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Quantitative Analysis of Caffeine Levels in Local Coffee (*Coffea* sp) Powder on Dabo Island with UV-Vis Spectrophotometry

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Abstract

Coffee (*Coffea* sp) is the second-largest beverage consumed by people around the world whose process comes from the processing and extraction of coffee beans. Coffee has a chemical compound, one of which is caffeine. Caffeine is a crystal-shaped compound. Caffeine can be a tangible white powder or a shiny white needle-shaped, odorless caffeine, and caffeine has a bitter taste. The purpose of the study was to determine the caffeine levels of local ground coffee on the island of Dabo with the spectrophotometry UV-Vis method. Analysis of the ground coffee caffeine levels is quantitative determined using spectrophotometry UV-Vis. The equation of the calibration curve of caffeine is regression y = 0.1307x + 0.0112 with a correlation coefficient value (r) of 0.9993. Based on Indonesian National Standards (SNI) 01-7152-2006, The maximum limit of caffeine in foods and beverages is 150 mg/day and 50 mg/serving. The results of the analysis of caffeine levels from three samples of ground coffee circulating on Dabo Island each in 2 g were 0.3383 mg for Sample A; 0.3786 mg for Sample B; and 0.5803 mg for Sample C.

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INTRODUCTION

Coffee (*Coffea* sp) is a type of beverage that process comes from the processing of coffee beans. Nowadays, coffee is the second-largest beverage consumed by people all over the world, after water (Gaascht *et al*., 2015). Coffee has many benefits for health if used within reasonable limits, such as reducing headaches, coffee aroma relieving stress, caffeine coffee prevents cavities, relieve people with asthma, enrich the body's antioxidants, protect the skin, and stimulate brain work (Temple *et al*., 2017).

Coffee has one compound content that is caffeine. Caffeine is one of the many types of alkaloids found in coffee beans, tea leaves, and cocoa beans (Wilson, 2018). Caffeine is a white crystalline compound. The main constituent of protein derived compounds are called Purin xanthine (Arwangga *et al*., 2016). Based on Indonesian National Standards (SNI) 01-7152-2006 The maximum limit of caffeine in foods and beverages is 150 mg/day and 50 mg/serving (Fajara & Susanti, 2017). This caffeine compound in normal body condition does have some efficacy among others is an analytic medication that can lower the pain and reduce fever (Grgic *et al*., 2018). However, on the body that also has problems with the presence of uric acid metabolism hormone, the content of caffeine in the body will trigger the formation of high uric acid (Pasalic *et al*., 2012).

Research on the determination of caffeine levels in coffee has been done by the method of UV-Vis spectrophotometry. The research from Aptika *et al*. (2015) on the sample of the coffee powder in the check using UV-Vis spectrophotometry method obtained by the result of caffeine content consumed by the people of

Banjar Lebah, Bukian Village amounting from 647.5 to 690.9 mg, where the rate of caffeine passes the maximum limit according to SNI 01-7152-2006 which is 50 mg/serving or 150 mg/day. From the research of Arwangga *et al*. (2016), levels of caffeine in coffee in Sesaot Narmada Village raw coffee 1.28 ± 0.82% with water content of 3%, pure coffee of 1.63 ± 0.13% with water content of 1%, and mixed coffee of 0.87 ± 0.01% with water content of 1%. Based on the breakdown of research results above, researchers are interested in researching quantitative analysis of caffeine levels in some local coffee powder from Dabo Island with UV-Vis spectrophotometry method.

MATERIALS AND METHODS

The materials used in this research are samples of powdered coffee, caffeine standard, aquadest, chloroform, and calcium carbonate. The samples used in this study consisted of three ground coffee specimens obtained from three different places on Dabo Island, namely samples A, B, and C. The tools used in this research are UV-Vis spectrophotometers (Shimadzu® UV 1800), Analytical scales (Kenko®), water bath, separating funnel, measuring flask (Iwaki®), drip dropper (Normax®), Beaker Glass (Iwaki®), hot plate, Erlenmeyer, measuring cup (Iwaki®), Spatula, stirring rods, and filter paper.

Preparation of standard solutions

Caffeine standards of 250 mg are weighed and then entered in 250 ml measuring flasks. The standard is then dissolved in distilled water to the limit then homogenized by shaking. A total of 2.5 ml of the solution is then taken with a measuring pipette and then transferred in a 25 ml measuring flask. The solution is then diluted with distilled water to the limit and homogenized to obtain a standard solution of 100 ppm (Maramis *et al*., 2013).

Determination of the maximum wavelength

Uptake of 1 ml of standard solution was measured using a UV-Vis spectrophotometer with a wavelength range of 200-400 nm and blanks in the form of aquadest. The maximum wavelength obtained is 205.4 nm.

Determination of the calibration curve

Work standards are made by making a series of six solutions, each with a concentration of 2; 3; 4; 5; and 6 ppm. Each is made by taking as much as 2; 3; 4; 5; and 6 ml of standard solution respectively, then transferred to a 100 ml volumetric flask and dissolved with distilled water to the limit and homogenized.

