fish viscera. United Nations University Fisheries Training Programme. http://www.unuftp.is/static/fellows/document/rizal15prf.pdf
10) Febrian, P. A., & Ismail, Y. 2022. The Study of Composting from Spent Coffee Grounds in Making Process Liquid Fertilizer. Journal of Environmental Engineering and Waste Management, 7(2), 107–124. https://doi.org/10.33021/jenv.v6i2.1512
11) Fitriyanto, N. A., Priyadi, D. A., Suranindyah, Y., Yusiati, L. M., Erwanto, Y., Kurniawati, N., & Pertiwiningrum, A. 2019. Biochemical and physical properties of goat feces liquid biofertilizer fermented with chicken excreta combination and different fermentation condition. IOP Conference Series: Earth and Environmental Science, 387(1). https://doi.org/10.1088/1755-1315/387/1/012108

12) Franca, A. S., & Oliveira, L. S. 2022. Potential Uses of Spent Coffee Grounds in the Food Industry. In Foods, 11(14). https://doi.org/10.3390/foods11142064
13) Gomes, T., Pereira, J. A., Ramalhosa, E., Casal, S., & Baptista, P. 2013. Effect of fresh and composted spent coffee grounds on lettuce growth, photosynthetic pigments and mineral composition. Environmental Science, Agricultural and Food Sciences, 1372–1376.
14) Gustiar, F., Munandar, M., Ammar, M., & Yakup, Y. 2022. Potential Utilization of Catfish Wastewater, Livestock Manure and Waste of Fish as Media and Nutrition for Organic Hydroponic. Agritropica : Journal of Agricultural Sciences, 5(2), 62–75. https://doi.org/10.31186/j.agritropica.5.2.62-75
15) Haryanta, D., Sa'Adah, T. T., & Thohiron, M. 2022. Physico-Chemical Characterization of Liquid Organic Fertilizer from Urban Organic Waste. Chemical Engineering Transactions, 96, 457–462. https://doi.org/10.3303/CET2296077
16) Haryanta, D., Sa'adah, T. T., Thohiron, M., & Rejeki, F. S. 2023. Utilization of urban waste as liquid organic fertilizer for vegetable crops in urban farming system. Plant Science Today, 10(2), 120–128. https://doi.org/10.14719/pst.2028
17) Jayvardhan, B., & Arvind, C. 2020. Preparation of organic fertilizer from fish waste: a new avenue in employment generation. https://www.irjse.in
18) Johnson, K., Liu, Y., & Lu, M. 2022. A Review of Recent Advances in Spent Coffee Grounds Upcycle Technologies and Practices. In Frontiers in Chemical Engineering (Vol. 4). Frontiers Media SA. https://doi.org/10.3389/fceng.2022.838605
19) Jumar, J., Saputra, R. A., Wahdah, R., Elmi, M., & Sholeha, Y. N. 2023. The potential of coffee ground compost to enhance soil pH, growth, and production of mustard greens in acid-dry land. IOP Conference Series: Earth and Environmental Science, 1266(1). https://doi.org/10.1088/1755-1315/1266/1/012037
20) Kim, M. S., Kim, S. H., Jeong, M., Park, M. K., Jo, Y., Kang, G. U., Jung, D. R., Lee, C. Il, & Shin, J. H. 2021. Fermented coffee grounds diminish livestock odors: A microbiome study. Agronomy, 11(10). https://doi.org/10.3390/agronomy11101914
21) Kusuma, I. M., Syafrudin, S., & Yulianto, B. 2019. Utilization of Fish Waste Processing as Compost Raw Material in Tambak Lorok Market. E3S Web of Conference. https://doi.org/10.1051/e3sconf/201
22) Mariana, M., Mahidin, M., Mulana, F., & Aman, F. 2018. Utilization of Activated Carbon Prepared from Aceh Coffee Grounds as Bio-sorbent for Treatment of Fertilizer Industrial Waste Water. IOP Conference Series: Materials Science and Engineering, 358(1). https://doi.org/10.1088/1757-899X/358/1/012027
23) Muscolo, A., Mauriello, F., Marra, F., Calabrò, P. S., Russo, M., Ciriminna, R., & Pagliaro, M. 2022. AnchoisFert: A New Organic Fertilizer from Fish Processing Waste for Sustainable Agriculture. Global Challenges, 6(5). https://doi.org/10.1002/gch2.202100141
24) Radziemska, M., Vaverková, M. D., Adamcová, D., Brtnický, M., & Mazur, Z. 2019. Valorization of Fish Waste Compost as a Fertilizer for Agricultural Use. Waste and Biomass Valorization, 10(9), 2537–2545. https://doi.org/10.1007/s12649-018-0288-8
25) Setiawan, F. A., Mukti, N. I. F., Rahwamati, A., Putri, D. K. Y., & Fachri, B. A. 2020. Slow release fertilizer production from coffee spent ground: A preliminary study. AIP Conference Proceedings, 2278. https://doi.org/10.1063/5.0015332
26) Thankachan, M., & Chitra, G. 2021. The Potential Effect of Fish Waste Fertilizer on The Growth and Yield of Amaranthus dubius and Trigonella foenum-graecum. International Journal of Advanced Research, 9(04), 406–411. https://doi.org/10.21474/IJAR01/12702
27) Hepsibha, B. T., & Geetha, A. 2019. Physicochemical characterization of traditionally fermented liquid manure from fish waste (Gunapaselam). Indian Journal of Traditional Knowledge, 18(4), 830–836.
28) Tombarkiewicz, B., Antonkiewicz, J., Lis, M. W., Pawlak, K., Trela, M., Witkowicz, R., & Gorczyca, O. 2022. Chemical properties of the coffee grounds and poultry eggshells mixture in terms of soil improver. Scientific Reports, 12(1). https://doi.org/10.1038/s41598-022-06569-x
29) Winarso, S., Hermiyanto, B., Romadhona, S., & Martinus, H. 2020. Effectiveness of the combination of biopellet, biochar, chicken manure and fish waste to the improvement of chemical properties of sandy soil and soybean plant growth. Journal of Degraded and Mining Lands Management, 7(4), 2263–2268. https://doi.org/10.15243/JDMLM.2020.074.2363
30) Woo, E. J., Oh, Y. J., Yoo, J. Y., & Park, C. J. 2017. On the Control Process of Odor Material by Using Coffee Wastes. International Journal of Environmental Science and Development, 8(4), 281–284. https://doi.org/10.18178/ijesd.2017.8.4.963