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CHEMICAL PROFILE OF GROUND COFFEES IN SOUTH SUMATERA

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ABSTRACT
South Sumatra is the largest coffee-producing province in Indonesia. However, many ground coffee products circulating in the market have yet to meet the Indonesian National Standard (SNI) or obtain Geographical Indication (GI) certification. This study aimed to analyze the chemical characteristics of ground coffee from South Sumatra that meets SNI standards, possesses GI certification, and those that are uncertified. Three chemical parameters were examined: moisture content, ash content, and caffeine content. The results showed that the ash and caffeine contents of all six ground coffee samples met the quality standards set by SNI. However, the moisture content of all samples exceeded the maximum limit specified in the SNI for ground coffee, ranging from 7.38% to 9.10%. These findings indicate that although two parameters meet quality standards, improvements in processing or storage practices are still necessary to reduce moisture content and ensure the quality and shelf life of ground coffee.

1. Introduction

Globally, coffee represents the most extensively traded plantation commodity and is predominantly consumed as a beverage (IISD, 2022). According to data published by the Food and Agriculture Organization in 2024, coffee industry generated revenues exceeding USD 200 billion (FAO, 2024). For Indonesia, ranked as the fourth-largest coffee producer worldwide, coffee constitutes a significant source of foreign exchange, contributing USD 1.15 billion. This value marks an increase of USD 6 billion compared to 2021, with export volumes reaching 437.56 thousand tons in 2022 (Kementerian Pertanian Indonesia, 2023). This figure is expected to continue rising in line with increasing global popularity of coffee.

The largest coffee-producing region in Indonesia is South Sumatera, with a production volume reaching 212.452 thousand tons in 2022 (Kementerian Pertanian Indonesia, 2023). Coffee production in South Sumatera primarily originates from smallholder plantations (Direktorat Jenderal Perkebunan Indonesia, 2016). However, coffee produced by smallholder farmers tends to be of substandard quality. This is mainly due to the limited knowledge of farmers regarding standardized coffee quality. Coffee quality is influenced by numerous factors, starting before the harvesting process. These factors include variety, climate, nutrient availability, harvesting practices, and post-harvest handling. Each of these factors can affect the chemical properties of coffee, such as moisture content, ash content, and caffeine levels (Iflah & Rokhman, 2019). Chemical analysis is essential to ensure quality consistency and to enhance competitiveness in both local and global markets. Such analysis also serves as the basis for determining product compliance with quality standards such as the Indonesia National Standard (SNI) and Geographical Indication (GI).

For coffee enterprises, both SNI and GI play critical roles in improving coffee quality and fostering fair and transparent market competition. However, in practice, many ground coffee products produced and marketed, particularly from South Sumatera, have yet to comply with SNI or obtain GI certification. According to the latest data, only five coffee products from South Sumatera have been granted GI status (Kementerian Hukum Indonesia, 2025). This indicates that only a limited number of ground coffee products from the region have well-documented chemical characteristics. Therefore, this study aims to analyze the chemical characteristics of ground coffee originating from South Sumatera by comparing

samples that comply with SNI, those certified with GI, and uncertified products. The analysis focuses on three key parameters, moisture content, ash content, and caffeine level.

2. Materials and methods

2.1. *Materials*

Ground coffees were brought from Palembang, Indonesia. The chemicals used included calcium carbonate, chloroform, distilled water, hydrochloric acid, hydrogen peroxide, phenolphthalein (PP) indicator, and sodium hydroxide. The equipment used in this research included glassware, muffle furnace, oven, rotary evaporator, and UV-Vis spectrophotometer (Shimadzu).

2.2. *Study design*

The study was conducted by comparing six ground coffee samples of varying quality, two samples compliant with the SNI (coffee A and coffee B), two samples certified with GI (coffee C and coffee D), and two uncertified samples without SNI or GI (coffee E and coffee F).

2.3 *Quality assessment*

2.3.1. *Moisture content*

Moisture content was determined using the oven-drying method (SNI 01-2891-1992). Approximately 1 gram (g) of ground coffee sample was weighed and dried in an oven at 105°C for 3 hours. After drying, the sample was cooled in a desiccator and then reweighed. The drying and weighing procedures were repeated until a constant weight was obtained. Moisture content was calculated based on the weight loss before and after drying using the following equation:

$$\text{Moisture content: } \frac{\text{w1}}{\text{w}} \times 100\%$$

where w is the initial weight of the sample (g) and w1 is the weight loss after drying (g).

