The effect of fermentation on acidity, caffeine and taste cascara robusta coffee

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Abstract. Robusta coffee is in demand by the global market because of its distinctive aroma. Along with the high demand, robusta coffee waste known as cascara needs processing. Cascara which has a unique taste needs innovation to improve its quality. One of the efforts made is by varying the fermentation process. The purpose of this study is to examine the effect of the fermentation process on pH, caffeine and flavor in cascara robusta coffee. This type of research is experimental. The results showed that the fermentation process had an effect on pH, caffeine and flavor values. The non-fermented cascara has the lowest pH average value of 4.22, the natural fermented cascara has a pH value of 4.58, while the fermented cascara wrapped in banana leaves has a pH value of 5.24. Calculation of caffeine content in non-fermented cascara, natural fermented cascara and fermented cascara wrapped in banana leaves were 1.22%, 1.17%, and 1.14%, respectively. The taste test results of the non-fermented cascara, natural fermented cascara and cascara wrapped in banana leaves were different for each treatment.

Keyword: Fermentation cascara, acidity, caffeine, taste.

1. Introduction

Indonesia is the fourth largest coffee producing country in the world. One of the varieties of coffee grown in Indonesia is robusta. Robusta has advantages including it is resistant to pests and diseases and has a high acidity and strong aroma [1] and has a relatively bitter taste. The uniqueness of coffee taste and its caffeine content is very interesting to investigate. Apart from caffeine, there are also other compounds in coffee that have a million benefits in preventing several diseases so that it is considered a functional drink.

The byproduct of coffee processing known as cascara has not been used optimally. Most of the cascara is discarded, not processed into a useful product. If farmers are innovative, cascara can be used as a functional material in the industrial sector. Cascara can be processed into a refreshing drink with
rich benefits [2]. Cascara is also unique in terms of aroma and taste [3]. Processed coffee relies on bioactive components including phenolic compounds (chlorogenic acid, cafestol and kahweol), alkaloids (caffeine and trigonelin), and other secondary metabolites [4]. The presence of chlorogenic acid in cascara as a dominant phenolic can be beneficial because it has antioxidant properties for health [5]. The content of other compounds in cascara is carbohydrates, protein, fiber, fat and caffeine [6].

In general, post-harvest coffee processing is carried out using dry / natural, wet and mixed processes. Correct processing of cascara gives off a fruity aroma such as watermelon and black currants. However, although there are many processing processes, cascara has not been liked by many people. Based on the results of observations made, cascara robusta coffee has a less distinctive aroma and even tends to be unpleasant, tasting, and slightly bitter. This is due to the presence of protein in coffee which is a derivative of free amino acids so that it affects the bitter taste apart from coffee caffeine [7]. Caffeine can show cytotoxic properties in biotechnological transformation microorganisms and physiological disorders of the nervous system [8], caffeine can also affect the cardiovascular system, kidneys and adipose tissue and have a regulatory effect on inflammatory diseases.

One of the efforts to improve the taste is the fermentation process. The use of the fermentation process is considered effective for health using modern biotechnology [9] which can be done by utilizing the growth and metabolic activity of microorganisms to stabilize the desired agricultural products in food products [10]. This is in line with research [11 &12], fermentation is considered to change the chemical composition with the help of microbes and enzymes. The coffee processing process using the remaining coffee residue is also considered to be able to maximize fermentation because it can be used as a substrate for fermentation [6]. The fermentation stage is considered important in coffee processing because it affects the final quality of the product [13]. In addition, the use of cascara fermentation can increase the selling value, the nutritional value of the material and the digestibility coefficient, in addition to minimizing greenhouse gases and making the agricultural environment not polluted [14].

Therefore, this research will apply the fermentation process and pH measurement in an effort to improve the taste of cascara. Based on the description above, the authors are interested in conducting research on "the effect of the fermentation process on pH, caffeine and the taste of cascara robusta coffee". This study aims to examine the effect of the fermentation process on pH and taste in cascara robusta coffee.

2. Methods

This research was conducted at the Biology Education Laboratory of the University of Jember in May 2020. The sample used was cascara robusta coffee obtained from coffee plantations in the Gunungpasang area, Panti, Jember. The materials used are cascara robusta coffee and banana leaves. The tools used in this research are analytical scales, separating funnel, hot plate, oven, drying tray, grinder, packaging equipment, fermentation tub, coffee peeler, beaker glass, measuring cup, micropipette and digital pH meter. The acidity test used a digital pH meter, the caffeine test was carried out by the extraction method and the taste test was carried out on 20 people. This type of research is experimental research where the sample is divided into 2 groups. In this study, the control group used non-fermented cascara. The treatment group, cascara was carried out by natural fermentation wrapped in banana leaves.

