Effect of Fermentation Media on the Quality of Arabica Wine Coffee

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Abstract. The fermentation of arabica wine coffee from the cherry is one of the methods in processing the coffee which has the wine taste. The selection of media of fermentation is also one of the factors influencing the taste of the arabica wine coffee. The difference in the fermentation process of the coffee bean affects the taste and quality of the coffee. The fermentation process can take place in the aerobic, anaerobic and semi-aerobic state. The process is a fermentation using a glass bottle, can, and a plastic sack as the media and kept in the storage for seven days. After the fermentation, the coffee was dried for 21 days until the moisture content reaches 10% and the total bacteria were enumerated. The enumeration of Lactic Acid Bacteria (LAB) which was conducted before and after fermentation with a dilution factor of 10⁻⁴ to 10⁻⁶ shows that the total LAB tends to decrease along with the higher factor of dilution. This result comes from the dilution factor of 10⁻⁴ to 10⁻⁶ with the total bacteria of 2 to 8 colonies depends on the number of dilutions. The sample analysis used was cupping test which gives the result that the coffee aroma of ages, woody, strawy, fermented, clean and fresh, which is the characteristics of wine taste. The best container obtained in this research is the coffee which fermented in a glass bottle and can. Meanwhile, the coffee fermented in a plastic sack was highly contaminated when the fermentation occurs.

1. Introduction
Coffee plant (Coffea sp.) is an important plantation commodity in Indonesia. Indonesia is the third-largest coffee producer country with a percentage of 6.8% production from the total coffee production in the world. The number one coffee producer is Brazil with the percentage of 35.8%, followed by Vietnam in the second place with the percentage of 14.5% from the total coffee production in the world [1, 2].

There are several types of coffee (Coffea sp.) that had been known in society which are arabica, robusta, and liberica. The type of arabica and robusta is the most supplier of the worlds’ coffee trade due to its economic and commercial value. The robusta has the lower cost because it is considered to have a lower taste quality and higher caffeine content than arabica coffee. In Indonesia, the area of the plantation for robusta coffee is larger than arabica because the robusta is more resistant to coffee leaf rust and the area of arabica plantation is limited to the growth altitude of up to 1000 meters above sea level [1].

According to the National Coffee Association, coffee drinkers nowadays consists of various ages. The highest ranking of coffee drinkers currently occupied by an average age of 25-39 years old. However, the increase in a number of restaurant or café which process the coffee to be more attractive and varied makes the percentage of the coffee consumer in teenager and adult tends to improve every year. In 2017, about 50% of people aged 18 to 24 years old consumed coffee every day. This percentage
is increased from 2016 before which has the number of 48%. Meanwhile, the age of 40 to 59 years increased from 53% in 2016 to 65% in 2017 [2, 3].

Arabica coffee is one of the types of coffee produces in Gayo Highland. Gayo arabica coffee is the top 10 best arabica coffee in the world. It makes the Gayo arabica coffee has the potential to developed into a product of diversification. One of the product diversifications that can increase the added value for Gayo arabica coffee farmers is wine coffee. The terms of wine coffee obtained from the presence of aroma and taste of coffee brew which is similar to the aroma and taste of the wine. The production of wine coffee begins with the fermentation process of cherries for seven days in a closed container and then dried in the morning until the moisture content reaches 10 – 12 %. The aroma of wine coffee brew is the result of compounds converts which is caused by the metabolism process of microorganism during the fermentation. Nevertheless, the strong aroma and taste of wine in coffee do not eliminate the authentic taste of Gayo arabica coffee. This combination of unique taste cannot be formed in another kind of processing.

The processing of coffee depends on the type of coffee produced. Some of the problems in coffee processing are when in time of harvesting, there is a delay in direct processing. Thus, the coffee that has been picked will be stored. The storage will lead to the occurrence of a fermentation process which produces a different taste from the regular coffee processing. The change in taste will create a new group of a coffee drinker on the consumer. This change that caused by the delay in the process can be a bad value for processing the coffee drink [4,5].

The coffee taste produced has a taste similar to wine; the wine had been known as an alcoholic drink product in France since 6000 BC. The wine was made from the fermentation of sugar in grapes which converted into alcohol [3]. The processing of wine with different material has been applied by the winemaker to create a various taste and has promising market competitiveness. One of the raw materials requirements in the making of wine is the ones that contain a high COMPOUND OF SUGAR [6]. The processing of wine coffee was found inadvertently. Thus, it becomes the reasons to find out the complete information about processing coffee that has the taste of wine.

The wine has polyphenolic compounds which consist of two categories namely flavonoid and nonflavonoid compounds. The non-flavonoid compounds are phenolic acid and lignin. In wine, there are also hydroxiflavonoid compounds such as flavonols, flavones, flavononols, flavanones, isoflavonones, catechins, and anthocyanidins. These compounds act as an antioxidant, antithrombocytes, anti-inflammatory, hypo-allergenic, anti-microbial and viruses, and anTI-CARCINOGENIC [7].