2.3.2. *Ash content*

Ash content was determined using the dry ashing method (SNI 01-2891-1992). A total of 2 grams of ground coffee sample was weighed and incinerated in a muffle furnace at 600°C until complete ashing was achieved. The sample was then cooled in a desiccator and weighed. The ashing and weighing processes were repeated until a constant weight was obtained. Ash content was calculated using the following formula:

$$\text{Moisture content: } \left(\frac{w1 - w2}{w}\right) \times 100\%$$

Where w is the initial weight of the sample (g), w1 is the weight of the crucible and ash after ashing (g), and w2 is the weight of the empty crucible (g).

2.3.2. *Caffeine level*

Caffeine content was determined using the UV-Vis spectrophotometric method adapted from Maramis et al. (2013). A total of 1 gram of ground coffee sample was placed in a beaker, then extracted with 150 mL of hot distilled water under constant stirring. The hot coffee solution was filtered through filter paper into an Erlenmeyer flask. Subsequently, 1.5 grams of calcium carbonate ($CaCO_3$) was added to the filtrate, and the mixture was transferred into a separatory funnel for liquid-liquid extraction using chloroform (4 x 25 mL). The chloroform layers (bottom phase) were collected and evaporated to dryness using a rotary evaporator. The solvent-free caffeine extract was transferred into a 100 mL volumetric flask, diluted to the mark with distilled water, and homogenized. Caffeine concentration was measured using a UV-Vis spectrophotometer at a wavelength of 275 nm.

2.4. *Statistical analysis*

The data were analyzed using Analysis of Variance (ANOVA), Honest Significant Difference (HSD) post hoc test was applied to identify significant differences, at a significance level of $p < 0.05$.

3. Results and discussions

3.1. *Moisture content*

One of the key indicators of coffee quality is its moisture content. Excessively high moisture content (above 12.5%) can lead to mold growth during storage, as well as physical degradation and loss of coffee flavor. However, coffee flavor can also deteriorate if the moisture content in ground coffee is too low (Purwanto et al., 2015). According to the SNI (SNI 01-3542-2004), the maximum allowable moisture content in ground coffee is 7% (w/w). Based on this standard, all tested samples failed to meet the moisture content criteria. Each sample exhibited a moisture content exceeding 7%, ranging from 7.38% to 9.1% (**Fig. 1**). The high moisture content in ground coffee may be attributed to several factors.

