
Coffee cherry's pulp variety and pulping delay time leading to cascara tea products

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Abstract The effect cherry's pulp variety and pulping delay time after harvest on the physical, chemical, and organoleptic properties of cascara tea products were investigated. The results indicated that all parameters were decreased with the pulping delay times, excepts the ash content. The best robusta cascara tea was characterized by 4.90% of yield, 6% of moisture content, the lightest color value 7.5 YR 7/8, 4.01 of pH, 7% of ash content, 241.19 mg/L of polyphenol content, 554.74 mg/L of tannin content, 32.67 ppm of antioxidant activity and 107.03 mg/L of caffeine content. On the other hand the best arabica cascara tea demonstrated 7.74% of yield, 6.67% of moisture content, the strongest color intensity 5 YR 5/10, 4.33 of pH, 5.33% of ash content, 170.87 mg/L of polyphenol content, 334.91 mg/L of tannin content, 12.80 ppm of antioxidant activity and 56.08 mg/L of caffeine content. The robusta cascara tea excelled in in the moisture content, polyphenol content, and tannin content while the Arabica cascara tea was superior in yield, pH, ash content, antioxidant activity, and caffeine content. In term of organoleptic scores the Arabica cascara tea produced from the fresh pulp was the most preferable for the panelists. All pulps were qualified as raw material for cascara tea production.

Keywords: Cascara, Coffee variety, Delay time, Pulp

Introduction

Tea is a beverage containing caffeine which is obtained by brewing the leaves or shoots of the *Camellia sinensis* plant utilizing hot moisture (Siringoringo *et al.*, 2012). The tea drink is widely preferred due to its distinctive aroma and taste. Initially, the term tea was only intended for green products from the *Camellia sinensis* plant, such as black tea, tea, and oolong tea. Along with the development of food science, other types existed, today known as herbs. Herbal tea is a processed tea that does not come from the tea leaves of the *Camellia sinensis* plant (Inti, 2008), one of which is tea from the pulp of coffee fruit. The pulp of coffee cherries is the non-bean part that becomes a waste in the processing of coffee beans which may create a problem

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for the environment. Coffee fruit pulp is easy to find in Indonesia considering that Indonesia is the fourth largest coffee producing country in the world after Brazil, Vietnam, and Colombia. Two varieties of coffee commonly cultivated in Indonesia are Robusta and Arabica. One of the provinces contributes to Indonesian coffee production is Bengkulu province. This commodity is usually trading in the form of green coffee obtained from the separation bean from non-bean parts of coffee cherry.

The Coffee fruit pulp consists of the outer coffee skin (exocarp) and fruit flesh (mesocarp) in which the proportion may reach 40-45% (Simanihuru and Sirait, 2010). So far, the use of this coffee bean processing waste by farmers has only been limited to organic fertilizer and animal feed. So it is necessary to find other solutions that can help to reduce the amount of waste from the coffee bean processing business, one of which is by utilizing this waste to produce cascara tea.

Cascara tea has actually been a common product in the international market but is still not quite familiar in Indonesia due to the lack of knowledge and public interest about its existence. Producing cascara tea from coffee fruit pulp will be beneficial since it is nutritious leading a high economic value. Esquivel and Victor (2012) observed that coffee pulp has a valuable composition such as 35% carbohydrates, 10% protein, 30.8% fiber, 10.7% minerals, and 4.1% sugar. So it is believed that this material can be processed into beverage products with a simple method but it becomes very promising economic potential. Galanakis (2017) states that the stages of the cascara making process consists of sorting and washing coffee cherries, peeling, and drying the pulp to obtain the final product.

The preferable raw material in the process of making cascara tea is the pulp of the red-picked coffee cherries. Coffee cherries marked by their red skin are called ripe fruit. Ripe coffee cherries have soft and slimy flesh and contain relatively high sugar compounds (Suhendra and Siska, 2020) so that they lead to produce a sweet taste in the produced cascara tea. The coffee cherries that have been harvested and then stored (cured) in sacks in the shade for days to remove mucus from the fruit cause the acidity of the coffee berries increase, so that the sweetness of the pulp of the coffee cherries decrease and this affects the taste of cascara tea.

The research conducted by Ariva *et al.* (2020) on the effect of drying temperature on the quality of cascara tea from Arabica coffee pulp showed that the ash content of cascara tea still did not meet the standards of SNI 3836:2013 and the resulting dry tea and its aroma and taste of cascara tea did not show the characteristics of tea. Nafisah *et al.* (2018) studied the effect of drying methods and brewing ratios in the process of making cascara coffee Arabica coffee

(*Coffea Arabica* L.) showed that the antioxidant activity of cascara tea was in the medium – very weak range. Prayitno *et al.* (2019) experimented the type of equipment and drying time on quality in the manufacture of cascara tea demonstrated that the caffeine content of cascara tea was still quite high with a value of 12,300 mg/L – 1,600 mg/L. These problems indicated that further research is needed to obtain cascara tea with better results.

