Beneficial impact and its role of liquid bio fertilizer from liquid waste fermentation on coffee growth to support innovative agrotourism

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Abstract. In managing organic coffee farming at Wanagiri village, Sukasada subdistrict of Buleleng, once a year farmers are faced by the problems of high volume of liquid waste produced from wet coffee processing. This waste usually danger to soil and crops, all plants dead when touch with this waste. Improvement of the soil need to take at least 6 month to be normal again. The purpose of this study is to create technology in solving this waste problem through implementing fermentation by using indigenous micro organism (IMO) which finally produce liquid bio fertilizer. This fertilizer is then examined to the field research on coffee. In applying bio fertilizer for coffee crop it is shown that dilluting 5 times with water can produce better result for all parameter measured as indicated by high significant different amongst treatment. Therefore, liquid waste which was exposed as the main factor to break soil condition, in contrast now become a fruitful benefit for farmers in order to fulfill the need of organic fertilizer to protect organic sertification.

1. Introduction

In the globalization and fee trade era currently, the word quality becomes very important to take into account. The condition of comparative and competitive product especially coffee becomes more competitive. In the centre of bali coffee especially arabica coffee in the region called GI (geographical indication) start from Kintamani Bangli, Pelaga Badung and Sukasada subdistrict Buleleng, specialty coffee is one of the premium quality which can be broadly informed as the special taste for coffee buyers [1]. This region is cultivated by thousand of local farmers and they are called “MPIG (masyarakat perlindungan indikasi geografis)” – the organization to take care for the continuation of qualified coffee production. Now, producer coffee from many countries have been implementing the certification of GI (geographical indication) where they can improve the taste of coffee based on the region. They ussually provide special taste, that is called coffee specialty. The GI of Bali coffee is based on the some evaluation such as : (a) arabica bali coffee has an agroecosystem highland (more than 1000m above sea level), monoculture planting system, cool air, soil type entisol and inceptisol from volcanic ash of Batur mountain. (b) cultivation of specialty coffee here is managed by farmers group under “MPIG” organization who care with environmental aspects with love to God, humanbeing and environment called “Tri Hita Karana” means in implementing agriculture has to be harmonious, and coffee has been cultivated since along ago that is now classified as single origin [2], [3].
In cultivating coffee, Bali has total area about 15,000 ha where most coffee type is robusta normally in western and South part of Bali like in Tabanan. From this area about 74,34 % is robusta and 25,66 % is arabica coffee. From arabica coffee region, in 2007, Bangli district developed coffee around 3,935 ha and produced bean 1,661,328 ton and most production from Kintamani about 92,52 % and the rest is from Pelaga village Petang subdistrict, Badung and Sukasada subdistrict Buleleng. While development of robusta coffee is from Buleleng around 10.774 Ha with production about 5,902,949 ton [4]. With promoting specialty coffee for consumen local and international, therefore the requirement for quality is high. This is why, research on integration between crops and livestock become important in order to produce organic fertilizer as well as research on the utilization of wet organic fertilizer from fermentation of liquid waste of wet coffee processing. Many research similar to this activity has been reported capable to increase production and quality of products, as well as increase efficiency and income of farmers [5], [6], [7] and [8]. In cultivation of coffee crop, every year farmers finds problem of liquid waste. Similarly, two times per year farmers always find difficulty to supply organic fertilizer because they have to protect organic certificate for their crops. That is the main problem faced by farmers everu time. Therefore potency for increasing coffee bean quality currently can be improved through the role of wet organic fertilizer from liquid waste coffee processing which has been implemented on young coffee plant.

2. Metodology

2.1. Location and time of implementation
Research was conducted at the area of GI coffee located at Wanagiri village, Sukasada subdistrict of Buleleng Bali. The location is classified as upland farming systems. Most farmers are arabica coffee farming. Research was implemented in fiscal year 2016.

2.2. Materials and tools
In processing wet organic fertilizer from waste, it is required some materials and tools to support the processing activities, i.e. skin coffee from wet coffee processing 1 (one) kg, red palm sugar 1 kg, mature papaw fruit 1 kg, bamboo leaf waste one bunch, rice water 15 liter, and old coconut water 2 liter. Furthermore, it is also needed tools from a bucket of water for storing media liquid to collect microbes as a fermentor, liquid storage/kerosene, and fermentation plastic cover. In conducting field research to exam wet organic fertilizer on coffee, it is needed tools such as bucket, stick mixer, scoop, sprinklers for spraying wet fertilizer, scales, measure tools, land cultivation tools, etc.

