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# Analysis of Caffeine Content of Robusta Coffee Powder from the Coffee Powder Industry in Pasaman Regency

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**A B S T R A C T**

It is crucial to determine the amount of caffeine in coffee grounds so that people can safely consume coffee. According to SNI 01-7152-2006, the acceptable daily amount of caffeine is 50 to 150 mg. This study seeks to characterize the caffeine content of local coffee powder produced by small- and medium-sized enterprises (SMEs) in Pasaman Regency. Samples of coffee powder were collected from the two major coffee powder SMEs in Pasaman Regency, namely Matahari coffee powder SMEs and Gunpas coffee powder SMEs. This study's caffeine content will be compared to the standard caffeine content established by SNI 013542-2004, which is 0.45-2.00%, and SNI 01-7152-2006, which shows a daily caffeine consumption maximum of 50-150 mg. This investigation uses UV-Vis spectrophotometry. Caffeine levels in four samples per 1 gram of coffee powder are as follows: sample A, 6.878 mg; sample B, 6.855 mg; sample C, 6,674 mg; sample D, 7.688 mg. For the caffeine concentration in Pasaman Regency to be safe for everyday consumption, 4 grams of coffee powder are used in each cup. Sample A has a caffeine concentration of 0.687%, sample B contains 0.685%, sample C contains 0.667%, and sample D contains 0.768%. The coffee caffeine content produced conforms to SNI 01-3542-2004 regulations.

## 1. INTRODUCTION

### *1.1. Research Background*

Pasaman Regency is one of the coffee centres in West Sumatera Province, with an area of coffee land, according to BPS 2021, covering an area of 1,738 hectares and a production of 1,050 thousand tons [1]. This regency has several coffee processing industry centres with the two largest Industries according to the Office of Cooperatives, Pasaman Regency Labor and Trade, and *UMKM*, namely coffee powder industries with the trademarks *Matahari* Coffee Powder Industry and Gunpas Coffee Powder industry. These two Industries are in Panti District, Pasaman Regency, West Sumatera Province.

These two coffee powder Industries produce coffee powder with several grades, with the selling price of the coffee powder adjusted to the grade produced. The higher the grade of coffee, the higher the price offered.

Based on interviews with Industry owners, determining the grade of coffee powder is through several criteria. The *Matahari* coffee powder industry determines the grade based on the moisture content of the raw material. Grade A is obtained from coffee beans with a water content of 10%, while grade B is from coffee beans with a moisture content of 13-15%. Gunpas coffee powder industry determines the grade criteria based on the size of the coffee beans processed into coffee powder. Coffee beans are sorted to get the same size. Grade A is obtained from coffee beans that do not pass a 6.5 mm diameter sieve, and grade B is obtained from coffee beans that pass a 6.5 mm sieve.

Research on quality analysis of Matahari and Gunpas coffee powder was carried out in 2021 but has not yet analyzed caffeine as a quality component in coffee powder. Based on research results, water content, ash content, ash alkalinity, other ingredients, and total plate number (ALT) are in accordance with SNI 3542-2004 [2]. This research is a continuation of previous research, namely the analysis of coffee powder caffeine and comparison with SNI coffee powder, namely SNI 3542-2004.

Coffee is the most commercialized food product and the most consumed beverage globally [3]. Coffee consumption has increased every year, from 2017 to 2021, the increase in consumption has increased by 1% every year, with world coffee production of 10.18 thousand tons. [4]. Currently, coffee is Indonesia's most consumed drink after mineral water, so coffee has a fairly high economic value [5].

| Coffee powder | Image |
|---|---|
| Matahari Coffee powder grade A |  |
| Matahari Coffee powder grade B |  |
| Gunpas Coffee powder grade A |  |
| Gunpas Coffee powder grade B |  |

**Figure 1.** Coffee powder products in two industries:

Coffee is also one of the main commodities of Indonesian plantations. In addition, coffee is also known for its high caffeine content. Most people consume coffee expecting that the caffeine in coffee can restore lost energy and increase alertness to provide a sensation of being awake longer. However, consuming excess caffeine will cause side effects of anxiety and insomnia [6].