Muzaifaet *al.* (2019) investigated the effect of pulp treatment and brewing time on the chemical quality of cascara tea, and showed that the lowest pH value was obtained in the natural pulp treatment and the lowest Total Dissolved Solids (TPT) value was obtained in the pulp soaking treatment in moisture. Research on the effect of drying temperature on the quality of cascara tea from Arabica coffee husks was conducted by Arivaet *al.* (2020) and showed that the oven drying method at a temperature of 45°C and a drying time of 32 hours was the best treatment.

Research on the characteristics of the best cascara tea in terms of coffee fruit pulp varieties and pulping delay time has never been done. This study aimed to investigate the effect of coffee fruit pulp varieties and pulping delay time on produced cascaratea products.

Materials and methods

The experiments were conducted in December 2020 to March 2021 at the Agricultural Technology Laboratory, Agricultural Technology Department, Faculty of Agriculture, University of Bengkulu. The main material used were the pulp of Arabica and Robusta coffee cherries which were selectively picked with red fruit skin indicative mark in a coffee farm of Kepahiang district, Bengkulu province. Before pulping, the measurement was taken on harvested fruit for pH and sugar content. The pH values of coffee cherries before pulping were in the range of 5.59 – 4.35 for Robusta coffee and 5.06 – 4.01 for Arabica coffee, while the sugar contents were in the range of 6.50% Brix – 11.5% Brix for Robusta coffee and 9% Brix – 15.1% Brix for Arabica coffee.

The materials for chemical analysis of cascara tea samples included 70% methanol, distilled water, Folin-Ciocalteu reagent, standard caffeine, chloroform, CaCO₃, tannic acid (tannin standard), DPPH solution, Na₂CO₃ solution, gallic acid, and buffer solution. The main equipments for cascara tea processing were a pulper machine and an oven. The pulper machine was used to separate pulp from coffee beans, while the oven was utilized in the drying process in making the cascara tea. Supporting tools used in the cascara tea making process were a baking sheet to place the pulp during drying and an analytical scale to periodically weigh that material during drying. The

analytical equipments used for parameter's analysis were spectrophotometer, pH meter, refractometer, Munsell color charts for plant tissues, porcelain dish, blender, 30 mesh sieve, measuring flask, dropper, erlenmeyer, measuring cup, test tube, test tube rack, analytical balance, desiccator, tissue, organoleptic test assessment sheet, label paper, teapot, and cup glass.

This study used a Factorial Statistical Design (FSD) which consisted of two factors. The first factor was the coffee fruit pulp variety (V) with 2 categories (Robusta, Arabica) and the second factor was the pulping delay time after harvest (P) which consisted of 4 levels (0, 1, 2, 3 days) resulting in 8 treatment combinations with repeated 3 times to obtain 24 experimental units. This research consisted of 2 stages. The first stage was the making of cascara tea which began with harvesting the red coffee cherries, washed the harvested coffee cherries to be free from dirt, pulped the coffee cherries using the pulping machine to separate the pulp and seeds, and dried the pulp using the oven at a temperature of 45°C to obtain the moisture content of the material was below the limit of INS 3836:2013 (ISB, 2013) for the tea of *Camellia sinensis* plant which is 8%. The next stage was tested the physical parameters which consisted of yield and moisture content according to INS 3836:2013 (ISB, 2013), and a color test by comparing the color of cascara tea steeped moisture with the color in the Munsell Color Chart for Plant Tissues, and chemical test included pH utilizing pH meter value test, ash content by weighing the remaining minerals as a result of burning organic matter at a temperature of 525°C according to SNI 3836:2013 (ISB, 2013), polyphenol content (INS 3836:2013 (ISB, 2013), tannin content by using visible ultraviolet spectrophotometry method based on maximum filtrate's absorbant of 385 nm wavelength, antioxidant activity using the DPPH method, where the antioxidant activity was based on the compound's ability to capture free radicals. The effectiveness of a sample to scavenge free radicals from the DPPH method is named IC₅₀. IC₅₀ is a concentration that can reduce 50% of DPPH free radicals. The smaller the IC₅₀ value, the greater the antioxidant activity. The organoleptic test was carried out by 30 untrained panellists. The test was carried out on the state of cascara tea steeping water to determine the level of consumer preference/acceptance in 4 parameters, namely color, aroma, taste, and overall.

The data obtained were analyzed by ANOVA (Analysis of Variance) to determine the effect between treatments. Significantly different treatments were continued with the DMRT (Duncan Multiple Range Test) at a significant level of 5%. The physical, except color, and chemical parameters were than plotted against the pulping delay time. Analysis of organoleptic test data were carried out using non-parametric statistical methods with Friedman test, while the results of antioxidant activity tests employing spectrophotometric methods and

color tests using MunsellColor Charts for Plant Tissues were analyzed descriptively.

Results

Based on the tabulated data of physical and chemical parameters, the results of ANOVA and DMRT are presented in Tables 1 and 2. The result of color test is described in Tabel 3. The parametric values, including yield, moisture content, pH, ashcontent, polyphenolcontent, tannincontent, antioxidantactivity and caffeine content, plotted against the pulping delay time are shown in Figures 1-8. The result of organoleptic test is indicated in Table 4.

