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Refermentation technology is re-fermenting dry coffee beans that have not been fermented or the market term is inferior coffee bean using kefir starter in automatic fermenter. Re-fermentation of coffee beans can enhance the pleasant aroma until 23 compounds in 37°C for 18 hours. Some compounds groups including of acid, alcohol, aldehyde and acetate groups were contributed to acidy, fruty, nutty and caramelly aroma. In this study, we continue our study to utilize SCG (Spent Coffee Ground) from refermented bean. Adding fungi starter such as Penicillium sp and Aspergillus sp with temperature control in composting SCG can improve quality compost produced, with the physical characteristics of compost black and crumb, and normal pH. While the chemical characteristics of compost produced is a C/N ratio below 10 with a far difference from the control. Compost is also richer in minerals, such as phosphorus, potassium, calcium, and magnesium, as well as rich in humic acid as shown from the results of the FTIR analysis. The Germination Index of the compost sample with the addition of fungi activator (C2) is 191.86% greater than the commercial activator (C1) 183.88%.

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Refermentation of Coffee Beans and utilization of Spent Coffee Ground

Advance Technology Processing to produce specialty coffee and organic compost from spent coffee grounds

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Asmak Afriliana
Prefectural University of Hiroshima
February 2021

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CHAPTER 1

GENERAL INTRODUCTION

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Chapter 1

General Introduction

1.1. RATIONALE

Coffee is an agricultural commodity that is in great demand by peoples. Coffee has become widespread throughout the world as a favorite beverage. This is because coffee has a special taste and often has an addictive effect for the drinker. In addition, there are many health benefits of coffee. That is the main reason researchers are competing to do research on coffee. In producing countries, fruit cultivated in coffee trees harvested, subjected to dry refining or wet refining, and then exported as raw beans. Dry refining involves sun drying the harvested fruits and removing the raw beans from a completely dry state. In wet refining, the peel and pulp are mechanically peeled off and immersed in water to decompose the sticky substances that adhere to the raw beans due to the action of microorganism. In consuming countries, raw beans are roasted to make roasted beans. To produce good quality coffee flavor, researchers work hard to carry out processing engineering, such as optimization of the coffee processing method where the main key to taste is the fermentation process. The following are the stages of the coffee refining process, in Figure 1.1.

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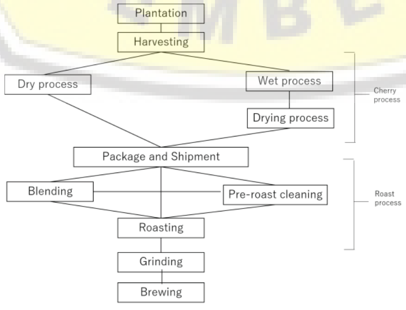

Figure 1.1. General Scheme of Coffee Processing

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Therefore, in this doctoral thesis study, fermentation processing engineering was also studied, which is a relatively new technique, namely the coffee bean refermentation technique to improve the taste quality of coffee. In addition, we also studied the utilization of Spent Coffee Ground (SCG). The term referenced which means re-fermenting dry coffee beans that have not been fermented or the market term is inferior coffee bean. The purpose of this refermentation technique is to improve the taste quality of the inferior coffee beans that are already on the market. From dry coffee beans that have low flavor quality, we can still improve their quality with this technique. Usually in the market, the inferior coffee is sold so low price that it is very detrimental to farmers.

The fermentation process usually requires a medium as nutrients for the growth of microorganisms. In coffee, coffee fermentation techniques are usually carried out on coffee cherries, which are fruit that are still intact or coffee beans that have been peeled or dipped and still contain mucilage as a medium or nutrition for microorganisms to carry out the fermentation process. Mucilage enveloping the coffee beans, Figure 1.2 shows the anatomy of the coffee cherries. Whereas in the refermentation technique, because the fermentation process is carried out on dry coffee beans, it is necessary to recondition the beans so that they are ready for fermentation. The coffee beans are soaked in water until the water content is around 60%, then a starter is added and fermented at temperature of about 21, 37, and 47^{0}C in a controlled reactor. In this study we use kefir or fermented milk beverage containing lactic acid bacteria and yeast as starter cultures. In addition, in this study, lactose was added to increase nutrition for microorganisms and improve flavor. The dried beans were roasted and crushed to extract coffee, and sensory test and chemical analysis were performed. The pyrazine and aldehyde components increased to more than 20% each. These were factors that made smell of chocolate and nuts by expert panelist. In addition, this study will add references to coffee fermentation techniques. The results of the analysis using this technique were able to increase the score by about 4 due to the change in these chemical composition.

