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CHARACTERISTICS OF PHYSICO-CHEMICAL PROPERTIES OF GAYO ARABIKA COFFEE WITH SEMI WASH PROCESS AT HEIGHT 1500 MDPL AND 1600 MDPL

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Abstract

Arabica coffee (Coffea arabica L.) is a coffee with the best taste compared to other types of coffee. The most ideal altitude for cultivating Arabica coffee is between 1200 mdpl -1400 mdpl, but Arabica coffee grows and produces well at an altitude of 900 mdpl - 1700 mdpl which is an ideal habitat for cultivating Arabica coffee. If Arabica coffee is planted in the lowlands, especially at an altitude of 600 - 700 mdpl, usually the production and quality are low and susceptible to leaf rust disease. This study aims to analyze the characteristics of the physicochemical properties, namely reducing sugar, extract content and caffeine content of Gayo Arabica coffee at an altitude of 1500 mdpl and 1600 mdpl. This study uses the Completely Randomized Design (CRD) Non-Factorial method with 2 levels of altitude treatment, namely 1500 mdpl and 1600 mdpl with 4 replications. The results of this study indicate that an altitude of 1500 mdpl has an average of 43.49013% and 1600 mdpl has an average of 51.10553% significantly affecting the coffee extract content. At an altitude of 1500 mdpl, it has an average of 0.3504% and 1600 mdpl has an average of 0.3792% which has no significant effect on coffee reducing sugar. At an altitude of 1500 mdpl, it has an average of 0.74625% and 1600 mdpl has an average of 0.5095% which has a very significant effect on coffee caffeine content.

Keywords : ***Gayo Arabica Coffee, Semi Wash, 1500 Mdpl And 1600 Mdpl***

1. Introduction

Indonesia is the world's fourth largest coffee producer after Brazil, Vietnam, and Colombia. This commodity is one of the largest foreign exchange contributors to the country's plantation sub-sectors with exports reaching US$ 1.03 billion (BPS, 2015). Currently, the growth of the coffee market has increased sharply. This is marked by the proliferation of cafes that excel in coffee in the form of specialty coffee, instant, espresso. The increase in coffee lovers is not only happening in Indonesia, but also in the international market.

Nearly two-thirds of the world's population consumes coffee as a habit, even as part of a lifestyle (Tarigan et al., 2016). Coffee is a plantation crop that is widely cultivated by farmers in Indonesia. According to Wahyudin in Winarni (2013), there are two types of coffee plants in Indonesia, namely Arabica and Robusta coffee. Arabica coffee is the type of coffee most widely known by the Indonesian people. Arabica coffee is a type of traditional coffee and is considered to be the coffee with the best taste among other types of coffee (Fitrianda, 2013). Arabica coffee (Coffea arabica L.) is the coffee with the best taste compared to other types of coffee.

Arabica coffee beans are large-sized pickak-shaped with a weight of 18-22 g per 100 beans. The most ideal altitude for cultivating Arabica coffee is between 1200 mdpl - 1400 mdpl, but Arabica coffee grows and produces well at an altitude of 900 mdpl - 1700 mdpl which is an ideal habitat for cultivating Arabica coffee. If Arabica coffee is planted in the lowlands, especially at an altitude of 600-700 mdpl, usually the production and quality are low and susceptible to leaf rust disease caused by the pathogen Hemileia vastatrix. The susceptibility of Arabica coffee to leaf rust disease is a

limiting factor in production (Anshori, 2014). The quality of ground coffee is determined not only by the type of coffee, but also by its processing. Ground coffee is obtained through a series of coffee bean processing activities, which are continued with the roasting and grinding process. Coffee bean processing can be done dry or wet (Siregar et al., 2020).