Table 1. Overall ANOVA Test Results

Parameters for Observing		Cherry's Pulp Coffee Variety (V)	Pulping Delay Time (P)	V*P
Physical Test	Yield Calculation	*	*	ns
	Moisture Content	ns	ns	ns
	Color Test	Descriptive		
Chemical Test	pH Value	*	s	ns
	Ash Content	*	ns	ns
	Polyphenol Content	*	*	ns
	Tannin Content	*	*	*
	Antioxidant Activity	Descriptive		
	Caffeine Content	*	*	*

Note: the notation (*) states that the treatment was significantly different and ns (not significance) states that the treatment was not significantly different.

Table 2. The Results of DMRT test

	Yield Calculation	pH Value	Polyphenol Content	Tannin Content	Caffeine Content
P3	a	a	a	a	a
P2	a	a	ab	b	a
P1	a	a	b	b	b
P0	b	b	c	c	c

Note : the same symbol shows results that were not significantly different, while different symbols indicatedsignificantlydifferent results.

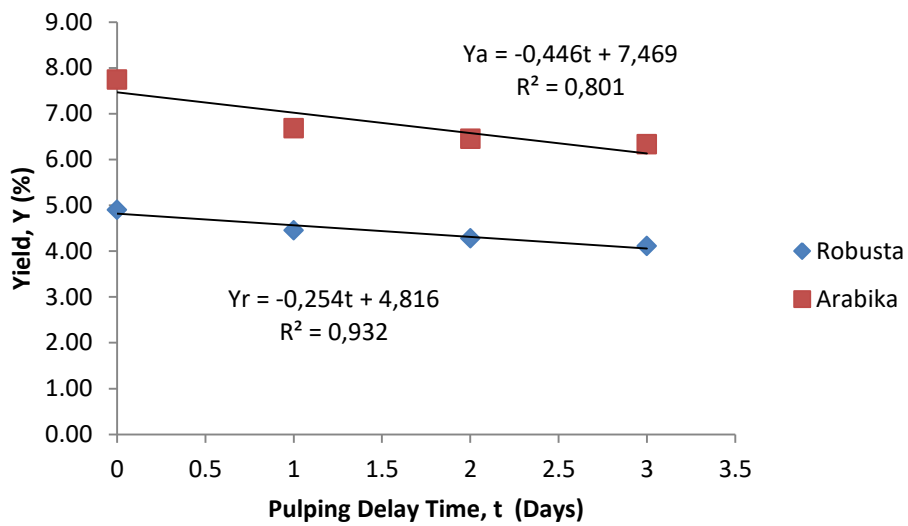


Figure 1. Cascara teayieldersus pulping delay time

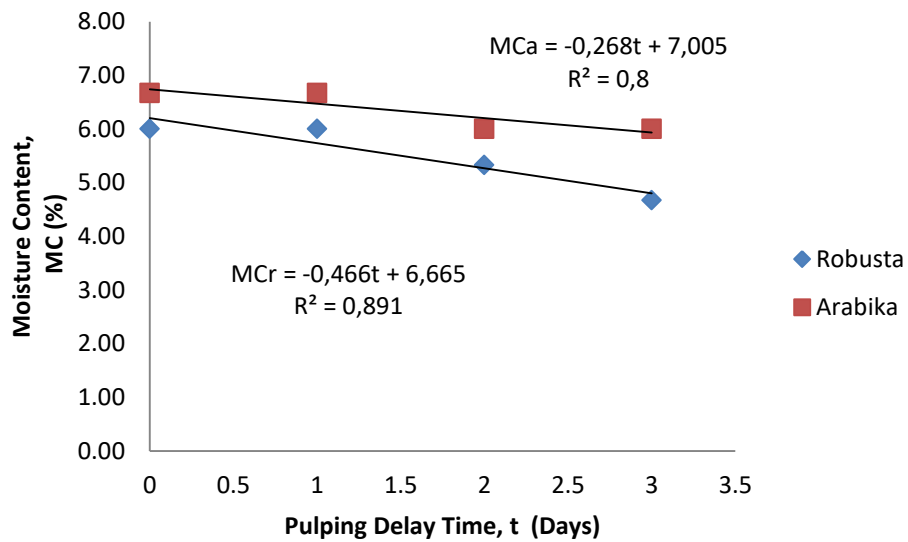


Figure 2. Moisture content versus pulping delay time

Table 3.Color Test Observation Results

Sampel		Hue	Value	Chrome	Munsel's Note	Foto
Robusta	0 day	7,5 YR	7	8	7,5 YR 7/8	
	1 day	7,5 YR	6	8	7,5 YR 6/6	
	2 days	7,5 YR	6	6	7,5 YR 6/6	
	3 days	7,5 YR	6	6	7,5 YR 6/6	
Arabika	0 day	2,5 YR	4	8	2,5 YR 4/8	
	1 day	2,5 YR	5	8	2,5 YR 5/8	
	2 days	5 YR	5	10	5 YR 5/10	
	3 days	7,5 YR	5	8	7,5 YR 5/8	