2. Material and Method

The materials used in this research are coffee cherries of Tim-Tim variety which were sourced from Bies Sub-district, Aceh Tengah Regency with the altitude of 1200 meters a.s.l. The coffee used is ripe cherries. The method used is fermentation of cherry with the variation of media, which are a glass bottle, can, and plastic sack. The cherry is fermented for seven days and dried for 21 days without the sunlight until the moisture content reaches 10%. After that, the coffee is roasted in standard medium roasting. Analysis performs on total LAB using TCC MRS method for each sample and compares the quality using descriptive test.

2.1. Total Microba Analysis [8, 9].

Sample (5 g) was put in 45 mL buffered peptone water sterile (BPW, b/v) solution and then homogenized. After that, 1 ml of the sample was taken and added into 9 ml sterile BPW and diluted until 1:10n. Subsequently, the sample used for three highest dilutions is piped about 100 microliters aseptically and put into a sterile petri dish and poured into a sterile de Man Ragosa Sharpe Agar (MRSA). Then the sample was incubated at 37°C for 48 hours, and the colony was enumerated with the value ranged from 30-300 colonies.
2.2. SCAA Descriptive Test [8, 10].

2.2.1. Serving method
The coffee ground is scaled about 8.25 g and placed in a uniform petri dish and given random code. Subsequently, 150 ml of water is heated for each cup and left to a temperature of 90-95°C, and the questionnaire was prepared.

2.2.2. Testing Method:
The panelist sat in the space provided, afterward the sample is randomized, and the panelist tested and assessed the attribute of aroma, flavour, aftertaste, acidity, body, balance with the order of: Aroma/fragrance: the coffee ground is brewed with 150 ml hot water in temperature of 90-95°C and left for 3-5 minutes. Do the brake by stirring the solution three times until the coffee ground and foam decreased. Flavour, aftertaste, acidity, body, and balance: tested on the cold sample with a temperature of 71°C in 9-10 minutes of brewing. The evaluation of steeping need to conducted immediately, the liquor aspirated into the mouth to cover as much area as possible especially the tongue and upper palate. Flavour and aftertaste were rated at this point. During the process, the coffee would cold down from 71-60°C and acidity, body and balance were rated at that time.

3. Result and Discussion
Fermentation process which conducted to produce wine coffee with a variation of media resulting coffee with different quality (Figure 1). In this research, it can be seen that the quality of coffee from the altitude of 1200-meter above sea level {asl} is one of the best coffees in the processing of wine coffee. The higher area of the coffee grown, the better quality of coffee produced. This result is shown in the characteristic of fruit and quality of the coffee bean produced.

The process of making wine coffee has certain methods, one of which is used in this research that is not using the sun drying but exposed to wind in the morning. Thus, the drying takes time about 2 hours per 21 days to produce dried coffee bean with a standard moisture content of 10%. This method was conducted to make the fermentation proceed thoroughly.

The difference of fermentation container resulting in different color and taste, also total bacteria, fungi, and other microorganisms. This result is due to the growth media is in the state of aerobic, anaerobic, and semi-aerobic. The research shows that the product in the glass bottle has a brighter color than the one in the cans. Moreover, it has a significant difference with the coffee fermented in a plastic sack which tends to have microorganism growth considerably.

This process influences significantly on the fermentation process during the coffee processing. Fermentation in the can shows a darker color due to the coffee fermented in an anaerobic environment and without the light. Furthermore, the can is highly contaminated with the acid. Hence, it affects the color of the product. The fermentation in the plastic sack resulting in a darker color than the one in an anaerobic state. This is due to the availability of oxygen which can be used by the bacteria to complete the fermentation. Moreover, the fermentation converts the red cherry into blackish color accompanied by maggots, bacteria, and living mold. Thus, the total microorganism in aerobic fermentation is higher than anaerobic and semi-aerobic fermentation.

![Fermentation in a glass bottle](image1)
![Fermentation in can](image2)
![Fermentation in a plastic sack](image3)

**Fig. 1.** Coffee bean after seven days of fermentation
The result of the research shows that seven days fermentation with the variation of fermentation media effect significantly on the taste quality. It can be seen in the graphic below that the total LAB in control before the fermentation is very high, which attained 653 colonies. Similarly, the fermentation in the can gives nearly the same result (Figure 2). This outcome shows that there is a rapidly growing organism in the can. Meanwhile, in the glass bottle, the fermentation occurs lower than the other. Hence, it shows that the fermentation occurs semi-aerobic

**Table 1.** Analysis data of TCC MRS on seven days fermentation

| Sample | Factor of Dilution |
|--------|-------------------|
|        | 10-1 | 10-2 | 10-3 | 10-4 | 10-5 | 10-6 |
| Control | 653  | 317  | 26   | 3    | 0    | 0    |
| Glass   | 383  | 184  | 30   | 3    | 2    | 1    |
| Can     | 646  | 220  | 53   | 8    | 1    | 0    |
| Sack    | 400  | 313  | 50   | 2    | 1    | 1    |

The alteration in coffee bean when fermentation takes place is due to the conversion of sugar compounds in outer skin which lies mucilage into the alcohol. The conversion induces the coffee plant to absorb the water from the environment. Hence, the coffee bean tends to release water. The water that comes out from the bean is utilized by the microorganism as the growing media so that the bacteria, mold, maggot, and other living microorganism emerged during fermentation. The mucilage or outer skin in coffee will produce a mild taste on coffee [4, 11].

