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Phytochemical Screening of Gayo Arabica Spent Coffee Grounds (*Coffea arabica* L.)

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Abstract. *Spent coffee grounds (SCG) from Gayo Arabica coffee contain bioactive compounds such as caffeine, flavonoids, tannins, and polyphenols with antioxidant and skin-protective benefits. This study aimed to determine the secondary metabolites present in Gayo Arabica coffee grounds. The methods used were alkaloid identification using Mayer, Wagner, and Dragendorff reagents, flavonoids using magnesium powder and HCl, tannins and polyphenols using FeCl3, triterpenoids/steroids using Liebermann–Burchard, and saponins using distilled water. The results obtained were red-yellow or orange coloration for flavonoids, precipitate or turbidity in the alkaloid test, and blackish-green coloration for tannins. No blue-green coloration or foam formation indicated negative results for triterpenoids/steroids and saponins. Conclusion: Phytochemical screening confirmed alkaloids, flavonoids, tannins, and polyphenols*

Keywords: *Gayo Arabica; spent coffee grounds (SCG); phytochemical screening*

1. Introduction

Coffee is known for its distinctive flavor and aroma. Aceh province, specifically in the Bener Meriah and Central Aceh regencies, is one of the most abundant coffee producers in Indonesia. One of the most commonly consumed coffees in Aceh is Gayo Arabica (Teniro *et al*., 2017). Due to the large amount of coffee produced, coffee grounds are often discarded into the environment. Coffee grounds are the solid residue or sediment from brewed coffee beans that contain little or no extract (Agustiningsih and Dwiyanti, 2017).

Coffee grounds apparently still contain several bioactive compounds, such as phenolics, chlorogenic acid, flavonoids, and organic compounds (Harefa, 2018). Research (Bouhzam *et al*., 2023) indicates that the total polyphenol content in coffee grounds remains high. The results of this study indicate that coffee grounds contain diterpenes, kahweol, and cafestol, compounds detected throughout the coffee grounds extracted using various methods. Therefore, the presence of these bioactive compounds will provide significant benefits for the food, cosmetics, and pharmaceutical industries. One method of processing coffee grounds in the cosmetics and pharmaceutical industries is a gel scrub mask.

2. Method

Materials

Spent coffee grounds (SCG) of *Gayo Arabica* coffee (*Coffea arabica* L.) were obtained from Aceh, Indonesia, 90% ethanol (Bratachem, Indonesia). Phytochemical reagents comprised Mayer, Wagner, and Dragendorff reagents for alkaloid detection, Liebermann–Burchard reagent for triterpenoids and steroids, $FeCl_3$ for phenolic compounds, and magnesium powder with concentrated HCl for flavonoid testing. All reagents were of analytical grade.

Sample Preparation

Raw SCG approximately 2 kg of wet SCG were collected and air-dried at room temperature, protected from direct sunlight.

Phytochemical Screening

Phytochemical screening was performed to identify the presence of alkaloids, flavonoids, saponins, tannins, triterpenoids/steroids, and polyphenols.

a. Alkaloids: 0.5 g of SCG was treated with Mayer, Wagner, and Dragendorff reagents. The formation of turbidity or precipitate indicated a positive result.
b. Flavonoids: Samples were reacted with magnesium powder and concentrated HCl; red or orange coloration indicated flavonoids.
c. Saponins: Samples were shaken with distilled water; persistent foam (1–3 cm) indicated the presence of saponins.
d. Tannins and Polyphenols: A few drops of 5% $FeCl_3$ solution were added; a dark green or blue coloration indicated tannins.
e. Triterpenoids/Steroids: Liebermann–Burchard reagent was added, and a blue-green color indicated triterpenoids or steroids.

3. Results and Discussions

This The Phytochemical screening revealed that Gayo Arabica spent coffee grounds (SCG) contained flavonoids, tannins, alkaloids, and polyphenols, while triterpenoids/steroids and saponins were absent (Table 1). Characteristic reactions were observed, including red–yellow or orange coloration for flavonoids, precipitate or turbidity in the alkaloid test, and blackish-green coloration for tannins. No blue–green coloration or foam formation indicated negative results for triterpenoids/steroids and saponins, respectively.

Table 1. The Phytochemical screening

Group	Methods	Result
Alkaloid	Bouchardat test	+
	Mayer test	+
	Dragendorf test	+
Flavonoid	Mg dan Hcl test	+
Tanin	Fecl3 test	+
Saponin	Aquadest test	-
Steroid	Liberman Burchard test	-
Polifenol	Fecl3 test	+

Note : (+) containing a group of compounds
(-) not containing a group of compounds

Positive alkaloid reactions with Mayer's, Bouchardat's, and Dragendorff's reagents resulted from complex formation between alkaloids and nitrogen-reactive agents. The red coloration in the flavonoid test confirmed the presence of flavonoids after reaction with magnesium and hydrochloric acid. The tannin test using $FeCl_3$ yielded green to deep-blue coloration, consistent with complex formation between Fe^{3+} ions and phenolic groups. The absence of foam in the saponin test suggested no

glycosidic compounds, which normally hydrolyze to glucose in aqueous media (Fadri *et al*., 2021.

The presence of alkaloids, flavonoids, and tannins not only contributes to the phytochemical profile but also correlates with important biological activities such as antioxidant, antimicrobial, and metabolic enzyme modulation. Alkaloids and flavonoids are currently targeted research classes in drug discovery due to their broad therapeutic potential, including the ability to inhibit pathological enzymes and synergism in various bioactive mechanisms (Yao et al., 2024). Flavonoids and tannins are also reported to possess significant antioxidant properties through free radical scavenging and oxidative stress inhibition, which are often used as indicators of in vitro antioxidant activity in recent phytochemical studies of medicinal plants (Wiraswati et al., 2024). Furthermore, conventional phytochemical screening shows that secondary metabolite profiles can vary between plant parts and species, but the presence of alkaloids, flavonoids, and tannins is consistently associated with the biological activities observed in many local plant extracts (Ugwu et al., 2024).

Phenolic constituents of SCG—including melanoidins, protocatechuic acid, chlorogenic acids, and tannins—along with nitrogenous compounds such as caffeine and trigonelline, exhibit notable psharmacological activities. These bioactives are associated with antioxidant, antimicrobial, anti-inflsammatory, and anti-aging effects, supporting the potential cosmetic application of SCG extracts (Singh *et al*., 2022).

4. Conclusions

Gayo Arabica *spent coffee grounds* (SCG) were found to contain alkaloids, flavonoids, tannins, and polyphenols.

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