



Optimization of Coffee-Clove-Ginger Formulated Powder Based on Antioxidant Activity and Physicochemical Properties

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Abstract

The development of coffee products as functional drinks is hoped to increase the popularity of coffee as a healthy drink. One way of improving is by adding spices into the coffee. The purpose of this research was to obtain optimization of coffee-spice formulated powder based on its antioxidant activity, water content, ash content, and extract content. The spices used in this research were ginger powder and cloves(1:1). In this research, the ratio of coffee:spices (%b/b) tested varied with F₀(100%: 0%), F₁(95%: 5%), F₂(90%:10%), F₃(85%:15%), and F₄(80%:20%) each ratios underwent 4 repetitions of tests for physic and chemical properties. F₀-F₄ was roasted for 35 minutes at 200 °C. The results showed that all formulas except F₄ had met the SNI certifications of ground coffee. The best formula was F₃ had water(6.55%), ash content(4.72%), extract content(28.13%) was the highest(p<0.05) out of all the high varying ratio of coffee: spices formula (F₄), and F₃ had the lowest IC₅₀(22.42µg/mL). Thus the formula with the lowest proportion of spices was considered as the optimal formula based on the water content, ash content, and extract content, whereas of antioxidant status, the formula with the highest proportion of spices was considered the best formula. The conclusion of this research was proportion of spices in the formula, the better the antioxidant status, but less optimum in terms of its other physic and chemical properties. It is hoped that the spiced coffee formula could potentially serve as a functional beverage for the community.

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Introduction

Coffee as a beverage is no longer a foreign product. It has a fragrant aroma, a distinctive taste and efficacy that can stimulate the body to be more awake or refreshed that make coffee quite popular and familiar on the tongue of the people. The content in coffee that most would correlate it with is caffeine. But additionally, it also contains vitamin C, vitamin E and phenolic components that act as antioxidants (Putri and Latunra, 2013). To increase the demand of coffee products, development needs to be done. One of the ways that can be taken is by adding spices into the coffee so that it can therefore be considered as functional coffee. Functional coffee itself is called so because in it there are nutrients or non-nutrients that if being consumed, not only will it give the effect of refreshment to the body alone but also provide positive health effects for consumers. Functional drink is a functional food type that has now become a trend to

raise public awareness of the importance of consuming healthy foods.

Spices added to the coffee are natural ingredients containing active components that are strong and effective enough to provide health effects such as antioxidants known as natural antioxidants (Embuscado, 2015). In Indonesia, spices are aplenty, however, cloves and ginger have particularly high antioxidants. Cloves have high eugenol compounds and were proven to have high antioxidant properties compared to bay leaves, cinnamon, and nutmeg (Towaha, 2012). Ginger is also a rhizome that has the highest antioxidant gingerol compared with other rhizomes.

Antioxidants are substances that can prevent oxidation reactions from free radicals that can trigger cell damage and it can also prevent degenerative diseases to occur (Mu'nisa *et al.*, 2012). Human body does not have a lot of antioxidant reserved. Therefore, external

natural antioxidants become alternatives needed by humans to prevent the formation of more radicals. If humans are to use synthetic antioxidants excessively it will create toxic and carcinogenic effects (Alenisan *et al.*, 2017). Natural sources of antioxidants are found in fruits, vegetables, and spices. In this research, the source of natural antioxidants are taken from spices (ginger and cloves).

This study was conducted to obtain optimization of coffee-spice formulated powder based on antioxidant activity, water content, ash content, and extract content. It is hoped that this study can potentially promote spiced coffee as a functional beverage for the community.

Materials and Methods

Preparation of ground coffee, cloves, and ginger

Robusta coffee beans were obtained from Banaran Plant, while cloves and ginger were obtained at Rasamala traditional market. Coffee beans and ginger were roasted together for 35 minutes at 200 °C. Then the roasted coffee and spices, were cooled first for 5 minutes, grounded and then sifted (60 mesh) to obtain coffee powder ready to brew. It is then packed in plastics according to a predefined formula.