Post-harvest processing processes include dry and wet processes which are generally found in coffee beans. These differences result in differences in the Physicochemical Characteristics of coffee beans. Different physicochemical compositions provide different flavors of roasted coffee (ready-to-drink coffee). (et al., 2020). In general, semi-washed processing is used in Central Aceh Regency, Aceh Province. This study aims to determine the physical and chemical characteristics of green Arabica beans at two altitudes, namely 1500 mdpl and 1600 mdpl. This study will analyze the physicochemical characteristics including the levels of extract, caffeine and green bean quality found at both altitudes of Arabica coffee planting.

2. METHOD

2.1 Place and Time of Research

This research was conducted in Arabica coffee plantations of farmers observed at an altitude of 1500 mdpl and 1600 mdpl in Pregen village, Linge sub-district, Central Aceh Regency, Aceh Province.

2.2 Tools and Materials

The tools used are: burlap sacks, tampah, 1 kg clear plastic, pestle and mortar, roaster machine, coffee pulper machine, filter paper, marker, oven, analytical balance, sample plastic, beaker glass, porcelain cup, desiccator, electric heater, Erlenmeyer flask, burette, measuring flask, pipette, measuring cup, oven, spatula, test tube, micropipette, spectrophotometer.

The materials used are: Arabica cherry coffee varieties long berry, tim-tim and ateng super, ethanol, formate, aquades, Pb-acetate, K-oxalate, Nelson Somogy solution, arsenomolybdate, water.

2.3 Research Stages

2.3.1. Selection of Research Area

The area used in this study was a farmer's garden observed at 2 (two) altitude classes in Linge District, Central Aceh Regency, Aceh Province.

2.3.2. Sampling

Samples of Arabica Gayo coffee with long berry, tim-tim, and ateng super varieties at altitudes of 1500 mdpl and 1600 mdpl were harvested in red fruit conditions using the random sampling method with an even proportion for each specified altitude. This method is carried out because there is already a sampling frame for each altitude. The number of samples taken is 12 kg of red cherry coffee/log at each altitude of the research site and is divided evenly for processing using the semi-wash method.

2.3.3. Peeling, Fermentation and Washing Process

The process of peeling the fruit skin is done with a pulper machine which aims to separate the fruit skin from the coffee beans. The coffee beans are then fermented for 12 hours to release the slimy fruit flesh (mucilage) that is still attached to the horn skin and during the washing process it will be easily removed so that it facilitates the drying process. The coffee beans are then washed so that all the mucus attached to the horn skin is clean.

2.3.4. Drying Process, Peeling of Horn Skin and Roasting

After washing is complete, the coffee beans are dried until the water content reaches <13%, after that the process of peeling the horn skin is carried out by pounding it using a pestle and mortar until clean to obtain green beans. Green bean coffee beans are then analyzed for caffeine and carbohydrate content, the remaining green bean coffee beans undergo a medium roast roasting process at a temperature of 180 - 200 °C for 10 minutes, after which the roasted coffee beans will be analyzed for their essence content.

2.3.5. Quality Analysis

a. Analysis of Reducing Sugar Content (Nelson Somogy, Sudarmadji et al., 1997)

Weigh 0.5 grams of sample carefully. Add 25 mL of 80% ethanol. Stir for 10 minutes. Transfer the supernatant quantitatively into a 100 ml measuring flask. Repeat process no. 2-3 until the filtrate obtained is exactly 100 mL. Evaporate the ethanol in a water bath or hotplate with a beaker glass. Add 1 gram of CaCO3 + 100 mL of distilled water then heat for 30 minutes (in boiling conditions). Cool. Add 5 drops of Pb-acetate and saturated K-oxalate each. Then filter. Measure to 100 ml using a measuring flask. Take 5 mL of sample and put it in a test tube. Add 1 ml of Nelson Somogy solution. Heat for 20 minutes in boiling conditions. Cool quickly. Add 1 ml of Arsenomolybdate solution. Add distilled water to a total volume of 10 ml. Measure the absorbance at a wavelength of 540 nm.