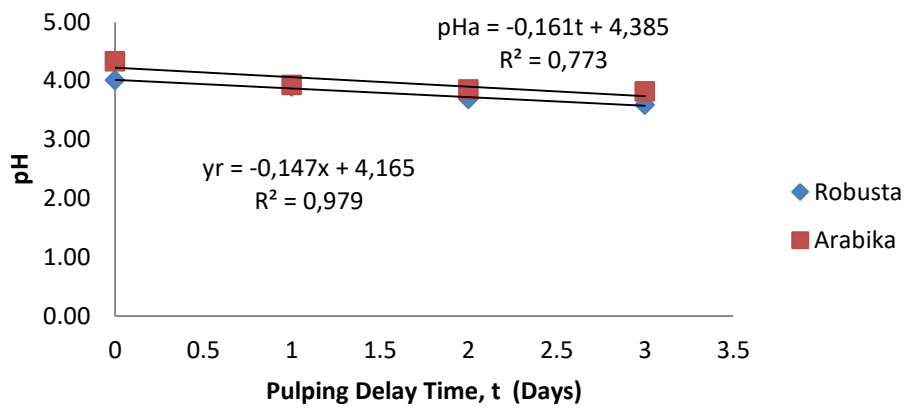


Figure 3. pH value of cascaratea versus pulping delay time

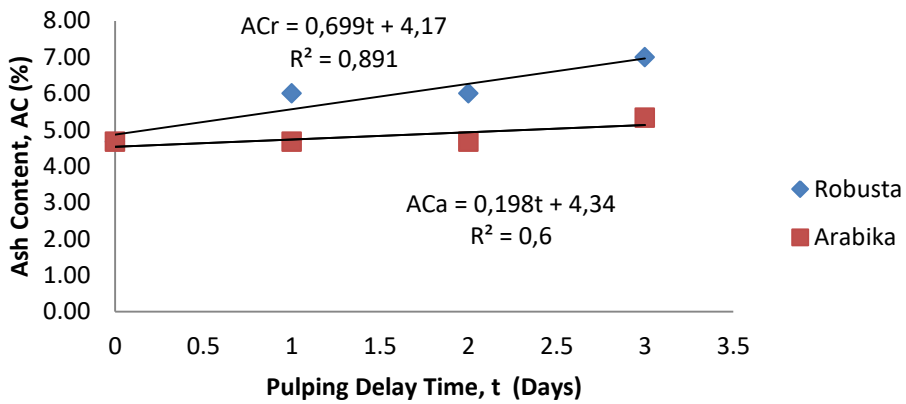


Figure 4. Ash content of cascarateaversus pulping delay time

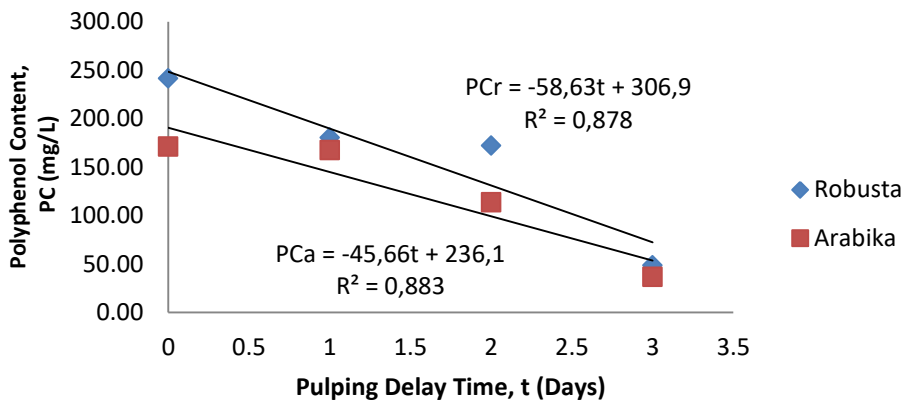


Figure 5. Polyphenol Content of Cascara Tea (mg/L)