Making of spiced coffee formula

Spiced coffee was made in 5 different formulas wherein each formula consisted of coffee: spice with proportions of F₀ (100%: 0%); F₁ (95%: 5%); F₂ (90%: 10%); F₃ (85%: 15 %) and F₄ (80%: 20%). The proportion of ginger: cloves in the spiced coffee formula was 1: 1. Each formula underwent 4 repetitions for physic and chemical properties.

Water Content

Water content analysis, based on the work of Handayani *et al.* (2016), was done using oven drying method. Porcelain plate coded according to the sample code was then heated in an oven with temperature of 105 °C for 1 hour. Porcelain cup was put in desiccator for ± 15 minutes, then the cup was weighed. 2 g (initial weight) of sample was weighed in a porcelain dish with a known mass then dried at 105 °C for 4 hours. The sample was weighed, then re-heated and re-weighed until constant weight (final weight) was obtained. The weight was considered constant if the weighing difference did not exceed 0.2 mg. Sample was inserted into the desiccator for ± 15 minutes then continued with weighing. Water content was calculated by the following formula: initial weight of sample minus final weight of sample divided initial weight of sample (in gram) multiplied one hundred persen.

Ash Content

Ash content analysis, according to Legowo *et al.* (2005), was done using direct method. The principle of determining the ash content in a sample was to weigh the mineral residue produced from the burning of organic matter at a temperature of about 550 °C. Determination of ash content was carried out directly by burning the materials in high temperature (500 - 600 °C) for 2 - 8 hours and then the residue left was weighed and was

regarded as ash. The amount in the samples that underwent ash content analysis was about 2 - 5 g. Ash content was calculated by the following formula: weight of ash divided mass of sample (in gram) multiplied one hundred persen.

Extract Content

Extract content analysis was undertaken based on SNI (1996) modification and Pangabean *et al.* (2013) gravimetric method. Approximately 1 g (w₀) of sample was weighed and dissolved in 150 ml of hot aquadest, then filtered with filter paper. However, before it was used, the filter paper had been first heated at 100 °C for 1 hour, then left in the desiccator for ± 15 minutes and then weighed. After filtration, the filter paper containing residue had been dried in a 105 °C oven for 3 hours, left in desiccator for ± 15 minutes and then weighed (w₁). The extract content was calculated by the following formula: sample weight – dry weight left in desiccator divided dry weight left in desiccator (in gram) multiplied one hundred persen.

Antioxidant Activity

One common method used in antioxidant testing is to use 2,2-diphenyl-1-picrylhydrazyl (DPPH). Testing of antioxidant activity was undertaken through analysis of different volume measurements of sample using micropipette with volumes of 30, 60, 90, 150 µL. The different volumes of sample were put into test tubes and added with 3.8 mL DPPH µM then put in the centrifuge and left for 30 minutes in the dark. The absorbance of the solution was then measured at a wavelength of 515 nm using a UV-VIS spectrometer (Andayani *et al.*, 2008). Tests were performed on functional coffee samples. The antioxidant activity (IC₅₀) was calculated according to the linear equation between concentration and sample absorbance.

Data Analysis

The results of antioxidant activity test were analyzed descriptively. The results of moisture content, ash content, and extract content were analyzed by using *Analysis of Variance* (ANOVA) at $\alpha = 5\%$. If there was a real difference then the analysis was continued with *Duncan Multiple Range Test* (DMRT) test to find the difference between each treatments. Organoleptic results data were analyzed using *Kruskall Wallis non parametric test* at $\alpha = 5\%$.

Results and Discussion

Results of variable testing of water content, ash content, extract content, and antioxidant activity are illustrated in Table 1.