b. Analysis of Essence Content (SNI, 2004) The sample is weighed carefully 0.5 grams of sample and put in a beaker glass. Add 100 mL of boiling water, let stand for 1 hour. Filter the sample solution into a 100 mL measuring flask, rinse with hot water until the solution is clear. Let the solution reach room temperature, add water and adjust to the limit. Pipette 10 mL of the solution into a porcelain cup of known weight. Heat on a hotplate until dry, then place in an oven at 105 ºC for 2 hours. Cool in a desiccator and weigh until the weight is constant (BSN, 2004).

b. Analysis of Caffeine Content using LCMS (SNI, 2004)

The sample is weighed as much as 1 gram and put into a 100 mL Erlenmeyer flask. Add 50 mL of distilled water to the Erlenmeyer flask. Heat using a hotplate stirrer for 20 minutes at a temperature of 100 ºC. Take the filtrate by filtering the solution using

Whatman paper No. 1. The separated filtrate was taken using a syringe and filtered using a membrane filter (pore size 0.45µ m, diameter 13 mm). After filtering, dilute the sample filtrate using filtered distilled water. Then the diluted filtrate was placed into an LC vial and ready to be analyzed using LCMS.

c. Green Bean Quality Analysis (SNI 01-2907-2008)

Coffee beans are taken randomly as much as 300 grams. Separate between broken beans, hollow beans, horny skin, etc. according to the procedure of SNI 01-2907-2008. Then enter the formula using the specified SNI standard. Reweigh all defects and waste that have been sorted. Also weigh the coffee beans that have been separated from defects to find out how many beans are obtained.

3. Results and Discussion

3.1 Characteristics of Arabica Coffee Land in Central Aceh Regency

Linge District is located at coordinates 4º 23′ 49.2” N, 97º 10′ 51.6” E with an altitude ranging from 1000 – 2000 meters above sea level, the topography is a hilly area with a slope ranging from 0% to 40%. Land characteristics are parameters that can be measured and will determine the land suitability class.

3.2 Coffee Essence Level at 1500 mdpl and 1600 mdpl

Coffee essence content indicates the amount of substances dissolved in water during brewing which is influenced by the size of the material. Based on SNI 01-3542-2004, the quality requirements for ground coffee for the coffee essence content parameter are 20 - 36% for ground coffee I and a maximum of 60% for ground coffee quality II. The coffee essence content is related to the solubility the material itself, namely the higher the coffee extract content, the higher the solubility of the material in water (Suwarmini et al., 2017). Table 1 shows that the content of the extract obtained from the two observations can be seen that the extract content at an altitude of 1500 meters above sea level in the first repetition was 45.0597%, the second repetition was 43.6512%, the third repetition was 38.9697%, the fourth repetition was 46.2799% and had an average of 43.49013% while at an altitude

of 1600 meters above sea level in the first repetition 46.8626%, the second repetition 55.3462%, the third repetition 51.1077%, the fourth repetition 51.1056% and has an average of 51.10553%.