2.3. Research implementation
There are two steps for implementing research activity, that are : (a) preparing the process of producing bio fertilizer through fermentation by using indigenous microbes as fermentor. All materials sources mentioned above (skin coffee from wet coffee processing 1 (one) kg, red palm sugar 1 kg, mature papaw fruit 1 kg, bamboo leaf waste one bunch, rice water 15 liter, and old coconut water 2 liter are demolished to be liquid media and it is stored in the plastic kerosene for two weeks. When it is opened will produce like wine smelling. During two weeks fermentation it is possible produced gas, and kerosene need to be opened then close again. After two weeks the liquid is called IMO (indigenous micro organism) [9]. IMO liquid is ready to be used for fermenting liquid waste of wet coffee red bean processing for around 10-4 days. When fermented liquid is ripe, it is ready to be applied for crops, beside its contain some microbes, this liquid aslo contain nutrients (maro and micro nutrients) [10], bio substances grow like gibberellin, sitokinin, GA, auxin [11]. (b) In research application of the above liquid bio fertilizer is examed on coffee using some treatments as follows:

- P0 : control (without given biofertilizer)
- P1 : bio fertilizer is dilluted 5 times
- P2 : bio fertilizer is dilluted 10 times
- P3 : bio fertilizer is dilluted 15 times
All treatments were given basic fertilizer 3 ton compost per hectare. Young coffee plant age 1.5 year was used to examine the effectiveness of liquid bio fertilizer. All treatments were made 4 times replications. Parameter measured were plant height, plant canopy and number of branch.

2.4. Data Analysis
After measurement of parameters, agronomic data is then analysis by statistics to understand whether the treatment weak or normal or high significant to influence the growth of young coffee.

3. Results and Discussion
Currently the main problem of cultivating coffee crop at rural farm level is lack of the availability of organic fertilizer to improve soil condition. Caring one or two cattle to support organic coffee is still not enough. With one cattle can only produce dunk about 1 ton per 6 months if convert to fertilizer, only 700 kg or 1.4 ton for two cattle. The requirement of fertilizer per ha is about 5 ton. While when processing wet coffee cherry once a year the production per hectare is predicted 800 kg, but it can produce liquid waste around 2.4 ton because cleaning 1 kg bean usually use 3 litre water. Currently this liquid is classified as waste and dangerous for environment. Trial for this waste by using fermentation of IMO within two weeks can produce liquid bio fertilizer from the so called dangerous liquid waste. Fortunately, the lack of organic fertilizer experienced by farmers during this time, exactly can be covered and solved by this fermentation result. The following data showed that fermented liquid waste to be bio fertilizer contain useful microbes and nutrients (see Table 1 and Table 2). While wet coffee processing can be seen at Figure 1, activities of processing microbial media at Figure 2 and producing bio fertilizer at Figure 3.

Table 1. Microbes content of bio fertilizer from fermentation of liquid waste of wet coffee processing.

| Type of microbes | Unit | Result |
|------------------|------|--------|
| Pseudomonas Sp.  | Cfu  | $5 \times 10^6$ |
| Bascillus, Sp.   | Cfu  | $6 \times 10^6$ |
| Ecoli            | Cfu  | NA     |

Source: [12]. Cfu = coloni form unit. NA = not available

From Table 1 above, data analysis showed that useful microbe was identified to be able for farming improvement, although more microbes can be explored from fermented liquid. Pseudomonas sp. For instance has a role in releasing the occluded P in the soil while Bascillus sp. is known as the degradator of organic matter and improve soil condition.

Table 2. Macro and micro nutrients available in the bio fertilizer from fermented liquid waste of wet coffee processing.

| Parameter | Content | Unit | Remark |
|-----------|---------|------|--------|
| N         | 0.0311  | mg/l | Low    |
| P         | 20.930  |      | High   |
| K         | 304     |      | High   |
| Mg        | 3.45    |      | Average|
| Ca        | NA      |      | -      |
| C-organic | 0.14    |      | Low    |
| Na        | 64.8    |      | High   |
| Zn        | NA      |      | -      |
| Cu        | 0.11    |      | Average|
| Fe        | 0.53    |      | Average|
| Co        | 0.01    |      | Low    |

Source: [13]
In addition analysis of biofertilizer is also result nutrients both macro and micro nutrients which is useful to support organic coffee development. It is showed that high content of P and K can be useful for coffee production in supporting development of flower or fruit. While trace or micro nutrient is required is securing he healthy of crops during steam and leaf development. It is therefore bio fertilizer from fermentaion of liquid waste of wet coffee processing has meaningful support for farmers in production system.

All above discussion is started from the process of fruit coffee processing such as the following step by step process:

**Figure 1**. Wet coffee processing activities to produce HS coffee.

From this processing, farmers are usually faced by the production of liquid waste until difficult to overcome. The more problems come up when the liquid waste move to field most crop within one week died. Because of this problem then one way to do is try to perform fermentation to change the poisonous element to be useful for crops. For producing fermentor, therefore, indigenous micro organism was used [11]; [14].

Processing liquid media to collect IMO usually takes time about 14 days and when this is success the smell of IMO like wine. The IMO is used then to perform bio fertilizer by mixing one liter IMO with 1000 liter of liquid waste. Many experiments showed that the role of local microbes is very effective they are both as soil improvement agents as well as its role as stimulating roots growth such as auxin content and other nutrients. [14] informed that process of producing local microbes can be made from fermentation of some substrate from organic materials which contain carbohydrate, protein, mineral, vitamin as the energy to attract the local microbes. The liquid media is then used to compost the organic material for producing organic fertilizer. Analysis content of microbes is presented at Table 3.

