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Incorporation of catechin extracts from gambier products and pasak bumi in the production of functional instant green robusta coffee

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ABSTRACT

The research was used to produce functional instant green coffee through gambier catechin extract and pasak bumi powder. This involved using a non-factorial completely randomized design with 5 treatments and 3 replications. The treatments consist of 5 formulations (F), including the instant green coffee (%), gambir catechin extract (%), and pasak bumi powder (%) where F1 was at 100:0:0, F2 was 80:15:5, F3 was 70:20:10, F4 was 60:25:15, and F5 was 50:30:20. The results showed the functional instant green coffee produced has a water content of 3.84 – 4.81%, soluble speed of 26.78 – 29.33 seconds, and total phenol of 16.79 – 169.48 mg/L, and IC50 of 44.68 – 207.59 ppm. The addition of gambier catechin extract and pasak bumi powder to the formulation was observed to have significantly increased the functional properties and water content. Moreover, the soluble speed of the instant coffee fulfils the quality requirements of the Indonesian National Standard (SNI) number 2983 of 2014.

Keywords: gambier, instant, catechin, green coffee, pasak bumi

INTRODUCTION

Humans accept coffee from both the sensory and functional aspects despite numerous pieces of information on its effects on body health. It has been reported that both robusta and arabica generally contain functional compounds in chlorogenic acid. This compound was also discovered by **[34]** to be present in coffee as an antioxidant, with robusta reported by **[38]** to contain higher content at 43. 63% than arabica, which has 36.18%. According to **[14]**, roasting can reduce robusta caffeine and chlorogenic acid levels by 13 – 25% and 37 – 59%, respectively. Several studies have been conducted to maintain the antioxidant properties of coffee such as the addition of herbal cereals in **[29]**, optimisation of roasting temperature to reduce damage to chlorogenic acid compounds in **[8]** and **[3]**, and the use of a spontaneous fermentation with *Wickerhamomyces anomalous* (Strain KNU18Y3) on green coffee beans in **[7]**.

Green coffee is currently gaining popularity among world coffee lovers, and it is mainly different from the ordinary types due to the effect of the bean processing method on its functional properties and aroma. According to **[6]**, green robusta has better functional properties than roasted coffee, as indicated by their total phenol contents of 208.89 mg/L and 119.22 mg/L, respectively. **[18]** also showed that green robusta contains 81.6% antioxidant compounds and has higher caffeine content and high antioxidant properties. It is important to add bioactive compound materials in its production process to increase its antioxidant properties and reduce caffeine levels. One source of these bioactive compounds is catechin and pasak bumi extract.

Catechin is a product from the aqueous extraction of the leaves and twigs of the gambier plant (*Uncaria gambir Roxb*), which have been discovered to contain more than 52.25% catechin compounds **[37]**. This extract was further reported by **[11]** to be an antioxidant with an IC_{50} of 2.74 g/mL, while **[30]** also showed its ability to form canna-based edible films, which are antioxidants. According to **[13]** and **[36]**, the roots of the pasak bumi plant also contain eurikomanone, quassinoids, flavonoid, phenolic, and terpenoid compounds which are observed to have antioxidant potentials.

Scientific Hypothesis

The addition of gambir catechin extract has a significant effect on increasing the functional properties of instant green coffee, especially its antioxidant activity.

MATERIAL AND METHODOLOGY

Samples

Instant coffee powder made from green robusta coffee powder incorporated with gambir catechin extract.

Chemicals

The materials used consist of distilled water, tannic acid, 96% ethanol, 2,2-diphenyl-1-picrylhydrazil (DPPH), folin-ciocalteu, methanol, Na_2CO_3, and nutrient broth (NB) obtained from the Laboratory of Chemical Agricultural Products, Faculty of Agriculture, Sriwijaya University, Indonesia.

Biological Material

Gambier powder from Babat Toman Village, Musi Banyuasin Regency, South Sumatra, Indonesia. Robusta green coffee powder from JagadRaye Coffee micro and small enterprise in Pagar Alam, South Sumatra, Indonesia. Pasak bumi powder from the Laboratory of Chemical Agricultural Products, Faculty of Agriculture, Sriwijaya University, Indonesia.

Instruments

The tools used include an autoclave, blender (Philips, Holland), hot plate, incubator (Memmert, Germany), filter paper, laminar airflow (LAF), brand analytical balance (Kenko, Japan), drying oven (Memmert, Germany), pH meter (Eutech, Malaysia), micropipette (Dragon Lab, China), rotary vacuum evaporator, 80 mesh filter, spectrophotometer (A and E Lab, USA), and vortex (Digisystem, Taiwan).