The fermentation process which takes place in the anaerobic state will produce union taste because there are a combination of acid and stink taste as the result of the decomposition of microorganism. Thus, it needs special handling after the fermentation process, one of which is periodic washing

![TCC MRS Analysis](image)

**Fig. 2.** Analysis Result of the Total LAB with TCC MRS

However, the washing was not done in this research because we expected a high acid taste so that the wine taste on coffee is more pronounced on its organoleptic test. The fermentation was conducted at a temperature of 28°C to 30°C. The microorganism growth is dominant in 30°C. In a condition when the temperature is less than 30°C, the microorganism who produce the acid is hampered and delay the process.

In a dry fermentation, it is expected that there is compounds transformation that occurs more intensively by the bacteria, and mold which is aerobic and produces a metabolite that emerges unpleasant odor. The result of the research from Ref. [12] shows that the aerobic mold, *Aspergillus amstelodami*, *A. Flavus, Penicillium cyclopium*, and *Fusarium culmorum* gives the main metabolite such as metal-
furan, 2 metil-propanol, and 3-metil-butanol. These three metabolites have the character of smoke odor, burned odor, and sweet and burned odor in sequence. Dry fermentation must be controlled so that there is no excessive fermentation process which leads to the onion taste due to the emergence of acid and stink as a result of decay by microorganisms.

This fermentation occurs with the contribution of the microorganism (Saccharomyces) which is called as ripening process [13, 10]. The yeast will convert the sugar on the substrate into alcohol in an aerobic environment and then evaporated. The pulp in coffee contains a high content of sugar; hence with the availability of oxygen from the air, the Saccharomyces cerevisiae will break down the sugar compound in the coffee bean. The fermentation reaction initiates from the top of the stack considering it has a lot of oxygen. The outer layer will be peeled off, and the compounds from the reaction moved down to the bottom of the plastic stack and accumulated at the base of the sack. This process detained the fermentation reaction of coffee bean which located at the bottom. The end of fermentation indicated by the peeled off of the outer skin which covers the parchment. Within one night, all sugar and carbohydrates in the outer skin will be fermented by yeast Saccharomyces cerevisiae.

An overlong fermentation process is yielding a musty coffee bean due to the occurrence of component breakdown in the endosperm. The accomplishment degree of fermentation is measured by the appearance or stickiness of the mucilage layer on the surface of the parchment [12,1].

**Cupping Test**
The wine arabica coffee was tested using cupping test. The method of cupping test used is the SCAA method, and the result from the test of arabica wine coffee which fermented for seven days shows a similar result with the other test. However, on the test for coffee in the sack, it is found that there is one sample that has the zero score for a clean cup, which means there are untypical taste or aroma in the coffee that has been tested.

| Table 2. Analysis Data of Test Cupper Team |
|-------------------------------------------|
| Fermentation Media | Bottle | Can | Sack |
| Aroma | 7.75 | 8.00 | 6.50 |
| Flavour | 7.50 | 8.00 | 6.00 |
| After taste | 7.50 | 7.50 | 6.00 |
| Acidity | 7.50 | 7.75 | 6.00 |
| Body | 7.75 | 7.50 | 7.50 |
| Balance | 7.25 | 7.50 | 6.00 |
| Uniformity | 10.00 | 10.00 | 10.00 |
| Clean cup | 10.00 | 10.00 | 0.00 |
| Sweetness | 10.00 | 10.00 | 10.00 |
| Overall | 7.75 | 7.75 | 6.00 |
| Total Score | 83.00 | 84.00 | 64.00 |

The value of aroma, flavour, aftertaste, acidity, body, and balance tends to have a similar result. Nevertheless, the slightly different result obtained from coffee fermented in the sack. This suggests that the fermentation in the plastic sack is more sensitive than the one in a bottle and can. Fermentation in bottle and cans are much more controlled.
Fig. 3. The result from cupping test value for glass, can and sack media

Therefore, the coffee product is more acceptable than those fermented in the sack when it is tested for the cupping test. This result is due to the number of other microorganisms which develop in the sack, which are mold and yeast that interfere with the fermentation process. It can be concluded that to produce a wine-like taste from a coffee can be obtained from aerobic and anaerobic fermentation using a closed bottle or can as the media.

4. Conclusion

The result from the research shows that the fermentation process in arabica wine coffee give a better result in a glass bottle and can media. The fermentation occurs in ambient temperature, which is about 30°C to supporting the fermentation process. Fermentation was conducted for seven days, while fermentation for lower temperature was conducted for 14 and 21 days, depends on the temperature used. From the result, it can be concluded that the variation of fermentation media has a significant effect on the result of cupping test.

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