From types of microbes content, problem of liquid waste faced by farmers at wet coffee processing is seemed to be solved. Event it can produce better quality of bio fertilizer from liquid waste. While [11] informed that the role of local microbes from fermentation of organic substrate can be seen at the following Table 4.
Table 3. Population of local microbes contain in IMO liquid from mixed substrate of rice, papaw, cattle urine.

| Type of Microbe                              | Population (cfu/gram) |
|----------------------------------------------|-----------------------|
| Azospirillum sp.                             | 6,0 x 10^4            |
| Azotobacter sp.                              | 4,0 x 10^5            |
| Microbe for releasing Phosphorus             | 1,6 x 10^6            |
| Microbe celulolytic                          | 4,0 x 10^4            |

Source: [10]

Similar result was also informed by [9] as the founder of the IMO, the role of IMO as is conducted by [10] and [11]. From this table indicates that local microbes contain in the fermentation of liquid waste can provide hope to coffee farmers in overcoming their main problems during harvesting and processing coffee bean. To prove this condition, research has been made by using fermented liquid of coffee IMO at the field to coffee plant.

Table 4. Source of substrat for local microbes and its role.

| IMO source         | Content       | Function                                       |
|--------------------|---------------|-----------------------------------------------|
| Banana tuber root  | Sitokinin (hormone) | - Stimulating root growth, composting organic matter |
| Berenuk fruit      | ZPT (hormon)  | - Stimulating plant growth, composting organic matter |
| Bamboo shoot       | Giberelin     | - Stimulating plant growth, composting organic matter |
| Molusca            | Auxin (hormon) | - Stimulating plant growth, composting organic matter |

Source: [11]

Parameter measured was the height of plant, canopy and number of branch. All data is shown in the Table 5. From Table 5, it is showed that all treatments provide significant effect on the growth, canopy and branch. Statistical analysis explains the highest plant growth P1 (122.8 cm) has high significant different to the control (P0), not significant different with treatment P2 (107.8 cm) and significant different with treatment P3 (100.1 cm).

Table 5. The effect of bio fertilizer fermented from liquid waste of wet coffee processing at Giri Tani Farmers Grup, Sukasada, Buleleng, 2016.

| Treatment | Plant height (cm) | Canopy (cm) | Number of branch / plant |
|-----------|-------------------|-------------|--------------------------|
| P0        | 75,8 a            | 63,5 b      | 11,5 a                   |
| P1        | 122,8 c           | 97,3 c      | 18,5 c                   |
| P2        | 107,8 c           | 95,4 c      | 17,0 b                   |
| P3        | 100,1 b           | 59,6 a      | 17,0 b                   |
| BNT 5%    | 7,5               | 3,5         | 1,0                      |

Note: Each treatment is given base fertilizer (compost 5kg/tree); (P0 - control (without treatment), P1 – bio fertilizer (diluted with water 5 times), P2 – bio fertilizer (diluted with water 10 times), P3 – bio fertilizer (diluted with water 15 times).

The effect of bio fertilizer on canopy can be seen similar the treatment P1 provide the hieghst wide (97,3 cm) high significant different to treatment P3 (59,6 cm), significant different to treatment control P0 (63,5 cm), and not different with P2 (95,4 cm). While treatment for number of branch can be informed
same treatment of P1 provide the highest number (18.5) high significant different to control P0 (11.5) and significant different to both P2 (17.0) and P3 (17.0).

From all above discussion, it is perfectly believed that the effect of bio fertilizer which was fermented by IMO is useful and has good benefit to support coffee organic development. The main problems of farmers during this time now can be overcome and even they have very good prospectus to not just secure on organic fertilizer but also possible to shell bio fertilizer to other farmers. This on step for farmers to not dependant on outsider agricultural inputs but farmers themselves produce more than enough liquid bio fertilizer.

If the effect of bio fertilizer on coffee crop is seen per parameter, it is clearly showed that dilution with 5 times can provide better result as indicated in the following Figures 4.

![Figure 2. The effect of bio fertilizer per parameter on the growth of coffee, wide of canopy and number of branch](image)

4. Conclusion
From discussion it can be made conclusion: (a) main problem of coffee farmers during period of harvest and wet cherry processing can be overcome by processing liquid waste from wet coffee processing by using fermentor IMO (indigenous micro organism), (b) Research result showed that the best effect of bio nutrient from fermentation of liquid waste is noted from diluting bio nutrient 5 times with water followed by dilution 10 times. It is recommended to use 5 times dilution with water. (c) It is very possible farmers provide enough liquid bio fertilizer for their farmers group, even possible to use this chance for their business and welfare.

Acknowledgement
This research was conducted under budget support from AIAT Bali. Please allow me to express my sincere appreciation to AIAT Bali which had facilitated this research, and also my sincere thanks to research team and farmers group as well as all resource person, who had share this research. Thank you.

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