Bakasang fermentation of Tilapia fish (*Oreochromis mossambicus*) waste for production of liquid organic fertilizer (LOF)

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Abstract. In previous study, the mixture of manure and sand have been tested successfully as media growth of local Jackfruit seedlings, called Tulo-5 and Beka-3 from Central Sulawesi area. It shows that the organic fertilizers are a good fertilizer to use. One of organic fertilizers in this study is liquid organic fertilizer (LOF) from Tilapia fish (*Oreochromis mossambicus*) waste. The process to produce LOF used “Bakasang fermentation technology” as a part of a local wisdom source in North Sulawesi area. The objective of this research is to produce liquid organic fertilizer using this traditional fermentation technology and to analyse macro nutrients of N, P, K elements and micro nutrients of Zn, Mn, Fe, Cu, Ni, Co elements by using spectrophotometry method. The sample was divided into 3 parts for the analysis of the nutrients. The first part was based on macro and micro nutrient contents after making the LOF. The second part was based on the kind of local Tilapia fish which were taken from Lindu Lake and Kabanena fresh water fish-culture area. The last, the LOF was made through Bakasang fermentation process with the bacterial feeding and without the bacterial feeding. From the result of this study showed that the nutrient levels in most part of organic liquid fertilizer from the waste of Tilapia fish met the general quality standard levels of the LOF.

1. Introduction

In terms of agro ecological aspects, Jackfruit plant is well growth in Palu valley. In terms of taste, Jackfruit from Palu is more crunchy and sweet then from other areas of Indonesia. Opportunities to lift up Jackfruit from Palu as a superior commodity is open wide. One of the opportunities is a potential accessibility of Palu as a capital city and the center of economic growth of Central Sulawesi Province [1].

The idea of this research was looking for organic fertilizer to grow of superior Jackfruit from Palu that are Tulo-5 and Beka-3. It is based on previous study that organic planting media made from manure and sand can provide the best seed vigor results for this superior Jackfruit Tulo-5 and Beka-3 [2]. The continuing good growth of Jackfruit depended on the organic fertilizer.

Therefore from the local wisdom and abundance of resources point of view, the choice of Tilapia fish (*Oreochromis mossambicus*) waste as the source of liquid fertilizer is necessary reason to be taken with some considerations. Most of households in Palu fulfill their protein from various sources, including by consuming fresh water fish that found in many surround as Tilapia (*Oreochromis mossambicus*) fish. The main source of Tilapia fish (*Oreochromis mossambicus*) is from Lake of
The lowland areas of Palu Valley and from the lowland areas of Palu Valley Sigi Sulawesi Tengah [3, 4]. The unique of selling tilapia fish by local seller is to clean fish on stage, separating between clean fish with intestine, fins and scales.

According to Davis [5], fish can be used as a material to make liquid fertilizer or solid fertilizer. The fertilizer with fish raw material can increase yield of some type of fruit plants up to 60%. There are several other benefits that can be obtained if using fertilizer with fish raw materials which can decrease the attack of macrophomina phoseolina, rhizoctonia solani and fusarium spp pathogens in okra and long bean plants [6]. Abbasi shows that the LOF stimulated the development of actynomicetes spp., and rhizobacteria spp that play a role in producing hormones grown around rooting plants [7].

Plants need complete nutrition and macro nutrient form consisting of primary macro such as N-P-K,(nitrogen, phosphorous, potassium) as well as secondary macro such as Ca (calcium), Mg (magnesium), and S (sulfur). While micro nutrients consist of Fe (iron), Zn (zinc), Cu (copper), Mn (manganese), and Cl (chlorine) [8]. Food Association Organisation (FAO) standard for liquid fertilizer has defined the basic criteria for this type of fertilizer, namely: macro elements content must have a minimum value of N (12%), P (8%), and K (6%) if the fertilizer will be sold [9].

Other local wisdom that used is from North Sulawesi Province area for making fish's stomach sauce called “Bakasang” that is part of traditional fermentation process. This paper will report nutrients analysis on liquid fertilizer from Tilapia fish waste (intestine, fins and scale) after fermentation process [10] as a part of making the LOF.

2. Materials and Method
The first step in this study was making Liquid Organic Fertilizer (LOF) from Tilapia fish waste by two type’s modification fermentation method. The materials needed were 10 kg fish from Lake Lindu producing 1.44 kg of intestine, 10 kg of fish from Kabonena fresh water fish-culture area producing 1.37 kg of intestine, 1 kg rotten tomato, and 250 g brown sugar. The equipment needed plastic container as fermenter reactor, pH meter, glassware, and atomic absorption spectrophotometry (AAS-GBC 932 A) to analyze minor substances. Sample preparation was divided into two stages.