Coffee is one of the most popular drinks in the community. This can be seen in the coffee shop, which has become a cultural symbol and an identity for the people of Pasaman Regency. The culture of drinking coffee is enjoyed by people from the young to the elderly, which can be seen in coffee shops' development. Ground coffee is generally preferred because it has a distinctive taste, is low priced, and is easy to obtain. Coffee connoisseurs usually consume 3-4 cups of coffee every day [7]. One of the reasons for dependence on coffee drinks is the caffeine content in coffee.

Caffeine is an alkaloid in coffee, tea, and chocolate [8]. Caffeine is an alkaloid compound from coffee that is naturally found in xanthine (purine base). Caffeine has clinically beneficial pharmacological effects, namely stimulating the central nervous system, eliminating fatigue, hunger, and drowsiness, and increasing concentration power. Excessive caffeine consumption can also cause heart palpitations, gastric disorders, and shaking hands. [9]

Caffeine levels in coffee circulating in the market are different due to differences in the quality of coffee beans, processing, and the presence of a mixture of other ingredients. The national standardization agency sets standards for caffeine in coffee powder ranging from 0.455% -2% w/w. [10]

Determining the level of caffeine in coffee grounds is very important so that people can consume coffee safely. Caffeine levels or recommendations for daily consumption limits for these types of coffee can be listed on the packaging. Based on the Food and Drug Administration (FDA), the permitted dose of caffeine is 100-200 mg/day [11]. The maximum use of caffeine in food and beverages is also contained in SNI 01-7152-2006 concerning Food Additives – Flavor Requirements and Their Use in Food Products, namely caffeine consumption per day of 150 mg/day or 50 mg/serving [12].

The determination of caffeine content in several beverage and non-beverage products has been carried out by many previous researchers using various methods, such as determining caffeine content in cola-type soft drinks by high-performance liquid chromatography (HPLC) [13]. Research on reducing caffeine and total acid levels in Robusta coffee beans used facultative anaerobic fermentation technology with Nopkor MZ-15 microbe[14]. Several studies on the caffeine content in coffee used UV-Vis spectrophotometry [15; 16; 17 and 18].

Identification of caffeine levels using the UV-Vis spectrophotometry method. Spectrophotometry is a method used to determine the absorbance of a sample quantitatively or qualitatively based on the interaction between electromagnetic light and matter (organic compounds) using a spectrophotometer. The electromagnetic light in question is visible, UV, and infrared. UV-Vis spectrophotometry is a measurement based on visible light that uses a source of ultraviolet electromagnetic radiation with UV-Vis spectrophotometry as an instrument. The principle of UV-Vis spectrophotometry is the absorption of visible light for UV by a molecule which can cause the excitation of the molecule from a lower energy level to a higher energy level. UV-Vis spectrophotometer is used to measure absorption in the UV region with wavelengths in the range of 100-200 nm and visible light in the range of 200-700 nm [19]. The advantages of the UV-Vis spectrophotometric method are that the analysis is simpler, faster, economical, and more sensitive compared to the HPLC method which requires relatively expensive and complicated instrumentation [20].

### *1.2. Research Objectives*

This study aims to analyze the caffeine content in local ground coffee, which comes from the coffee powder Industry in Pasaman Regency. The caffeine content obtained in the study will be compared with the standard caffeine content according to SNI 013542-2004 which is 0.45-2.00% and also the limit for caffeine consumption per day based on SNI 01-7152-2006 which is 50-150 mg/day

## 2. MATERIALS AND METHODS

### *2.1. Place and time of research*

This research was conducted in December - January at the Vahana Scientific Laboratory on Jl. Medan Raya Wisma Indah IV, Siteba, Kec. Nanggalo, Padang City, West Sumatra.

### *2.2. Tools and materials*

The tools used in this study were ultraviolet spectrophotometry, analytical balance, erlenmeyer, spatula, stir bar, separating funnel, filter paper, funnel, measuring cup, measuring flask, beaker, tissue, gloves, mask, and pipette. The materials used in this study were packaged ground coffee, caffeine as a raw material, aqua dest, calcium carbonate (CaCO3), and chloroform (CHCl3).

### *2.3. Caffeine Content Analysis Procedure*

#### *2.3.1. Standard Solution Preparation*

A total of 20 mg of caffeine standard was weighed carefully, put into a 100 ml volumetric flask, dissolved with distilled water, and then made up to the mark with distilled water and shaken homogeneously so that a solution with a concentration of 200 ppm was obtained, and this solution is called standard mother liquor.