Code Sample	Test	Sample weight (g) (W2)	FP	Volume Analysis (ml)	Heavy cup (g)	Cup weight and dissolved solids (g)	Extract weight (g)(W1)	Dissolved Solids (%)	Average	SDV	RSD
1500 U1	simple	0.4494	100	10	67,7718	67,7920	0.0202	44,9488	45,0597	0.1568	0.3480
	double	0.4162	100	10	79,8465	79,8653	0.0188	45,1706			
1500 U2	simple	0.4441	110	10	80,6659	80.6835	0.0176	43,5938	43,6512	0.0812	0.1860
	double	0.453	110	10	70,7067	70,7247	0.0180	43,7086			
1500 U3	simple	0.4345	100	10	66,2863	66,303	0.0167	38,4350	38,9692	0.7555	1,9386
	double	0.443	100	10	69,5078	69,5253	0.0175	39,5034			
1500 U4	simple	0.4336	100	10	69,033	69,0525	0.0195	44,9723	46,2799	1.8492	3,9956
	double	0.4518	100	10	68,4203	68,4418	0.0215	47,5874			
1600 U1	simple	0.4105	100	10	67,7718	67,791	0.0192	46,7722	46,8626	0.1279	0.2728
	double	0.4004	100	10	79,8465	79,8653	0.0188	46,9530			
1600 U2	simple	0.4139	110	10	80,6659	80,6874	0.0215	57,1394	55,3462	2,5360	4,5820
	double	0.4067	110	10	70,7067	70,7265	0.0198	53,5530			
1600 U3	simple	0.4067	100	10	66,2863	66,3068	0.0205	50,4057	51,1077	0.9927	1.9424
	double	0.4034	100	10	69,5078	69,5287	0.0209	51,8096			
1600 U4	simple	0.4187	100	10	69,033	69,0541	0.0211	50,3941	51,1056	1,0062	1,9689
	double	0.4265	100	10	68,4203	68.4424	0.0221	51,8171			

Table 1.Results of Analysis of Essence Content

Based on the results of the analysis of variance, the treatment (altitude) showed a significant effect on the differences in the altitude of the Arabica coffee growing place, the results of the analysis of the coffee essence content produced in ground coffee which was at quality II (maximum essence content of 60%). Coffee essence is greatly influenced by particle size and the surface area of the particles that come into contact with the solvent, the more coffee that is dissolved means less dregs and the surface area of the ground coffee is wider. The essence content value shows how much dregs are left behind when extracted (Budiyanto et al., 2021).

Coffee essence in ground coffee samples shows how much substance is dissolved in water during coffee brewing, if the particle size of the coffee powder is smaller, the value of the coffee essence content produced is higher. This is because the smaller the particle size of the coffee will increase the surface area, so that the greater the amount of dissolved solids. Coffee essence is related to its solubility properties, solubility is influenced by factors such as temperature, time and surface area (Puspitasari, 2020).

3.3 Coffee Reducing Sugar Content at Altitudes of 1500 mdpl and 1600 mdpl

Reducing sugars are monosaccharides and some disaccharides that have reducing properties, especially in alkaline conditions. Reducing sugars are a group of sugars (carbohydrates) that can reduce electron-accepting compounds, the end of a reducing sugar is the end that contains a free aldehyde or ketone group (Afriza & Ismanilda, 2019). The results of the analysis of reducing sugars produced in this study are presented in Figure 4.3. Table 4.5 shows that the reducing sugar content obtained from both observations can be seen that the reducing sugar at an altitude of 1500 mdpl in the first replication was 0.2622%, the second replication was 0.3862%, the third replication was 0.2512%, the fourth replication was 0.3504% and had an average of 0.3125% while at an altitude of 1600 mdpl in the first replication was 0.3447%, the second replication was 0.3789%, the third replication was 0.3933%, the fourth replication was 0.3999% and had an average of 0.3792%. Based on the results of the analysis of variance, the treatment (altitude) showed no significant effect on the reducing sugar content of Arabica coffee. The reducing sugar content in coffee beans needs to be known as a component for microbial growth in the coffee bean fermentation process. In areas at an altitude of 1500 and 1600 meters above sea level, the temperature is colder when compared to the temperature in areas below it, therefore it can be stated that photosynthesis activity (sugar synthesis in leaves) and its

transportation to all coffee plant tissues including the beans are more and faster in areas with hotter temperatures than in areas with cold temperatures (Alam et al., 2010).