Laboratory Methods

The parameters evaluated include water content **[2]**: measurement of water content using the gravimetric method. Soluble speed [2]: Dissolve 100 g of instant coffee in 200 mL of water. Then the length of time instant coffee dissolves in water is calculated as the speed at which it dissolves in water using a stopwatch. Total phenol **[31]**: Determination of total phenol content was carried out by means of a spectrophotometric method using Folin-Ciocalteu reagent. Antioxidant activity **[17]**: Antioxidant testing using the DPPH method (2,2 diphenyl-1-picrylhydrazyl) was used.

Description of the Experiment

Sample preparation: The instant green coffee powder, gambier catechin extract, and instant pasak bumi powder with a size of 80 mesh are mixed. Each treatment is put into a cup and then brewed with 100 mL of hot water at 80 °C and stirred using a magnetic stirrer.

Number of samples analyzed: A non-factorial completely randomized design was used in this study. A total of five treatments are carried out using the percentage ratio of instant green coffee: gambier product catechin extract: instant pasak bumi. F1 = (100:0:0), F2 = (80:15:5), F3 = (70:20:10), F4 = (60:25:15), and F5 = (50:30:20).

Number of repeated analyses: Three repetitions for each treatment factor. The total sample analysed was 15 samples.

Number of experiment replication: Each treatment was repeated 3 times.

Design of the experiment:

Instant green coffee

Green coffee beans were dried to a moisture content of 12% and ground using a grinder. The powder was filtered using an 80-mesh sieve, after which water was added at a temperature of 100 °C and a ratio of 1:2, stirred, left for 10 minutes, and later filtered using a filter cloth to obtain the filtrate. Moreover, maltodextrin (10% w/w) and egg white (20% w/w) were added to the filtrate, mixed using a mixer for 10 minutes at high speed to form foam, and spread out on an aluminium pan lined with Polypropylene plastic. The mixture was dried in a carbine dryer at 60 °C for 4 hours, blended, and filtered using an 80-mesh filter to obtain a green coffee powder.

Gambier product catechin extract

The catechin extract was prepared using the maceration method. This involved blending the dried gambier sticks until smooth and sieved through an 80-mesh sieve. The 100g gambier powder was macerated using ethanol for 1 day (24 hours) at a ratio of 3:1. Moreover, the catechin extract was filtered using Whatman filter paper No. 41 and evaporated at 85 °C with a rotary vacuum evaporator to vaporise the ethanol and remove the aroma. The catechin extract was later dried using an oven at a temperature of 85 °C for approximately 20 hours, blended, and sifted again.

Instant pasak bumi powder production

The instant pasak bumi powder was prepared. This involved the filtration of the powder using an 80-mesh sieve after which water was added at 1:2 and a temperature of 100 °C; the mixture was stirred, left for 10 minutes, and filtered again using a filter cloth to obtain the pasak bumi filtrate. Moreover, maltodextrin (10% w/w) and egg

white (20% w/w) were added to the filtrate, mixed using a mixer for 10 minutes at high speed to form foam, and spread out on an aluminium pan lined with Polypropylene plastic. The mixture was dried in a carbine dryer at a temperature of 60 °C for 4 hours, blended, and filtered using an 80-mesh filter to obtain a green coffee powder.

Statistical Analysis

This study used a factorial completely randomized design. The treatment with a significant effect was further tested using the honest real difference test (HSD) at = 5%. The data were analysed using the SAS software version of Windows 9 to analyse of variance.

RESULTS AND DISCUSSION

Water content

The water content of the functional instant green coffee produced ranged from 3.84 to 4.81% with the highest and lowest recorded in F5 and F1 treatments respectively as indicated in the following Figure 1.