#### *2.3.2. Determination of the Calibration Curve*

The calibration curve was carried out by making a series of standard solutions with concentrations of 3, 5, 7, 10, 15, and 20 ppm. Then the absorption was measured at the maximum absorption wavelength of 273 nm, and distilled water was used as a blank.

#### *2.3.3. Sample Preparation*

The four samples consisted of Grade A Matahari Coffee Powder (Sample A), Grade B Matahari Coffee Powder (Sample B), Grade A Gunpas Coffee Powder (Sample C), and Grade B Gunpas Coffee Powder (Sample D). A total of 2 grams of sample was put into a glass beaker and dissolved with 100 ml of boiling distilled water, filtered, then the filtrate was added 2 grams of CaCO3, then heated to half the mixture, cooled, and put into a separatory funnel, and extracted with 25 successive chloroform ml four times, then the filtrate is accommodated in an Erlenmeyer. Then the chloroform solvent was evaporated to obtain caffeine extract. The resulting caffeine extract was then put into a 100 ml volumetric flask and dissolved with distilled water up to the mark. Then dilution was carried out using a pipette of 2 ml of the solution into a 100 ml volumetric flask and dissolved with distilled water up to the boundary mark.

#### *2.3.4. Determination of Caffeine Content*

Sample and standard caffeine in chloroform solvent were taken, and then included in the spectrophotometer. The absorption was measured under a UV lamp at a maximum wavelength of 273 nm, and then recorded. The concentration of caffeine in the sample can be calculated by [21]:

Caffeine content (mg/g) = (MV Fp)/ m

Where:

M = Concentration (ppm)/(mg/L)

V = Volume (L)

Fp = Dilution Factor

m = Sample Weight (g)

#### *2.3.5. Data analysis*

All collected data is presented in the form of quantitative data analysis using ultraviolet spectrophotometry using the law of the regression equation: Y = bx + a and the caffeine content in the sample is determined using the following calculation formula: Caffeine content (mg/g) = $konsentrasi\ (\ mg\ L\ )\ x\ volume\ (\ L\ )\ x\ Fp\ berat\ sampel\ (\ gram\ )$

M is the concentration (ppm) or (mg/L);

V is the volume (L);

Fp is the dilution factor and

m is the sample weight (g).

## 3. RESULTS AND DISCUSSION

### *3.1. Calibration Curves and Regression Equations*

Quantitative testing method for caffeine using spectrophotometry UV-VIS, the linearity of the standard caffeine calibration curve was determined using aquadest solvent carried out at concentrations of 3, 5, 7, 10, and 15 ppm and measured at a maximum absorption wavelength of 273 nm, as well using distilled water as a blank solution. The measurement results can be seen in table 1 below.

**Table 1.** Absorbance Value of Standard Caffeine Solution on Absorption Wavelength 273 nm

| Ppm | Absorbent |
|---|---|
| 3 | 0.15111 |
| 5 | 0.23265 |
| 7 | 0.33128 |
| 10 | 0.4648 |
| 15 | 0.69398 |

Source: Primary Data, 2023

Measurement of the absorbance of the standard solution produces a standard curve, and the standard curve can be seen in Figure 2.

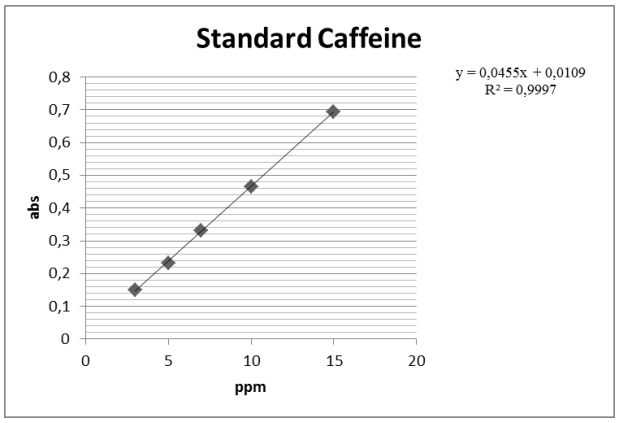


**Figure 2**. Standard Caffeine Curve

After obtaining the absorbance measurement results for the standard caffeine solution, the standard curve is linear, and the regression equation is y=0.0455x+0.0109 with a value of $R^2$ = 0.9974. After obtaining the linear regression equation, the caffeine content in ground coffee can be calculated.