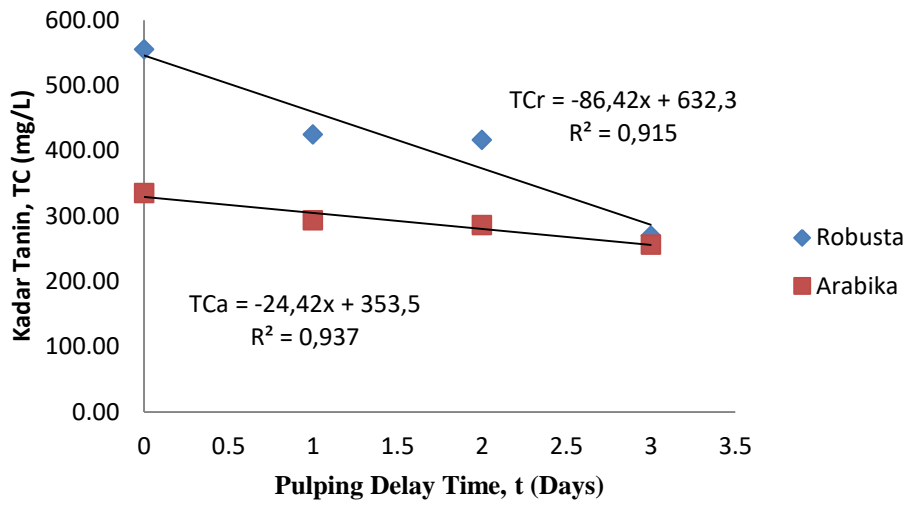


Figure 6. Tannin content of cascarateaversus pulping delay time (mg/L)

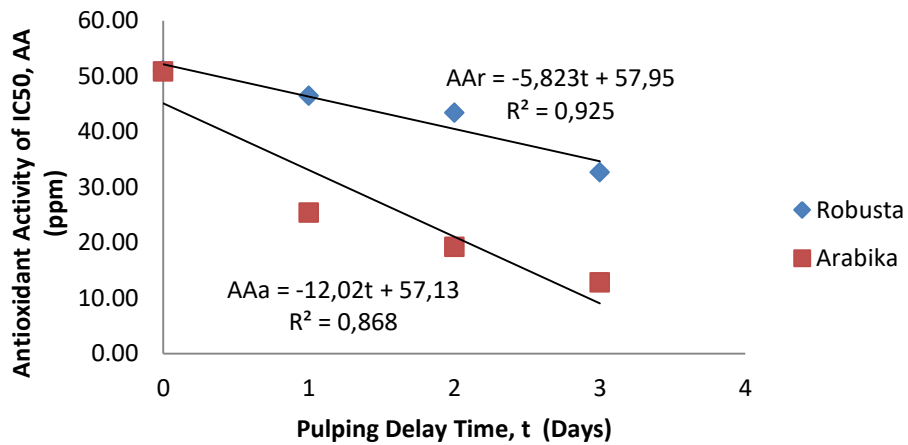


Figure 7. Antioxidant activity of cascarateaversus pulping delay time

Table 4. Panelists' Level of Preference for Cascara Tea Steeping

Pulping Delay Time (Days)	Preference Level							
	Color		Aroma		Taste		Overall	
	Robusta	Arabika	Robusta	Arabika	Robusta	Arabika	Robusta	Arabika
0	2,80	4,07	2,97	3,67	2,40	3,40	2,83	3,60
1	2,97	2,90	2,97	3,03	2,30	3,00	2,70	2,97
2	3,77	2,57	3,27	2,87	3,43	2,73	3,20	2,93
3	2,60	3,90	2,90	3,00	2,77	2,33	2,80	3,23

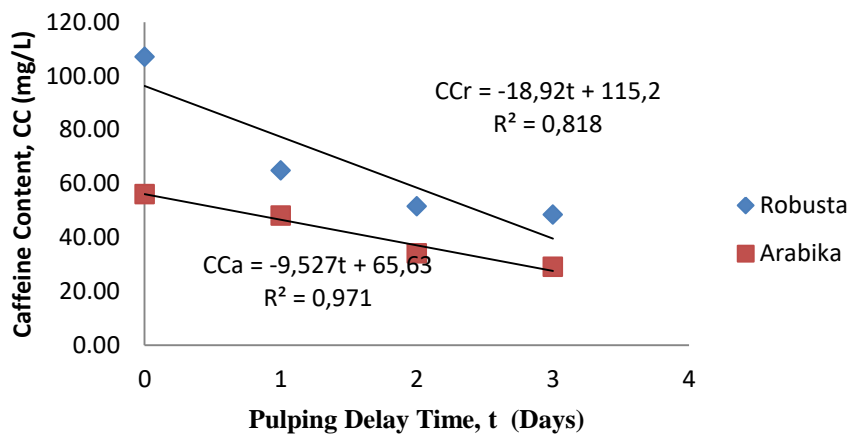


Figure 8. Caffeine content of cascarateaversus pulping delay time

Discussion

Physical test

Yield

The results of the 5% level ANOVA test showed that the coffee fruit pulp variety was significantly different for the yield of cascara tea with a significant level of 0.000 (< 0.05). The pulping delay time was also significantly different for the cascara tea yield with a significant level of 0.002 (< 0.05), while the interaction between the coffee fruit pulp varieties and the pulping delay time was not significantly different for the cascara tea yield with a significant level of 0.505 (> 0.05). The significant sample data were then analyzed with the DMRT test at a significant level of 5% ($\alpha=0.05$). DMRT test results showed that P3 was not significantly different from P2 and P1 but significantly different from P0. Then P2 was not significantly different from P3 and P1 but significantly different from P0. P1 treatment was not significantly different from P3 and P2 but significantly different from P0. Finally P0 was significantly different from P3, P2 and P1.