The stages of making non-fermented / natural fermented / fermented cascara wrapped in banana leaves are by preparing coffee fruit samples obtained from farmers, sorting manually with the aim of separating the young fruit and the rest of the dirt. Grind coffee with a pulper machine that aims to separate the coffee beans and the dregs (cascara). The cascara obtained is then collected and ready to be used for the manufacture of research raw materials. Cascara obtained from the pulper machine weighs 500 grams each and is separated according to several variations of the treatment to be carried out. The non-fermented cascara processing process begins with washing the cascara before stripping it, then separating the fruit skin from the seeds. The rind obtained, dried under the sun for 48 hours (moisture content about 12%).

In contrast to natural cascara fermentation, the cascara that has been obtained is not directly dried in the sun but fermented for 12 hours. The first step taken was washing the cascara before the process of separating the rind from the coffee beans. Let the cascara sit in a closed container for 12 hours, then dry it in the sun for 48 hours (12% moisture content). Do the same with the cascara fermentation with banana
leaves. Cascara, which has separated the skin of the fruit from the coffee beans, is not placed in a closed container, but wrapped in banana leaves for 12 hours. The cascara results from several treatments are then carried out by the grinding process, stored in a tightly closed glass container that has been coded, until they are ready to be used for measuring pH, caffeine content and taste testing. Cascara processing, can be seen in the following figure.

Before doing cascara brewing, make sure the cascara is completely dry. Cascara from each treatment was weighed as much as 2 grams and added 100 ml of hot water at 90oC. Cascara brewing is done after 5 minutes of soaking. Cascara is filtered then the results are taken and left to stand for ± 5 minutes to obtain temperature uniformity. Calculate the pH and perform an organoleptic test. Organoleptic test was conducted to determine the level of consumer preference for the color, taste and
aroma of the cascara produced. Preference test is a test that asks panelists to express their responses in the form of likes or dislikes on the material being tested. The preferred testing method used is scoring.

The caffeine test was carried out using the extraction method (Jacobs.1962). The cascara sample that had been finely ground and passed the 30 mesh sieve was weighed as much as 5 grams, then put it in the erlenmeyer. Once covered with a cooler, then simmer for 2 hours slowly. After chilling it is diluted with distilled water in a measuring flask so that the volume is exactly 500ml, then filtered. 300ml of the filtrate is taken, put in a volumetric flask, added 10ml of H$_2$SO$_4$ (1: 9) and shaken many times with chloroform using 25 ml, 20 ml successively, 15 ml, 10 ml, 10ml, and 10 ml. This rinse fluid is inserted into the separating funnel. Into the separating funnel, 5ml of 1% KOH is added then shaken and left for a while until the liquid is clear. The bottom liquid is a solution of caffeine in chloroform, removed and stored in erlenmeyer. To the separating funnel, another 10 ml of chloroform is added, shaken and left until the liquid is clear, then the lower liquid is removed and collected in the same erlenmeyer as above. This treatment was repeated once again. The caffeine solution in chloroform is then heated in a water bath so that the residue remains, then dried in an oven at 100$^0$C until a constant weight is obtained which is the weight of crude caffeine. The results of the cascara infusion were analyzed chemically and organoleptically. The chemical analysis carried out included acidity [15] and caffeine content, while the organoleptic test included taste tests in the form of aroma, taste and color which were analyzed using the panelists’ preference test (hedonic scale).

3. Result and Discussions

From the observation of the effect of fermentation variations on caffeine, pH and taste of cascara robusta coffee, both the control and experimental groups. Data on the effect of fermentation on acidity cascara robusta are presented in Table 1. below:

Table 1. Data on the effect of fermentation on acidity cascara

| No | Control Group | Eksperimental Group |
|----|---------------|---------------------|
|    | Cascara Non-Fermentation | Cascara Natural fermentation | Cascara Fermentation wrapped in banana leaves |
|    | Acidity | Acidity average | Group | Acidity | Acidity average | Group | Acidity | Acidity average |
| 1  | K$_1$ | 4.23 | 2.3 | E$_{1.1}$ | 4.61 | 4.60 | E$_{2.1}$ | 5.27 |
|    | 4.22 | 4.23 | 4.60 | 4.60 | 5.23 | 5.24 |
| 2  | K$_2$ | 4.20 | 4.22 | E$_{1.2}$ | 4.58 | 4.56 | E$_{2.2}$ | 5.25 |
|    | 4.24 | 4.22 | 4.60 | 4.60 | 5.24 | 5.24 |
| 3  | K$_3$ | 4.25 | 4.21 | E$_{1.3}$ | 4.60 | 4.60 | E$_{2.3}$ | 5.25 |
|    | 4.20 | 4.21 | 4.60 | 4.60 | 5.24 | 5.25 |
|    | Average | 4.22 | 4.58 | 5.24 |