### *3.2. Caffeine Levels on Ground Coffee in Mg*

Results analysis Quantitative ground coffee use method spectrophotometry UV-VIS, with test four sample Grade A Matahari Robusta Coffee, Grade B Matahari Robusta Coffee,

Grade A Robusta Gunpas Ground Coffee, and Grade B Robusta Gunpas Ground Coffee. Each sample was analyzed using spectrophotometry on a long wave with a maximum of 2.73 nm. The mark concentration sample can be seen in Table 2.

**Table 2.** Results of Analysis of Ground Coffee Caffeine Content by UV-VIS Spectrophotometry Method.

| No | Sample | Caffeine Content in 1 gram (Mg) |
|---|---|---|
| 1 | A | 6.878 |
| 2 | B | 6.855 |
| 3 | C | 6.674 |
| 4 | D | 7.688 |

Source: Primary Data. 2023

Based on the results of an analysis of caffeine content in milligrams. it was found that the caffeine content of coffee powder circulating in Pasaman Regency originating from the two industries was around 6-7 mg in one gram of coffee powder. According to Ref. [22], one cup of coffee requires 4 grams of coffee powder. This means that Matahari coffee powder Grades A and B produces 27.5 mg of caffeine in one cup. Grade A Gunpas coffee powder produces 26.696 mg, and grade B produces 30.752 mg.

The value of caffeine content of the coffee powder produced is still in the safe category for consumption per day, according to SNI 01-7152-2006. In SNI 01-7152-2006, the maximum daily caffeine consumption is 50-150 mg/day. so consumers can determine how many cups of coffee consumption do not exceed the maximum limit for caffeine consumption per day if people's habit of drinking coffee is 3-4 times per day. This is still in the category of safe maximum caffeine consumption per day. Coffee manufacturers are also advised to include caffeine levels on the packaging.

Based on the results of measurements of caffeine content. Water content. And coffee bean size did not affect the level of caffeine produced. The physical characteristics of the seeds are not significantly correlated with the caffeine content. So they cannot be used as indirect markers in the selection process [23]

### *3.3. Caffeine Levels on Ground Coffee in %*

Results study show the percentage rate contained caffeine _ in each sample is Matahari Grade A coffee powder at 0.68%. powder Matahari Grade B coffee is 0.68 %. Gunpas Grade A coffee powder at 0.66%. And powder Gunpas Grade B coffee at 0.76%.

In the results of the caffeine content of the Matahari coffee powder industry. Caffeine results were obtained with the same value. This shows that the water content of the coffee beans does not affect the value of the caffeine produced. Gunpas coffee powder industry obtained slightly different levels of caffeine. This shows that coffee beans do not affect the level of caffeine content of the coffee powder produced.

Caffeine content is also affected by the level of roasting. Coffee beans roasted in a Light roasting method have a higher caffeine content than those roasted in a dark method [24] in the four samples of coffee powder that were analyzed. They were roasted at a dark roasting level. This roasting level causes a low level of caffeine produced. This is by the resulting small caffeine content. namely 0.68% - 0.77%.

**Table 3.** Caffeine Content of Ground Coffee

| No | Sample | Caffeine Content in 1 gram (%) |
|---|---|---|
| 1 | A | 0.687 |
| 2 | B | 0.685 |
| 3 | C | 0.667 |
| 4 | D | 0.768 |

Based on SNI 01-3542-2004, the caffeine content in ground coffee is 0.455 % -2%. Coffee powder products are marketed by the requirements for caffeine content with SNI. Coffee powder caffeine content in the two industries already meets SNI requirements.

## 3 CONCLUSION

Caffeine levels in four coffee powder samples originating from industries in Pasaman Regency in 1 gram respectively had a caffeine content of 6.878; 6.855; 6.674; 7.688 mg. If in % then every 1 gram of coffee powder contains 0.687; 0.685; 0.667; 0.768 %. The four samples of coffee grounds from industries in Pasaman Regency all met the requirements of SNI 01-3542-2004. Namely between 0.45-2%, and the maximum limit for caffeine consumption per day based on SNI 01-7152-2006 is 50-150 mg/day.

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