The yield cascara tea was calculated by comparing the mass of cascara tea after drying to the mass of coffee flesh being pulped. The greater the final mass produced, the higher the yield value. The yield value for each treatment was in the range of 4.11% – 7.74%. The highest yield value was found in the V2P0, namely Arabica cascara tea produced from fresh pulp, while the lowest yield was found in the V1P3, namely Robusta cascara tea with a pulping delay of 3 days after harvest. In general, the yields of Arabica cascara tea were higher than those of Robusta cascara tea.

Moisture content

The results of the 5% level ANOVA test showed that the coffee fruit pulp varieties, the pulping delay time, and the interaction between coffee fruit pulp varieties and pulping delay time had no significant effect on the moisture content of cascara tea. The longer the pulping delay time was the lower the moisture content of the material. This was because with the longer fermentation process, there would be an increase in temperature that accelerated the microbial and enzyme activities (Barus, 2019) so that the moisture would escape faster from the material.

The lowest moisture content of cascara tea in the research of Ariva *et al.* (2020) was 6.57%, whereas the moisture contents found in this study were in the range of 4.67% - 6.76%. This finding indicates that the moisture content of cascara tea in this study was relatively better than the previous study. The highest moisture content was found in V2P0 and V2P1, namely Arabica cascara tea produced from fresh pulp and Arabica coffee cascara tea with the pulping delay time of 1 day after harvest, on the other hand the lowest moisture content was found in V1P3, namely Robusta cascara tea with the pulping delay time of 3 days after harvest. The moisture contents of Arabica coffee cascara tea were higher than those of Robusta coffee cascara tea. In fact all pulp of both varieties were suitable to be used as raw materials to produce cascara tea since all moisture contents of the cascara teas were below 8%, the limit of moisture content of tea in packing described by INS 3836: 2013 (ISB, 2013).

Color Test

The Munsell system classifies colors using three characteristics, namely chromatic color (hue), brightness (value), and color intensity (chroma or saturation). The hue is the name given to a color based on its position or location on the color spectrum as seen from its wavelength, the value is the level of brightness and darkness in a color, and the chroma in the Munsell circle is measured rotating from the center of each color slice representing the level of color purity (Jakti *et al.*, 2011). The smaller the value, the darker is the color and the higher the chromatic value is the stronger the color intensity (Priandana *et al.*, 2014).

In general, the hue letter notations for the cascara tea observed here were YR (Yellow Red) which meant the cascara tea brewed colors were in the yellow and red color range. The brightest color was found in V1P0, namely Robusta cascara tea produced from fresh pulp while the strongest color intensity was found in V2P2, namely Arabica cascara tea with the pulping delay time of 2 days after harvest. The results of the cascara tea steeping color test showed that all pulps were suitable to be used as raw material of cascara tea production

considering that the colors of cascara tea reflected the uniqueness of each tea. The color of the steeping of cascara tea showed that a longer pulping delay time led to produce the cascara tea with lighter colors. This occurred due to the increase in the fermentation time (Pratiwi *et al.*, 2012). The evident was also observed in the kombucha cascara (Nurhayati *et al.*, 2020).

Chemical test

pH Value

The result of ANOVA test showed that the coffee fruit pulp varieties and the pulping delay time were significantly different to the pH value of cascara tea steeping with a significant level of 5% while the interaction between varieties of coffee fruit pulp and pulping delay time was not significantly different to the pH value of steeping cascara tea. DMRT test result showed that P3 was not significantly different from P2 and P1 but significantly different from P0 whereas P2 was not significantly different from P3 and P1 but significantly different from P0. P1 was not significantly different from P3 and P2 but significantly different from P0. Furthermore P0 was significantly different from P3, P2 and P1. The pH value of cascara tea was acidic, in the range of 3.59 – 4.33 (< 7). These results were relatively better than the pH value of kombucha cascara (3 – 3.75) observed in the previous study by Nurhayati *et al.* (2020). In the case of kombucha cascara they stated that the safe pH value of kombucha cascara for consumption should not be less than 3 and kombucha cascara with a pH value of < 3 must be diluted before consumption. This statement suggested that all types of pulp used in this research were proper as raw materials for cascara tea production.

Ash content

The results of ANOVA test showed that the coffee fruit pulp varieties were significantly different to the ash content of cascara tea with a significant level of 0.043 (< 0.05) while the pulping delay time was not significantly different to the ash content of cascara tea with a significant level of 0.240 (> 0.05). The interaction between coffee fruit pulp varieties and pulping delay time was also not significantly different to the ash content of cascara tea with a significant level of 0.648 (> 0.05). The ash content of Arabica cascara tea in a previous study conducted by Ariva *et al.* (2020) was in the range of 4.51% - 9.71%, which means that some of the products did not meet the maximum ash content standard prescribed by INS 3836:2013 (ISB, 2013). The ash content of cascara teas observed in this study is shown in Figure 4 in which revealed that the cascara tea ash content varied from 4.67% - 7%. The ash content of cascara

tea obtained in this study better those of Ariva *et al.* (2020) since the values were less than 8%, the maximum threshold prescribed by INS 3836:2013 (ISB, 2013). This finding also confirmed that all types of pulp utilized are suitable as a raw material for cascara tea production. The ash contents increased with pulping delay time. This might be due to the effect of moisture content as indicated in Figure 2 since a decrease in moisture content increased the mineral contents (Barus, 2019).