Sample code	Test	Quantity			Abs	Blk	Abs sample-blk	Glucose concentration (mg/5 ml)	Reducing sugar concentration (mg/ml)	Sugar content reduction (mg/g)	Reducing sugar content (%)	Average	Standard Deviation	RSD
		Sample weight (g)	Volume total solution (ml)	Volume analysis (ml)										
1500 U1	simple	0.5202	100	5	0.4940	0.0330	0.4610	0.0694	0.0139	2,6682	0.2668	0.2622	0.0066	2,5149
	double	0.5109	100	5	0.4690	0.0330	0.4360	0.0658	0.0132	2,5749	0.2575			
1500 U2	simple	0.519	100	5	0.7230	0.0330	0.6900	0.1026	0.0205	3,9530	0.3953	0.3862	0.0128	3,3238
	double	0.5071	100	5	0.6750	0.0330	0.6420	0.0956	0.0191	3,7715	0.3771			
1500 U3	simple	0.5096	100	5	0.4430	0.0330	0.4100	0.0620	0.0124	2.4336	0.2434	0.2512	0.0111	4,4036
	double	0.5012	100	5	0.4630	0.0330	0.4300	0.0649	0.0130	2,5901	0.2590			
1500 U4	simple	0.5014	100	5	0.6600	0.0330	0.6270	0.0935	0.0187	3,7277	0.3728	0.3504	0.0316	9,0133
	double	0.5096	100	5	0.5920	0.0330	0.5590	0.0836	0.0167	3,2810	0.3281			
1600 U1	simple	0.5062	100	5	0.6200	0.0330	0.5870	0.0877	0.0175	3.4633	0.3463	0.3447	0.0023	0.6567
	double	0.5067	100	5	0.6150	0.0330	0.5820	0.0869	0.0174	3,4313	0.3431			
1600 U2	simple	0.5084	100	5	0.6600	0.0330	0.6270	0.0935	0.0187	3,6763	0.3676	0.3789	0.0159	4,1922
	double	0.5133	100	5	0.7060	0.0330	0.6730	0.1001	0.0200	3,9009	0.3901			
1600 U3	simple	0.5080	100	5	0.7020	0.0330	0.6690	0.0995	0.0199	3,9188	0.3919	0.3933	0.0020	0.5121
	double	0.5036	100	5	0.7010	0.0330	0.6680	0.0994	0.0199	3,9473	0.3947			
1600 U4	simple	0.5027	100	5	0.7030	0.0330	0.6700	0.0997	0.0199	3,9659	0.3966	0.3999	0.0047	1,1692
	double	0.5038	100	5	0.7160	0.0330	0.6830	0.1016	0.0203	4,0320	0.4032			

3.4 Coffee Caffeine Content at Altitudes of 1500 mdpl and 1600 mdpl

Coffee beans contain different levels of caffeine, depending on the geographical conditions and the type of coffee (Farida, 2013). The lower the planting area, the higher the caffeine content in the coffee, at low altitudes the intensity of sunlight is still high and the air temperature is also high.

Table 4. Coffee Caffeine Content at Altitudes of 1500 mdpl and 1600 mdpl

Height (mdpl)	I	II	III	IV	Average	SNI	
						I	II
1500	0.762	0.774	0.724	0.725	0.74625	0.9 – 2	0.45 – 2
1600	0.507	0.53	0.514	0.487	0.5095		

Table 4 shows that the caffeine content obtained from both observations can be seen that the caffeine content at an altitude of 1500 mdpl in the first repetition was 0.762%, the second repetition was 0.774%, the third repetition was 0.724%, the fourth repetition was 0.725% and had an average of 0.74625% while at an altitude of 1600 mdpl in the first repetition was 0.507%, the second repetition was 0.53%, the third repetition was 0.514%, the fourth repetition was 0.487% and had an average of 0.5095%. Based on the results of the analysis of variance, the treatment (altitude) showed a very significant effect on the caffeine content of Arabica coffee.

Different altitudes can affect the levels of chemical compounds in Arabica coffee beans, for example caffeine levels, the difference is due to the growing place factor where the growth and development of a plant (including secondary metabolites) are greatly influenced by environmental factors. The height of a plant's growth is one of the factors that influences the growth of the plant, so that differences in the height of the growing place affect the growth and development of the plant. The height of the growing place can affect the intensity of light, temperature and humidity of the plant's growing environment, so that it will disrupt the metabolic process in the plant and affect the

compounds produced from the plant's metabolic process (Putri et al., 2022).