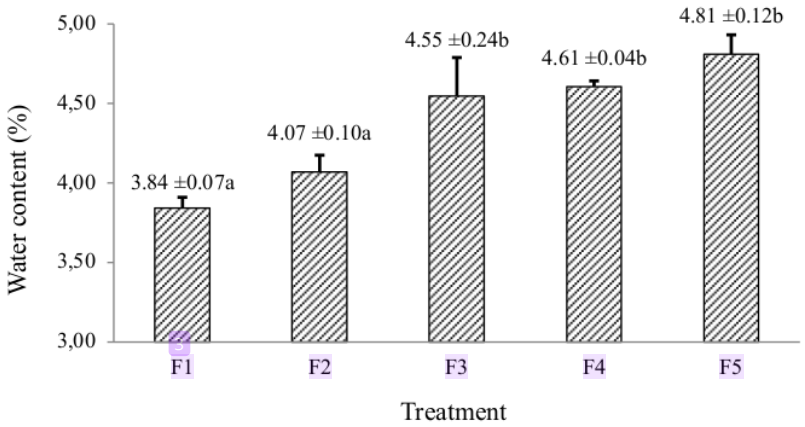

Figure 1 Effect of formulation on the water content of functional instant green coffee. Note: F1 = 100% green coffee instant: 0% gambir catechin extract: 0% instant pasak bumi; F2 = 80% green coffee instant: 15% gambir catechin extract: 5% instant pasak bumi; F3 = 70% green coffee instant: 20% gambir catechin extract: 10% instant pasak bumi; F4 = 60% green coffee instant: 25% gambir catechin extract: 15% instant pasak bumi; F5 = 50% green coffee instant : 30% gambir catechin extract: 20% instant pasak bumi.

The diversity analysis in Figure 1 showed that the formulation treatment significantly affects the water content of functional instant green coffee. Moreover, the F3 treatment with 20% gambier catechin extract and 10% pasak bumi was observed to have increased the water content. This is associated with the fact that the catechin extract and pasak bumi contain phenolic compounds with a hydroxyl group (OH) that can bind water. It is also important to note that the existence of more OH groups usually leads to more water being bound. Meanwhile, the water content in foodstuffs comprises both bound and free water.

This instant coffee fulfils the quality requirements of the Indonesian National Standard (SNI) No. 2983 of 2014 which states that the maximum water content is 5%. The values obtained in this research were observed to be higher than the 1.57 – 1.61% reported by **[21]** for instant coffee from Tungkal Jambi and the 2.34% by **[39]** for cold-brewed instant coffee. Meanwhile, the values are in the same range as 4.4.% found by **[15]** for instant coffee produced from micro-size coffee combined with *Bacillus coagulans*.

Soluble Speed

This is one of the quality requirements for instant coffee according to SNI No. 2983 of 2014, which is set at a maximum of 30 seconds. The values obtained in this research were between 26.78 – 29.33 seconds, as indicated in Figure 2 and this means the requirements are satisfied. Meanwhile, the values are higher than the 152.26 seconds **[19]** for instant coffee made from robusta coffee incorporating maltodextrin but lower than the 11.48 – 13.95 seconds reported by **[28]** while studying instant robusta with coconut sugar and cane sugar.

The diversity analysis showed that the formulation treatment significantly affects the soluble speed of functional instant green coffee. A higher concentration of gambier catechin extract in the formulation was found to cause a reduction in the soluble speed as indicated in Figure 2. This is because the catechin compounds in gambier products are semi-polar and a higher concentration of catechin usually leads to higher semi-polar nature of instant coffee, thereby, causing a reduction in the solubility of the product in water. This phenomenon was also reported in **[24]**.

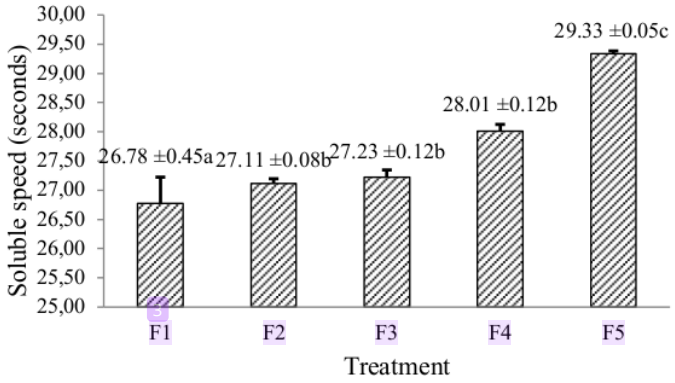

Figure 2 Effect of formulation treatment on the soluble speed of functional instant green coffee.

Total Phenol

The total phenol of the functional instant green coffee produced ranged from 16.79 to 169.48 mg/L as indicated in Figure 3.

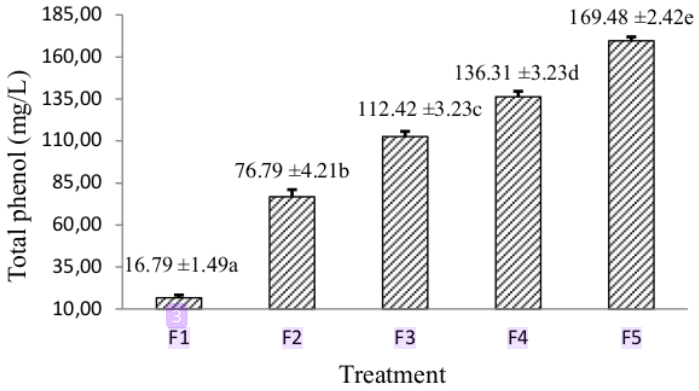

Figure 3 Effect of formulation treatment on total phenol of functional instant green coffee.