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Conclusion

Combination of some fungi activators with temperature control in composting SCG can improve quality compost produced, with the physical characteristics of compost black and crumb, and normal pH. While the chemical characteristics of compost produced is a C/N ratio below 10 with a far difference from the control. Compost is also richer in minerals, such as phosphorus, potassium, calcium, and magnesium, as well as rich in humic acid as shown from the results of the FTIR analysis. Addition of a combination of fungi starter such as *Aspergillus sp*, and *Penicillium sp* can compete with commercial activators. This is also evidenced from the results of the phytotoxicity analysis, where the Germination Index (GI) of the compost sample with the addition of fungi activator (C2) is 191.86% greater than the commercial activator (C1) 183.88

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CHAPTER 5

GENERAL CONCLUSION

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Chapter 5

Overall conclusion and future directives

In this book for each chapter give brief conclusions, which include comments and summary. The overall concluding remarks of this dissertation, the unsolved analysis for this investigation and the future direction of concerned issues are highlighted in this chapter.

5.1 OVERALL CONCLUSION

Technology of refermentation inside of automatic reactor using kefir starter can increase quality of coffee bean. Kefir microbial community, which is generally composed of different lactic acid bacteria (LAB), acetic acid bacteria (AAB), and yeast species (Farnworth, 2005). Presence some metabolic products by kefir such as organic acids (lactic acid, acetic acid, butyric acid, propionic acid, and citric acid). This organic acid plays a role in reducing the pH after the coffee refermentation process. The fermentation temperature has a significant effect on the pH of the coffee beans. Fermentation using a temperature of 37°C has the lowest pH value compared to seeds coffee is fermented using temperatures of 27 and 47°C. The total lactic acid bacteria at 37°C fermentation with time 12 and 18 were not significantly different, namely 7.59 and 7.76 log cfu / g. This value is higher than in temperature 27 and 47°C.

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Refermented beans for 12 hours produce the best score of cup test, 80.5. This value is up almost 5 points from the control or sample of unfermented Robusta coffee 75.87. This indicates that refermented Robusta beans have succeeded in entering the specialty coffee category. To be classified as specialty coffee, a coffee needs to obtain a quality score of 80 or higher on a 100-point scale from the coffee-tasting process (Specialty Coffee Association of America [SCAA], 2016). The characteristics assessed on the cup test are aroma, flavour, after taste, acid / salt, bitter / sweet and balance.

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Beside cup test analysis, we also conduct volatile compound analysis. Volatile compounds have an important role in quality coffee (Sunarharum, 2016). Based on the identification of volatile compounds in unfermented Robusta coffee (control) and refermented using kefir, shows during refermentation an increase in the number of volatile compounds that can be identified. 17 compound of control Robusta coffee beans were identified, while the fermentation treatment with kefir starter at 37°C shows that it increases with the time of fermentation. Fermentation during 6, 12 and 18 hours were identified 21, 22 and 23 volatile compounds, respectively. Some compounds group including of acid, alcohol, aldehyde and acetate groups were contributed to acidy, fruty, nutty and caramelly aroma.