Water Content

Table 1 shows the mean values of functional coffee water content and DMRT test results that differed significantly ($p < 0.05$) between formula F₀- F₁ with F₂-F₃ and F₄. Water contents of F₀- F₃ were respectively 5.26%; 5.58%; 6.55% indicating that F₀-F₃ complied with the standard set, based on the Indonesian National Standard (SNI) 01-3542-2004 of water content of coffee

Table 1. Analysis results of functional coffee variable testing with different coffee and spices (cloves and ginger) formulas

Parameter	Formula				
	F ₀	F ₁	F ₂	F ₃	F ₄
Water Content (%)	5,26±0,24 ^a	5,58±0,12 ^a	6,25±0,32 ^b	6,55±0,25 ^b	7,49±0,10 ^c
Ash Content (%)	4,52±0,08 ^a	4,63±0,15 ^a	4,70±0,14 ^{ab}	4,72±0,08 ^{ab}	4,84±0,10 ^b
Extract Content (%)	30,60±0,34 ^a	29,68±0,50 ^a	29,02±0,82 ^{ab}	28,13±0,63 ^{bc}	28,03±0,74 ^c

Note: F₀-F₄= Formula of coffee and spices (cloves and ginger) with coffee:spice proportions of F₀ (100%:0%) F₁ (95%:5%) F₂ (90%:10%) F₃ (85%:15%) F₄ (80%:20%)

powder with a maximum of 7%. However, F₄ had a water content of 7.49% which did not meet the standard water content of ground coffee.

Water content of F₄ formula was higher than that of F₀-F₁. It is suspected that the reason behind it was because the ingredients of spices (cloves and ginger) were used too much and still contained significant amount of water affecting the water content of coffee powder itself. According to Nurdjannah and Bermawie (2012), dry cloves had water content of 6.5% and Vasala (2012) stated that the water content of dried ginger was commonly 7%. Thus, the more cloves and ginger that still contained high amount of water added into the coffee, the higher the water content of the functional coffee. From the results obtained, the optimum water content of the functional coffee was in F₃ formula where there was no significant difference between F₂ and F₃ (6.55%). This was because water content in a dry food products such as powder was expected to have water content as little as possible to achieve material resistance from damage caused by microorganisms during storage. Decrease in water content within this study was obtained from the process of roasting at the right temperature and time. This corresponded with the opinion of Edvan *et al.* (2016) which stated that with the right temperatures and duration of roasting, water content gradually decreased from its original water content so that it was cultivated to meet the Indonesian National Standard (SNI) of ground coffee water content. The lower water content of the coffee with added the less cloves and ginger is getting better.

Ash content

Table 1 shows the mean values of functional coffee ash content and DMRT test results that differed significantly ($p < 0.05$) in the formula F₀- F₁ with F₂, F₃, and F₄. F₀- F₄ ash contents were 4.52%; 4.63; 4.70; 4.72; 4.84 respectively, indicating that F₀₋₄ fulfilled the standard set by Indonesian National Standard (SNI) 01-3542-2004 of ash content with maximum of 5%.

Ash contents of formula F₀- F₁ were lower than F₂- F₄. Differences in ash contents might be caused by differences in the amount of spices (cloves and ginger) added containing minerals that presumably increased the ash content in the coffee. Nurdjannah and Bermawie (2012) stated that the content of ash in cloves was 6.11% and Vasala (2012) stated that the dry ginger had ash content of 5.7%. Hence, the more cloves and ginger were added into the coffee, the ash content on the functional coffee was higher. According to the results obtained, the optimum ash content from the functional coffee was in F₃ formula where there was no significant difference between F₃ and F₄ with value of 4.72%. The

lesser the ash content in coffee, the better the quality of coffee produced. According to Febrianto *et al.* (2014) the purpose of testing ash content as a parameter of nutritional value in food was to know whether or not the process of making ground coffee was sophisticated and highly qualified. It was also conducted to check the excellence of the types of materials used. The lower ash content of the coffee with added the less cloves and ginger is getting better.

Extract content

Table 1 shows the mean values of functional coffee extract concentrations and DMRT test results that differed significantly ($p < 0.05$) on each of the F₀₋₁ formulas with F₂, F₃, and F₄. F₀- F₄ extract contents obtained were 30.60%; 29.68%; 29.02%; 28.13%; 28.03% respectively. This indicated that the formula F₀- F₄ already met the Indonesian National Standard (SNI) 01-3542-2004 of extract content of 20-36%.