Polyphenol content

The results ANOVA test showed that the coffee fruit pulp varieties and the pulping delay time were significantly different to the polyphenol content of cascara tea with a significant level of 0.028 (< 0.05) and 0.000 (< 0.05), while the interaction between coffee fruit pulp varieties and pulping delay time were not significantly different to the pH value of steeping cascara tea with a significant level of 0.340 (> 0.05). The results of the DMRT test showed that P3 was significantly different from P1, P2 and P0. P1 was not significantly different from P2 but significantly different from P3 and P0. P2 was not significantly different from P1 but significantly different from P3 and P0 while P0 was not significantly different from P2 but significantly different from P2, P1 and P3. Polyphenols are one of the secondary metabolites derived from plants. Polyphenols possess very diverse types of compounds and are bioactive compounds contributing many benefits for human health (Rasouli *et al.*, 2017). The polyphenol content decreased with pulping delay time. This was in line with the statement of Utami (2018) where the polyphenol content decreased after fermentation due to the diffusion of polyphenols out of the cotyledons. In addition, polyphenols underwent oxidation and condensation. The polyphenol content of Robusta coffee cascara tea was higher than Arabica those of coffee cascara tea. This phenomenon was also observed by Sholichah *et al.* (2020) where the polyphenol content of cascara Robusta tea was 2.65-8.09 mg GAE/g and those of cascara Arabica tea was 0.76-2.38 mg GAE /g. All cascara teas produced in this study contained polyphenol even though had not met the requirement of INS 3836:2013 (ISB, 2013)

Tannin content

The results of ANOVA test showed that the coffee fruit pulp varieties, the pulping delay time, and the interaction between coffee fruit pulp varieties and pulping delay time were significantly different to the tannin content of cascara tea with the same significant level, i.e. 0.000 (< 0.05). The results of the DMRT test showed that P3 was significantly different from P2, P1 and P0. P2

was not significantly different from P1 but significantly different from P3 and P0. P1 was not significantly different from P2 but significantly different from P3 and P0 whereas P0 had a significant effect on P3, P2 and P1. The tannin contents of Robusta cascara tea were 269.54 mg/L – 554.74 mg/L while those of Arabica cascara tea were 255.89 mg/L – 334, 91 mg/L. Nafisah *et al.* (2018) reported that the tannin content of cascara tea was < 250 mg/L. So the tannin contents of cascara teas found in this study were higher than that of the previous study. Figure 6 also shows that the tannin contents decreased with the pulping delay time. According to Nurhayati *et al.* (2020), the longer the fermentation / curing, the tannin levels will decrease due to the activity of microorganisms. The presence of tannin in the cascara teas in this study suggested all coffee fruit pulps used in this study were suitable as raw materials for cascara tea production.

Antioxidant activity

The IC₅₀ value decreased with the longer pulping delay time. The IC₅₀ values of Robusta cascara tea were higher than those of Arabica cascara teas. A compound is stated to have a very strong antioxidant activity if the IC₅₀ value is less than 50 ppm. A strong group of IC₅₀ was in between 50-100 ppm, a moderate group of IC₅₀ value is 101-150 ppm, and a weak group of IC₅₀ value is between 150-200 ppm (Molyneux, 2014). Research by Nafisah *et al.* (2018) showed that the overall IC₅₀ value was > 100 ppm to > 300 ppm, so the antioxidant activity value was in the medium - very weak categories. In this study, the antioxidant activities of cascara tea were in the very strong - strong range, 32.67 ppm - 51.06 ppm for Robusta cascara tea and 12.80 ppm - 50.84 ppm for Arabica cascara tea. These antioxidant activity levels were higher compared to previous studies conducted by Nafisah *et al.* (2018). This finding suggested that all pulps used in this study were potential as raw material for cascara tea production.

Caffeine content

The results of ANOVA test showed that coffee fruit pulp varieties, the pulping delay time, and the interaction between coffee fruit pulp varieties and pulping delay time were significantly different to the caffeine content of cascara tea steeping with a significant level of 0.000, respectively; 0.000; and 0.005. DMRT test results showed that P3 was not significantly different from P2 but significantly different from P1 and P0. P2 was not significantly different from P3 but significantly different from P1 and P0. P1 was significantly different from treatment P3, P2 and treatment P0. P0 was significantly different from P3, P2 and P1. Caffeine is one of the important compounds found in tea (2% - 4%)