These values are slightly lower than 171.633 mg/L reported by **[4]** and higher than 16.26 – 30.65 mg/L and 42.4 – 59.8 mg/L recorded by **[33]** and **[5]**, respectively. However, this coffee has a total phenol content similar to the results of research by **[9]**, which is 29.23 – 158.19 mg/mLGAE, **[22]** regarding cinnamon coffee of 34.46 mg/mLGAE, oven-roasted coffee, which is 16 – 66 mg/mLGAE **[1]**, famous brand coffee circulating in Indonesia is 46.27 mg/mLGAE **[16]** and roasted arabica coffee is 49.90 mg/mLGAE **[23]**. Compared with the research of **[6]**, this total phenol is much lower, i.e. unroasted coffee contains 208.89 mg/mLGAE of total phenol and 119.22 mg/mLGAE in roasted coffee.

The diversity analysis showed the significant effect of the formulation treatment on the total phenol of functional instant green coffee. It was discovered that a higher concentration of gambier catechin extract and pasak bumi in

the formulation increased the total phenol. This is, therefore, associated with the polyphenolic compounds in the catechin extract and pasak bumi. The result is in line with the findings of **[20]** and **[29]** that gambier contains polyphenol compounds in the form of catechins by 50%. In comparison, **[40]** found phenolic compounds of catechins and tannins at 65.6 – 74.2% and 11.32 – 17.76%, respectively. Moreover, **[10]** showed that pasak bumi contains several secondary metabolites: alkaloids, terpenoids, sterpenoids, steroids, flavonoids (phenols), and saponins.

Antioxidant Activity

The antioxidant activity of functional instant green coffee was measured using IC_{50} such that a higher IC_{50} value indicates lower antioxidant activity and vice versa. The values were observed to be from 44.68 – 207.59 ppm as shown in Figure 4, and are the same as the findings of **[25]** that the encapsulated green coffee extract has 87.65 ppm and **[39]**, which showed that green coffee brewed with cold water has 71.97 – 83.21 ppm. However, the values are higher than the 25.187 ppm reported for green coffee extract dried using the foam mat method by **[26]** and **[18]** reported that robusta green coffee contains antioxidants with an IC_{50} of 81.6 µg/mL and lower than 167.426 to 294.710 ppm recorded for green coffee from Ethiopia by **[35]** and **[12]** reported that robusta coffee contains antioxidants with an IC_{50} of 2210 µg/mL.

The diversity analysis showed that the formulation treatment significantly affects the IC_{50} of functional instant green coffee, as indicated in Figure 4. This was observed because a higher concentration of gambier catechin extract and pasak bumi powder in the formulation caused a reduction in the IC_{50} and a higher antioxidant activity. This is associated with flavonoid compounds that are considered antioxidants in the gambier catechin extracts and pasak bumi powder. Moreover, it also indicates consistency with the total phenol data recorded in Figure 3, which showed the same trend. Phenol is also an antioxidant, which means a higher content of this compound can increase the antioxidant properties of the product, as indicated by a decrease in IC_{50}.

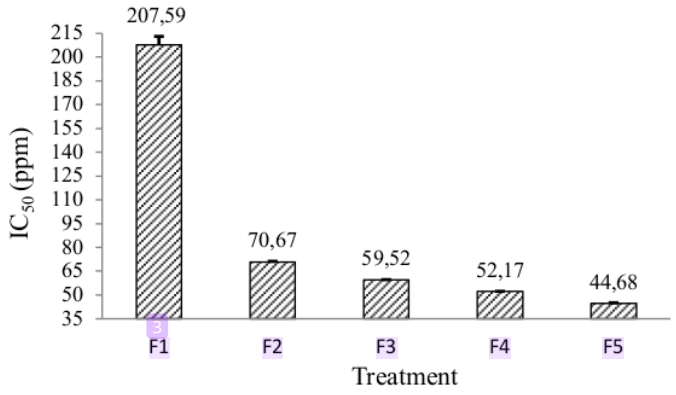

Figure 4 Effect of formulation treatment on IC_{50} of functional instant green coffee.

CONCLUSION

Added catechin extract of gambier and pasak bumi in instant green coffee significantly increases total phenol content and IC_{50}. Besides that, there was also a change in the physical properties of instant green coffee, namely an increase in water content and speed of dissolving. The functional instant green coffee produced has a water content value of 3.84 – 4.81%, soluble speed of 26.78 – 29.33 s, total phenol of 16.79 – 169.48 mg/L and an IC of IC_{50} of 44.68 – 207.59 ppm.

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