The lower the coffee area, the higher the caffeine content in coffee, at lower altitudes the intensity of the sun is still high and the temperature is high so that the photosynthesis process will run optimally. If the photosynthesis process occurs optimally, the most secondary metabolites will be produced, and one of these secondary metabolites is caffeine. The higher the rate of photosynthesis, the more caffeine is produced (Aprilia., et al., 2018).

3.5 Physical Quality of Coffee at Altitudes of 1500 mdpl and 1600 mdpl

Physical testing is a system used to assess the quality of coffee beans based on their physical appearance, either using aids or using human senses in accordance with applicable standards. The following are the stages of physical testing carried out on coffee beans, namely:

a. Test Trace

It is the percentage of defective beans in 100 grams of coffee beans. Trace testing is carried out by weighing, which will separate defective beans from normal beans. The results of weighing defective beans are called the trace percentage. Trace testing is carried out on raw coffee beans. The high and low traces indicate the quality of the coffee beans.

High Trace = Poor quality
Low Trace = Good quality

b. Defect Test

Is the sum of the value of coffee bean defects, defect tests are carried out on ready or export coffee beans to determine the quality or Grade of the coffee. The sampling method is carried out randomly with a weight of 300 grams per sample.

Table 5. Quality of Arabica Coffee Beans at Altitudes of 1500 mdpl and 1600 mdpl

Height	Test	Trace	Defects (%)	Types of Defects	Quality
1500 meters above sea level	1	5.2	1.73%	Broken Seeds	1
	2	6.4	2.13%	Broken Seeds	
	3	7	2.33%	Broken Seeds	
	4	4	1.33%	Broken Seeds	
Height	Test	Trace	Defects (%)	Types of Defects	Quality
1600 meters above sea level	1	7.4	2.46%	Broken Seeds	1
	2	5.8	1.93%	Broken Seeds	
	3	5	1.66%	Broken Seeds	
	4	4.6	1.53%	Broken Seeds	

Table 5 shows the results of the coffee bean quality test at an altitude of 1500 mdpl and 1600 mdpl at quality 1 SNI 01-2907-2008, this is due to the coffee bean sorting process by soaking and then selecting if the beans sink are good quality beans while the floating beans have poor quality.

4. CONCLUSION

Based on the results of the research on mapping the physical and chemical properties of Gayo Arabica coffee with a semi-wash process at an altitude of 1500 mdpl and 1600 mdpl, the following conclusions can be drawn:

1. The difference in the height of the place where Gayo Arabica coffee is grown shows a significant influence on the coffee essence content, that the essence content obtained at an altitude of 1500 meters above sea level has an average of 43.49013% while at an altitude of 1600 meters above sea level it has an average of 51.1056% which is still within the standard limits of the essence content in SNI 01-3542-2004 for ground coffee which is at quality II (maximum 60%).

2. Differences in the height of the Gayo Arabica coffee growing place show no significant effect on reducing sugar, that the reducing sugar content obtained at an altitude of 1500 meters above sea level has an average of 0.3447% while at an altitude of 1600 meters above sea level it has an average of 0.3792%. This is because the photosynthesis process does not occur optimally due to the cold temperature of the area.
3. The difference in altitude of the place where Gayo Arabica coffee is grown shows a very real influence on caffeine content, that the caffeine content obtained at an altitude of 1500 meters above sea level has an average of 0.74625% while at an altitude of 1600 meters above sea level it has an average of 0.5095% which is still within the standard caffeine content limit in SNI 01-3542-2004 for ground coffee at quality II (0.45% - 2%).
4. Coffee bean quality tests at altitudes of 1500 mdpl and 1600 mdpl are at quality 1 SNI 01-2907-2008.

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