Based on Table 1, there are differences in the acidity of the non-fermented cascara, natural fermented cascara and fermented cascara wrapped in banana leaves. In the control group, non-fermented cascara had a acidity value of 4.23. In the experimental group I, the natural fermentation cascara has a acidity value of 4.60. Whereas in the experimental group II, cascara fermentation wrapped in banana leaves had a acidity of 5.24. Based on these data, it can be stated that the presence of fermentation treatment can increase the acidity value of the cascara. The average number of acidity values in the control group was lower than the experimental group. Low acidity value indicates that it is more acidic than other treatments. The level of acidity of the cascara is influenced by the processing process and the type of coffee used. In this study, the type of coffee used is the same, namely robusta coffee, so it is suspected that what affects the acidity of this cascara is a different processing process. The higher the fermented sugar content, the higher the organic acid produced so that the acidity will be lower [16]. This study also examines the effect of the fermentation process on caffeine levels. Data on the effect of fermentation on cascara robusta caffeine levels are presented in Table 2. below:
Table 2. Data on the effect of fermentation on cascara caffeine levels

| No | Control Group | Experimantal Group |
|----|---------------|-------------------|
|    | Cascara Cena | Caffeine Average | Cascara Natural fermentation | Caffeine Average | Cascara Fermentation wrapped in banana leaves | Caffeine Average |
|    | Non- | | E1,1 | 1.16 | 1.17 | 1.13 |
| 1   | 1.19 | 1.22 | 1.19 | 1.16 | 1.14 | 1.16 |
| K1  | 1.25 | 1.19 | 1.16 | 1.14 | 1.15 | 1.15 |
|    | 1.19 | 1.16 | 1.16 | 1.14 | 1.15 | 1.15 |
| 2   | 1.21 | 1.18 | 1.18 | 1.14 | 1.15 | 1.15 |
| K2  | 1.26 | 1.21 | 1.21 | 1.14 | 1.15 | 1.15 |
|    | 1.19 | 1.16 | 1.16 | 1.14 | 1.15 | 1.15 |
| 3   | 1.22 | 1.23 | 1.19 | 1.16 | 1.14 | 1.14 |
| K3  | 1.26 | 1.19 | 1.16 | 1.14 | 1.15 | 1.15 |
|    | 1.19 | 1.16 | 1.16 | 1.14 | 1.15 | 1.15 |

Based on Table 2, there are differences in non-fermented cascara, natural fermented cascara and fermented cascara wrapped in banana leaves. In the control group, non-fermented cascara had a caffeine value of 1.22. In the experimental group I, the natural fermentation cascara had a caffeine value of 1.17. Whereas in the experimental group II, cascara fermentation wrapped in banana leaves had a caffeine of 1.14. Based on these data, it can be stated that the presence of fermentation treatment can reduce the value of cascara caffeine. The average caffeine value in the control group was higher than the experimental group.

The sensory evaluation of cascara tea was carried out by means of a hedonic test for color, aroma, and taste. The data from the analysis of the taste test can be seen in Table 3 below:

Table 3. Data on the effect of fermentation on the cascara taste test

| No | Control Group | Experimantal Group |
|----|---------------|-------------------|
|    | Cascara Cena | Natural | Fermentation wrapped leaves | Average |
| 1   | Color 8      | 8.7        | 9     | 8.56 |
| 2   | Flavor 7.5   | 8.65      | 8.95  | 8.36 |
| 3   | Acidity 7.5  | 9.1        | 8.8   | 8.46 |
| 4   | Bitterness 8.75 | 8.7 | 9     | 8.81 |
| 5   | Astringent 7.4 | 8.75     | 9.1   | 8.41 |

Based on Table 3, the color characteristics have different scores between the control group and the experimental group. The highest score of 9 is obtained for cascara fermentation wrapped in banana leaves, score 8.7 is natural fermented cascara and the lowest score is 8 which is cascara non-fermented. The highest score was 8.95 for aroma characteristics, namely cascara wrapped in banana leaves, then natural fermentation cascara with a score of 8.65 and finally non-fermented cascara with a score of 7.5. In contrast to the characteristics of Acidity, the highest score was 9.1, namely the natural fermentation cascara, then the fermentation cascara with banana leaves with a score of 8.8 and finally the non-fermented cascara with a score of 7.5. Characteristics of Bitterness, the highest score is 9 in cascara fermentation wrapped in banana leaves, then non-fermented cascara of 8.75 and the last is natural fermentation cascara with a score of 8.7. For astringent characteristics, the highest score was 9.1 in cascara fermentation wrapped in banana leaves, then natural fermented cascara was 8.75, and the lowest was in non-fermented cascara with a score of 7.4.