Sample preparation

A total of 2 g of coffee powder from all three samples used was inserted into 250 ml Erlenmeyer then added 150 ml of hot aquadest and stirred. A hot coffee solution is filtered through the mouthpiece with a filter paper so that the coffee grounds do not carry over. The coffee solution was added with 1.5 g of calcium carbonate and inserted into the separating funnel and then extracted with 25 ml of chloroform and repeated three times. The chloroform phase at the bottom is then taken and concentrated over the water bath until the chloroform completely evaporates.

Determination of caffeine concentration

The prepared sample was dissolved in 1 ml of distilled water and then transferred in a cuvette. The sample is then measured for absorption with a UV-Vis spectrophotometer at the maximum wavelength that has been obtained previously.

RESULTS AND DISCUSSION

Determination of the calibration curve

Determination of the maximum wavelength obtained at the determination of the level of caffeine is used to make calibration curves, resulting in accuracy at high

concentrations, thereby reducing placement errors or wavelength readings and obtaining maximum absorbance accuracy (Bhawani *et al*., 2015; Ahmed *et al*., 2015). Calibration curve determination has been done at a concentration of 2; 3; 4; 5; and 6 ppm. After obtaining the results of the measurement of absorption for caffeine raw solution, then the absorption is made of interference linearity curve to the concentration of the raw solution of caffeine to obtain line equation and linear regression. The absorbance value of the standard solution shows results in the range between 0.2 to 0.8 Å. The range is the range commonly used in determining the UV-Vis spectrophotometer calibration curve related to the accuracy of the results obtained (Khoshneviszadeh *et al*., 2015). The calibration curve obtained a linear relationship between concentration and absorption by the coefficient of correlation (r) is 0.9993 and the equation of the regression line y = 0.1307x + 0.0112. A value of r which is getting closer to 1 indicates that the calibration curve that is formed is more linear, indicating a better equation (Bewick *et al*., 2003). The calibration curve is presented in **Figure 1**.

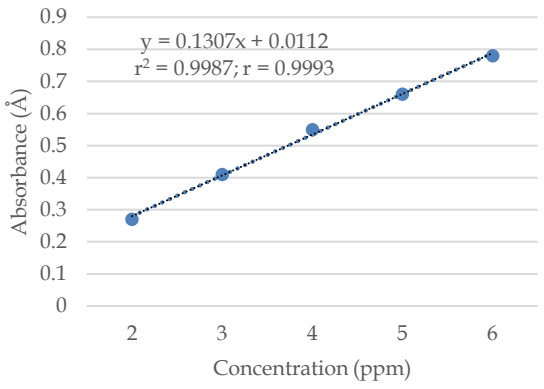

Figure 1. Calibration curves for standard caffeine solutions

Determination of caffeine concentration

Measurements of each sample showed varied results, where between Samples A and B showed close results, while Sample C showed the highest absorbance. As in the determination of the calibration curve, the absorbance of each sample also does not exceed 0.8 Å. That is because the absorbance that is too large can affect readings, especially on UV-Vis spectrophotometers with low resolution (Pratama *et al*., 2018).

The calculation of caffeine concentration in the sample is carried out using an equation that has been obtained previously. From the calculations, the concentration of caffeine from the sample is in the range of 0.1691 to 0.2902 mg/g of coffee samples or as much as 0.3383 to 0.5803 mg per packet of 2 g. The highest concentration is shown in Sample C, while the lowest is shown in Sample A. The absorbance results, as well as the calculation of concentration, are shown in **Table I**.

Table I. Absorbance and calculation of caffeine concentration in coffee samples

Sample	Absorbance (Å)	Average absorbance ± SD (Å)	Caffein Concentration (mg/g)	Caffein Concentration (mg/2 g)
A	0.452	0.453 ±	0.1691	0.3383
	0.453	0.0015		
	0.455			
B	0.502	0.506 ±	0.1893	0.3786
	0.509	0.0036		
	0.507			
C	0.769	0.770 ±	0.2902	0.5803
	0.771	0.0012		
	0.769			

The caffeine content of each sample itself is relatively not too high when compared to the maximum intake limit allowed by the Food and Drug Administration (FDA), which is between 100-200 mg/day. The range is equivalent to 591 to 689 g of samples that can be consumed daily (Reyes & Cornelis, 2018). When compared with SNI standards which require a maximum of the caffeine of 150 mg/day and 50 mg/serving, the value is equivalent to a sample of 516 g/day and 172 g/serving. This amount is quite a lot when compared to the amount of ground coffee used to brew a glass of coffee which is about 2 g/serving (Fajara & Susanti, 2017; Maramis *et al*., 2013). Some of the side

effects that often occur due to caffeine intake include palpitations, insomnia, headaches, tremors, anxiety, seizures, arrhythmias, nausea, and vomiting. Besides, the consumption of regular caffeine, especially in large quantities, can cause dependency effects (Cornelis, 2019; Wassef *et al*., 2017).

CONCLUSION

Of the three coffee samples marketed on Dabo Island that were tested, all three met the SNI requirements. The caffeine content in Sample A was recorded at 0.3383 mg/2 g of the sample; in Sample B 0.3786 mg/2 g of the sample; and in Sample C 0.5803 mg/2 g of sample. Further testing with other methods that have higher accuracy, such as HPLC can be done to ascertain the caffeine content of each coffee powder sample.

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