Stage one: the intestine sample 1.44 kg from Lake Lindu was divided into two parts and continued with different treatments as follow; about 718.33 g intestine sample was added by molasses consist of mixture of 152.67 g tomato and 38.16 g brown sugar as food source for bacteria. The mixing substance was fermented for 14 days then, dissolved 84.59 g flour of scales and fins (it made by drying through sun exposed and grinder followed by filtering to be the flour). To reduce the bad odour/preservative, it was added of 25 mL NaCl 2M and 25 mL lime juice. This was referred as LOF D A1 sample from Lake Lindu. For the sample of LOF D A2 was prepared by fermentation without molasses mixed between 718.41 g. of intestine sample with 41.88 g. flour fins and scale continued to stage two below. The LOF K B1 sample was from Kabonena fresh water fish-culture area : the intestine sample 1.37 kg, divided into two parts: 686.84 g., mixed with tomato 148 g., and brown sugar 37.33 g., fermented for 14 days, then dissolved flour scales and fins, 41.87 g. Added odor/preservative was mixing of 25 mL NaCl 2M and 25mL lime juice). The LOF KB2 made by 679.36 g intestine sample without molasses for 14 days, then dissolved 41.07 g of flour scales and find. Continued to stage two as below

Stage two: the sample of LOF D A1, LOF DL A2, LOF KB1, LOF KB1 extracted by adding 20 mL HNO3; follow by stirring and heating for 10 minutes at 60°C, then filtered by using filter paper. Ready to analyse using the sample by taken 10 mL filtering sample then diluted until sign in 100 mL flask.

The second step was nutrient analysis by using AAS for Zn, Co, Ni, Cu, Fe, Mn, Ca, Mg, K, with wavelength measurement according to the accuracy of the tool, AAS-GBC 932 A : Zn 213.9 nm, Ni; 232.0 nm, Co; 240.7 nm, Mn; 279.5 nm, Cu; 324.7 nm, Fe; 243.3 nm [10].

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3. Results and Discussion

In the production of LOF from both places with some modifications on basic procedure of fermentation were made in order to obtain better result and adapt with Bakasang fermentation procedure as a local wisdom process from North Sulawesi. [10]

Organic waste does not robbed the soil fertility and have resulted in health and environmental hazards, and no contain toxins or carcinogenic materials.[11] It can improve the soil structure, water holding capacity, microbial biomass, and nutrient availability. [12] Hence, by recycling the organic wastes as fertilizers, trough the simple processes helps farmers or households to have a simple and good quality fertilizer. So the way for sustainable solid waste management and agriculture will be on the tract.

Knowing that the problem of fish waste cause smell everywhere especially in Palu city, which is most of households and fish sellers throw out the fish waste in temporary legal or illegal waste disposal. So transforming them into useful products like fertilizers is the wise solution due to rich of essential macro and micro nutrients.[13] Fermentation of the fish waste to be liquid fertilizer is the right method and easy way to have get carbon source, moisture and aeration were provided in right proportion. The investigation on the yield of many vegetables and fruits used fermented fish waste as liquid fertilizer has been done.[14], [15]

The process of fermentation was done smoothly which some procedures; fish samples from Lake Lindu and from Kabonena fresh water fish-culture area as many as 10 Kg each produce waste offal, then fermented as in the working procedure of LOF D A1, LOF D A2, LOF K B1 and LOF K B2 for 14 days and in offal, fins scale previously dried in sunlight for 15 day and in the oven until it is easily crushed into flour.

Fermented all the fermentation process goes well, it is proven at the beginning of a dense mixed process of wet colored blood/brown blackish, after the fermentation becomes reddish brown liquid with a strong odor (not the smell of carcass).

One of the centers for fishery education of Indonesia said that in fermentation of fish there was occurred breakdown of protein, fat and other components. Especially the protein is hydrolysed into its derivatives, such as proteases, peptones, peptides and amino acids [16].

The process as well produced fragrance component or volatile compound composed of 16 kinds hydrocarbon compounds, 7 kinds of alcohols, 46 kinds of carbonyl, 7 kinds of fat, 34 kinds of nitrogen compounds, 15 kinds of sulfur compounds, and other compounds as many as 10 kinds. These compounds will produce ammonia odors, sour, rotten, savory and other distinctive smell.[17]

The presence of different odour component caused LOF have a distinctive odour/aroma according to the area of origin and the process of manufacture. At that stage the enzyme from fish body tissue, that plays a role and also enzyme produce by microbes. Protolithic enzymes contained in fish body tissue are mainly found in the gastrointestinal tract, namely the portion of the pyloric caecum and intestinal mucus. Protolithic enzymes from bacteria are mainly produced by halophile bacteria. The presence of water leads to the process of breaking down fat into fatty acids and glycerol can work well. The active lipase enzyme can be derived from muscle and adipose tissue, also from bacteria [17].