Table 3 shows the average value of the panelists' preference for color, aroma and taste. The highest value was obtained from cascara tea with natural fermentation treatment and fermentation wrapped in [17] banana leaves, while the lowest value was obtained from cascara tea without treatment. Based on, food acceptance generally depends on color, aroma, and taste which are directly related to food interactions at any given moment. Where the color of cascara tea with natural fermentation treatment or
wrapped in banana leaves has a distinctive color like tea, namely reddish brown, the color of cascara tea without treatment has a slightly pale yellow color. The distinctive color difference in each tea is different due to different processing processes.

The distinct aroma of cascara tea is due to the presence of organic acids and the aroma of the tea itself. The aroma of tea in cascara is also caused by the presence of aromatic folatyl compounds and other compounds that give rise to a distinctive aroma. The foreign taste was obtained by the panelists when drinking cascara tea. Based on [18] foreign taste is a taste that deviates from the typical taste of tea.

In this study, an analysis of the effect of fermentation on pH, caffeine and flavor was carried out. Based on the research data, the results obtained in the non-fermented cascara have a low pH, while the fermented cascara has a higher pH value. However, it is different from the amount of caffeine. Caffeine in non-fermented cascara is higher than cascara fermentation. so is the taste. The taste of the fermented cascara has a better taste than the non-fermented cascara. The acidity indicates the feasibility of coffee being safe for consumption. In general, the acidity of coffee is at a pH level of 5. Based on the results of the study, cascara which has a pH value of ± 5 is the fermentation treatment. When it comes to taste test, panelists prefer the taste in this treatment. Panelists said that the cascara tea that had been made tasted similar to tea leaves, without an unpleasant taste, refreshing and slightly sour. Based on research by [7], acidity levels correlate with caffeine levels. The lower the caffeine content, the higher the acidity level.

The brewing of cascara tea must be done appropriately. The process of making cascara tea is the variable that has the most influence on the number of metabolites. As explained above, non-fermented cascara has a high number of metabolites. The complex metabolites in cascara consisting of volatile and non-volatile compounds also contribute to flavor, nutrition and health benefits [19]. This is also in line with research [20], the chemical components in tea can affect sensory quality. Likewise research [21], secondary metabolites can affect tea quality. The concentration of compounds in tea can affect sensory characteristics which include bitterness and sweetness.

Aroma is one of the important aspects that affect the character and quality of cascara tea before tasting which determines acceptance or rejection of a product. The aroma of coffee is influenced by geographic location, the bitter taste in coffee is due to the presence of chlorogenic acid derivatives, namely the lactone group. Volatile compounds are essential for the aroma of tea, while phenolic compounds are responsible for color and taste [22]. The uniqueness of taste in coffee is influenced by alkaloid class compounds such as caffeine, trigonelin, and chlorogenic acid [23].

In research, there is still caffeine content in cascara. The high caffeine content is caused by the evaporation of water and acidic substances that are not maximal, besides that the cascara drying process using less than optimal sunlight also causes caffeine to not evaporate because caffeine is a substance that is difficult to evaporate. The need for proper post-harvest handling also affects the quality and taste of cascara [24]. In this study, fermentation was carried out as an effort to degrade the mucus layer by enzymes and microorganisms that occur naturally from coffee beans [25]. With the hope of reducing total phenol, caffeine content, acidity and color and improving quality [26].

4. Conclusions
The results showed that the fermentation process had an effect on pH, caffeine and flavor values. The non-fermented cascara has the lowest pH average value of 4.22, the natural fermented cascara has a pH value of 4.58, while the fermented cascara wrapped in banana leaves has a pH value of 5.24. Calculation of caffeine content in non-fermented cascara, natural fermented cascara and fermented cascara wrapped in banana leaves were 1.22%, 1.17%, and 1.14%, respectively. The taste test results of the non-fermented cascara, natural fermented cascara and cascara wrapped in banana leaves were different for each treatment. The taste of the fermented cascara has a better taste than the non-fermented cascara. The acidity indicates the feasibility of coffee being safe for consumption.

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