Coffee grounds from the results of this refermentation technique, with the minimum content of caffeine and polyphenols, have potential if implemented for plant growth. In this study, we continue our study to utilize SCG (Spent Coffee Ground) from refermented bean. We studied composting of SCG by the addition of some fungi as starter culture with temperature control, such as *Aspergillus sp* and *Penicillium sp.* Combination of this fungi with temperature control in composting SCG can improve quality compost produced, with the physical characteristics of compost black and crumb, and normal pH. While the chemical characteristics of compost produced is a C/N ratio below 10 with a far difference from the control. Compost is also richer in minerals, such as phosphorus, potassium, calcium, and magnesium, as well as rich in humic acid as shown from the results of the FTIR analysis. Addition of a combination of fungi starter such as *Aspergillus sp*, and *Penicillium sp* can compete with commercial activators. This is also evidenced from the results of the phytotoxicity analysis, where the Germination Index of the compost sample with the addition of fungi activator (C2) is 191.86% greater than the commercial activator (C1) 183.88%.

SCG compost then apply to plant growth for pot treatment. SCG compost which has been enriched with inoculant starter for composting can stimulate plant growth more when compared to commercial compost both organic and inorganic compost. This is evidenced by the longer the plant stem and the wider the leaves. In addition, the

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results of plant macronutrient content analysis also showed that the addition of compost during seeding can improve plant nutrients such as phosphorus, nitrogen, potassium, and other macro minerals so that it had a good impact on plant growth. Plants with the addition of SCG compost (C2) as much as 3% have the best results when compared to the addition of commercial compost (C1) and compost control (C0) in terms of plant physical and nutrients contained therein. Likewise, with the biomass produced. The results of the in vitro germination index analysis also proved that the fungi starter implemented in the Mustard plant had the best GI value, namely 200.4%.

5.2 FUTURE DIRECTIVES

To understand more deeply about the refermentation technology using the kefir starter. In the future, it is necessary to identify the types of microorganisms in kefir, then study each of the resulting metabolisms and what enzymes play a role. In addition, the chemical properties change in the coffee beans after the refermentation process. This is of course because the chemical properties also have an influence on the quality of coffee and its taste. One example is caffeine which affects the bitter taste of coffee beans.

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Likewise, with SCG compost, it is necessary to study how much the compounds in it have a toxic effect on plants. Such as caffeine, tannins, and polyphenols. For polyphenols, it is also necessary to research the types of polyphenols. Because not all polyphenols have a negative effect on plants. For starter fungi, it is also necessary to investigate the fungal species using PCR analysis, as well as their metabolism during the composting process which can degrade organic material from SCG and others material. In addition, to maximize the quality of compost, in the future this compost has the potential to be made nano compost so that nutrition release can be slowed down and have good effects not only in the short term, but also in the long term as well for plant growth.

While in pot treatment, in the future, to really know the effect of PGPF (Plant Growth Promoting Fungi) on plants, it is necessary to analyze the types of

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microorganisms or fungi in plant roots using SEM (Scanning Electron Microscopy). In addition, the analysis of pot treatment is further extended not only during the vegetative period but also during the generative period of the plant. This is to determine the long-term effect of compost on plants. It is also good to analyze the effects of compost on the soil. Therefore, the benefits of compost can be known for both plants and soil.

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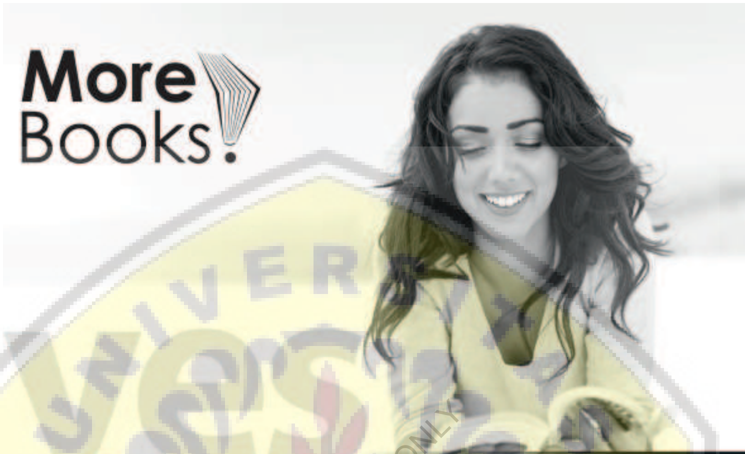

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