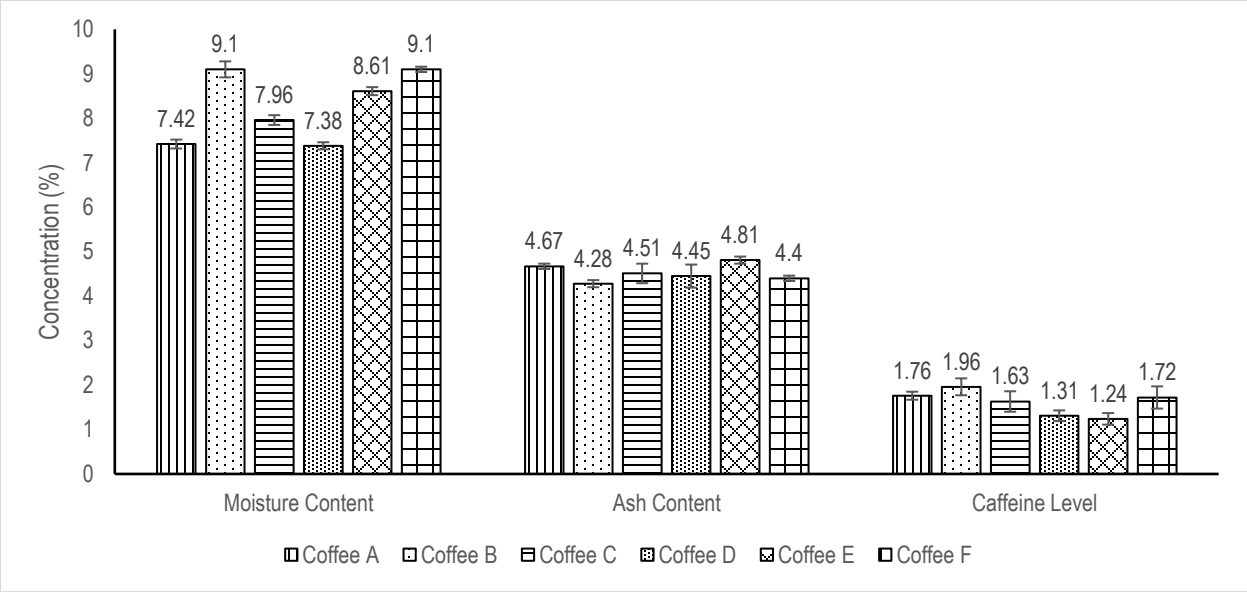

Figure 1. Chemical characteristics of ground coffees

The moisture content in ground coffee is influenced by three main factors: roasting conditions, packaging quality, and storage conditions. During the roasting process, the moisture content in coffee decreases depending on the temperature and duration of roasting (Tarigan et al., 2016). However, moisture content may increase if the packaging quality or storage conditions are inadequate. Environmental factors such as temperature, relative humidity, and air circulation must be properly managed to prevent moisture reabsorption during storage (Aditya et al., 2016).

The analysis results indicate that compliance with the Indonesian National Standard (SNI) or the possession of Geographical Indication (GI) certification does not guarantee that the moisture content of ground coffee falls within the established standard limits. The non-conformity of moisture content across all samples suggests that producers need to improve processing practices and pay greater attention to factors influencing moisture content in ground coffee, particularly during storage and distribution.

3.1. *Ash content*

The analysis results showed that the ash content of all ground coffee samples complied with the SNI standard, which specifies a maximum limit of 5% (w/w), with values ranging from 4.28% to 4.81% (**Fig. 1**). Compliance with the SNI ash content standard indicates that all six ground coffee samples are relatively free from contamination. Ash content in ground coffee represents the remaining minerals and inorganic substances after combustion. The concentration of ash in ground coffee reflects the cleanliness of the production process; higher ash levels suggest greater inorganic contamination in the coffee powder (Sutrisno et al., 2023).

The ash content in ground coffee is influenced not only by the roasting process but also by soil fertility and the geographical location of the plantation (Budi et al., 2020). The results of the analysis of variance (ANOVA) showed no significant differences in ash content concentrations among the samples ($p > 0.05$). This may be attributed to the fact that all six ground coffee samples originated from the same geographical region, namely South Sumatra Province.

3.1. *Caffeine level*

The caffeine content in ground coffee is regulated under SNI 01-3542-2004. This standard categorizes caffeine levels in ground coffee into two quality requirements: 0.9–2% (w/w) for Quality Requirement I and 0.45–2% (w/w) for Quality Requirement II. The analysis results showed that the caffeine content in all ground coffee samples complied with the SNI quality standards, ranging from 1.24% to 1.96% (**Fig. 1**). Based on these findings, it can be concluded that all six ground coffee samples, including those that are not SNI-certified or lack GI certification, possess good quality.

Caffeine is an alkaloid compound responsible for the flavor and aroma of coffee and serves as one of the

quality determinants (Santosa et al., 2020). Moreover, caffeine levels exceeding the permissible threshold may pose health risks to consumers. Caffeine is a psychoactive compound categorized as a central nervous system stimulant. While low to moderate doses are generally considered safe, excessive caffeine intake can have adverse health effects. High levels of caffeine consumption have been associated with increased anxiety and sleep disturbances (Heckman et al., 2010)

4. Conclusions

Analysis of six ground coffee samples originating from South Sumatra revealed that all samples exhibited moisture contents exceeding the maximum limit set by the Indonesian National Standard (SNI), ranging from 7.38% to 9.10%. In contrast, ash and caffeine contents of all samples were within the acceptable ranges specified by SNI, with values ranging from 4.28% to 4.81% and 1.24% to 1.91%, respectively. These findings indicate that although the ash and caffeine parameters comply with quality standards, greater attention must be directed toward moisture control to enhance product quality and stability.

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