After all the fermentation processes done followed by the extract of nutrients by reacting with 20 mL concentrated HNO₃ stirred heated for 10 minutes at 60°C. Because of too concentrated, result of extracted was diluted from 10 mL to 100 mL, and then was taken certain amount of each sample to be analyzed.

Sample from Lake Lindu, the level of every nutrient has greater than sample from Kabonena fresh water fish-culture area. In terms of amount of solution, sample LOF D A1 less than LOF D A2 and for LOF KB1 less than LOF K B2 for the level of nutrient.

Cobalt and nickel were not found in both samples. From the simplicity way and the level of nutrient, the fermentation processes without adding of molasses was better than the fermentation processes with adding of molasses. But if sample A1 and B1 were extracted the amount of molasses and salt and acid, it will have the same level.
The result can be compared to some study before such as in Vanny, 2017 [18] shows waste fish Tilapia has high content of calcium and phosphorus on the fins and scales. Hepsibha 2014[19] said that the proximate trace elements present in Gunapaselam (Fermented Fish waste) shown the level of micro nutrients fish in Gunapaselam is Zn (3.21±0.32), Mn (1.34±0.10), Fe (15.69±1.36), Cu (0.55±0.05), Pb (0.69±0.06), Ni (detectable below limit) and B (1.76±0.14) (mg/kg). The amount of sculpture and sodium were 0.04±0.00 and 0.07±0.00 (%) respectively. It means that the result of this study was relatively the same. It is enough for fertilized the crops as said by reference [15]. Most of the results shows in Table 1 were analyzed by AAS-GBC 932 A

| Tabel 1: Materials used in the manufacture of LOF and chemical analysis of nutrient content |
|------------------------------------------------------------------------------------------------|
| Material                  | LOF. D. A1 | LOF. D. A2 | LOF. K. B1 | LOF. K. B2 |
|----------------------------|------------|------------|------------|------------|
| Intestine (gr)             | 718.33     | 718.41     | 668.84     | 679.36     |
| Scales&fins (gr)           | 84.59      | 41.88      | 41.87      | 41.07      |
| Tomato (gr)                | 152.67     | -          | 148        | -          |
| Palm Sugar (gr)            | 38.16      | -          | 37.33      | -          |
| NaCl 2M (mL)               | 25         | -          | 25         | -          |
| Lime juice (mL)            | 25         | -          | 25         | -          |
| pH awal                    | 5.30       | 5.30       | 5.51       | 5.51       |
| pH akhir                   | 6.0        | -          | 5.41       | -          |
| Zn (mg/L)                  | 15.5       | 24         | 9.9        | 26         |
| Mn (mg/L)                  | 18.8       | 31.9       | 1.3        | 0.9        |
| Cu (mg/L)                  | 2          | 2.5        | 2.2        | 1.4        |
| Fe (mg/L)                  | 17.7       | 98.9       | 4.7        | 4.7        |
| Co (mg/L)                  | -          | -          | -          | -          |
| Ni (mg/L)                  | -          | -          | -          | -          |
| Ca (mg/L)                  | 404.1      | 503.3      | 341.3      | 454        |
| Mg (mg/L)                  | 77.2       | 46.2       | 84.2       | 74.8       |
| K (mg/L)                   | 90.8       | 41.6       | 93.9       | 91.9       |

4. Conclusion
In conclusion, from the study that Bakasang fermentation can be fermentation models used for produce Liquid Organik Fertilizer (LOF) from tilapia fish waste. It can be proven by successfully of fermentation processes and the level of nutrient found in, especially micro nutrient meet the requirement content of fertilizer.

From this study there are also few points that can be concluded, first, the nutrient content of both primary and secondary macro nutrients as well as micro elements have been measured in this study against the LOF of Tilapia fish waste with fermentation process. From the existing literature the content is able to meet daily needs of the plant's [15]. Second, the process of making LOF can follow the procedure of making "Bakasang" fermentation without additives or molasses. It can also add salt and lime juice as a preservative and deodorizing. Finally, to meet the requirements of FAO standards for LOF to sell (12% N), it is necessary to add extract sources of nutrient-rich organic materials.

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