and coffee (1.1% - 2.2%) (De Bruyn *et al.*, 2017). Prayitno *et al.* (2019) reported the caffeine contents of cascara tea obtained from their research were in the range of 1.23% - 1.56%. The caffeine contents of cascara teas in this were in the range of 48.8 mg/L – 107.03 mg/L (0.005 % - 0.011%) for Robusta cascara teas and 29.01 mg/L – 56.08 mg/L (0.003% - 0.006%) for Arabica cascara teas. So the caffeine contents here were lower than the caffeine contents in the previous study. INS 01-7152-2006 (ISB, 2006) prescribes the maximum limit for caffeine content in beverage products is 150 mg/day and 50 mg/serving. So the caffeine contents of cascara teas resulted from this study met the requirement suggesting that all pulps used to produce the cascara tea were proper as raw material. The caffeine contents of robusta cascara teas were higher than those of Arabica cascara teas, and the caffeine contents of cascara teas decreased with the pulping delay time. This last evident occurred because fermentation could reduce the caffeine content in coffee (Mubarok *et al.*, 2014). Chismirina *et al.*, (2016) also noted that the caffeine content of Robusta coffee is higher than that of Arabica coffee.

Organoleptic test

Color

The results of the organoleptic test on the panelists' preference for the color of cascara tea ranged from 2.57 to 4.07. Friedman test with significant level 0.05 shows that there was a difference in the average level of preference of the panelists on the color of cascara tea in each treatment. The color of cascara tea most preferred by the panelists was the color of V2P0, namely Arabica cascara tea produced from fresh pulp characterized by a bright color with preference level score of 4.07 (like - very like) whereas the lowest preference level was found in the V2P2, namely Arabica cascara tea resulted from the pulp of 2 days delay time after harvest with a preference score of 2.57 (dislike - neutral) characterized by the palest color among all samples although the color is still in the typical category of tea colors (ISB, 2013).

Aroma

Panelists' assessment score of the aroma of cascara tea ranged from 2.87 to 3.67. Friedman test with significant level 0.05 indicates there was a difference in the average level of preference of the panelists on the aroma of cascara teas. The highest preference level for the aroma of cascara tea was found in V2P0, namely Arabica cascara tea produced from fresh pulp characterized by the strongest distinctive aroma of tea with a preference level score of 3.67 (neutral - like) in contrast the lowest preference level score was found in V2P2,

namely Arabica cascara tea resulted from the pulp with a pulping delay of 2 days after harvest with a preference level score of 2.87 (dislike - like) marked by the less smelly aroma is less smelly so it did not characterize the distinctive aroma of tea. In general, the panelists regretted the unpleasant aroma of coffee pulp found in all samples of cascara tea suggesting that improvements should be done in next cascara tea production.

Taste

The panelists' preference scores for the taste of cascara tea was in the range of 2.30 to 3.40. Friedman test with significant level 0.05 shows that there was a difference in the average level of preference of the panelists on the taste of cascara tea. The highest panelists' preference level score was given for V2P0, namely Arabica cascara tea produced from fresh pulp with a preference level score of 3.40 (neutral - like) characterized the distinctive taste of tea, namely astringent taste (chelate) when drunk whereas the lowest score of preference level was found given for V1P1, namely Robusta cascara tea resulted from the pulp with a pulping delay of 1 day after harvest with a preference level score of 2.30 (dislike - like). The taste of this last cascara tea tended to be bland so it was considered as the less distinctive taste of tea (Chrismirina *et al.*, 2016).

Overall

The overall organoleptic assessment is a panelist's assessment of cascara tea justified from all categories, including color, aroma, and taste. The value of the panelists' overall preference level score ranged from 2.70 to 3.60. Friedman test with significant level 0.05 indicates there was a difference in the average level of preference of the panelists as a whole to cascara tea. The highest preference score was found in the V2P0, namely Arabica cascara tea produced from fresh pulp characterized by a thick yellow color, a sepat (chelate) taste on the tip of the tongue when drunk, the distinctive aroma of tea with preference level score of 3.60 (neutral - like). The lowest level of preference score was found in V1P1, namely Robusta cascara tea produced from the pulp with a pulping delay of 1 day after harvest with a preference level score of 2.70 (dislike - neutral). Ariva *et al.* (2020) noted that the color parameters were favored by the panelists whereas the taste and aroma parameters did not reveal the characteristics of tea. In this study all panelists considered that the color, aroma, and taste parameters of cascara tea demonstrated the general characteristics of tea.

It concluded that the coffee fruit pulp varieties and pulping delay time affected the physical, chemical, and organoleptic properties of cascara tea products. The yield, moisture content, pH value, polyphenol content, tannin

content, antioxidant activity, and caffeine content of cascara tea decreased with the pulping delay time. The ash content increased and the color of the steeping cascara tea became lighter as the pulping delay time increased. Based on color, aroma, taste, and overall scores, the Arabica cascara tea produced from the fresh pulp was the most preferable cascara tea. Fresh coffee pulp was the most suitable raw material for cascara tea production, but all pulps were acceptable as raw materials to produce cascara tea considering that moisture content and ash content met the threshold prescribed by INS 3836:2013. Finally characterized by acceptable consumption pH, the presence of polyphenols and tannins, low caffeine content, and high antioxidant activity suggesting that the cascara tea could serve as a natural antioxidant.

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