The extract contents of the F₀₋₁ formulas were higher than that of F₂₋₄. High levels of extract might be influenced by the amount of water-soluble solids and volatile compounds in the coffee and the spice. This complied with the opinion of Edria (2010) which stated that the greater the value of extract it meant the product was dissolved more quickly thus creating convenience for consumers when using the product. Low levels of extract in the F₂₋₄ were due to the amount of spice ingredients added containing lots of fibers and minerals that did not experience complete combustion during roasting. In consequence, it reduced the existing fiber in the material and the amount of dissolved materials in the coffee affecting the extract content. Extract content had strong opposite relation to ash content. The higher the ash content the lower the extract content in coffee. This was caused by the amount of deposits in the form of minerals within the coffee. From the results gained, we saw that extract content of the functional coffee was in F₃ formula where there was no significant difference between F₃ and F₄ with value of 28.13%. The higher extract content of the coffee with added the less cloves and ginger is getting better.

Antioxidant Activity

Based on Illustration 1, from the results of antioxidant activity test of IC₅₀ using DPPH, there was significant difference of the functional coffee between each formulas ($p < 0.05$). F₀ had the highest IC₅₀ value, that was 25.87 µg/mL, whereas F₄ had the lowest IC₅₀ value, that was 21.62 µg/mL but optimum was IC₅₀ 22,42 µg/mL. According to Filbert *et al.* (2014) the smaller the value of IC₅₀, the higher the antioxidant activity of the sample. In this case, the higher the addition of cloves and

ginger the antioxidant activity in the coffee increased. F₃ showed the ability to inhibit free radical that was comparatively higher to other formulas because of the influence of the addition of cloves and ginger having antioxidant contents of phenol compounds such as eugenol and gingerol. This is in accordance with Erminawati and Naufalin (2014) reporting that the more amount of antioxidant-containing substances in the sample the higher the antioxidant activity. The amount of phenols in cloves and ginger greatly affected the activity of antioxidants. This is in accordance with the opinion of Husni *et al.* (2015) stating that the antioxidant activity was associated with the amount of phenols, wherein the higher the amount of phenol compounds contained the higher the antioxidant activity.

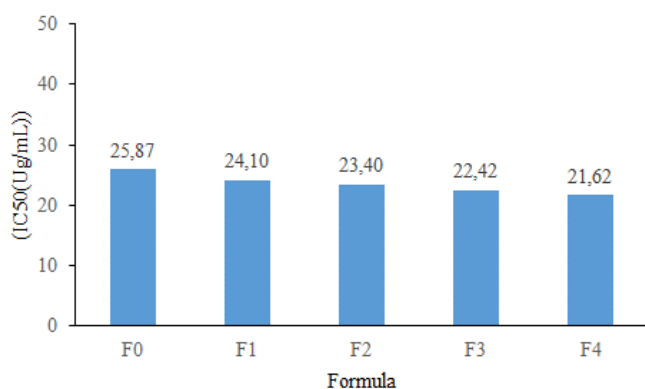


Illustration 1. Graphic of IC₅₀ Antioxidant Activity of Functional Coffee

The highest level of antioxidant activity was found in the F₃ formula with IC₅₀ value of 21.62 µg/mL. This indicated that antioxidant activity, including IC₅₀, was very active with value <50 µg/mL. This is consistent with the opinion of Imrawati *et al.* (2016) suggesting that the antioxidant activity strength of the compound tested using the DPPH method was classified according to IC₅₀ value. This method was broadly considered as a good measurement of antioxidant efficiency of pure compounds or extracts. The high amount IC₅₀ in F₃ was mainly caused by the amount of ginger that was higher compared to the other spiced coffee formulas (F₁₋₂), according to Carlsen *et al.* (2010) wherein ginger contained antibiotic activity of 31.8 µg/mL gingerol, while cloves contained antioxidant activity of eugenol of 1353.3 µg/mL, thus ginger had a high antioxidant activity in the mixture of spices. The more ginger added the higher the antioxidant activity was. Regardless of the addition of cloves and ginger, coffee had a high antioxidant as it contained chlorogenic acid which was one of the substances of phenol compounds. This is in accordance with the opinion of Putri and Andy (2013) stating that the largest chemical content of coffee as an antioxidant was chlorogenic acid. In coffee, chlorogenic acid had antioxidant activity of 41.0 µg/mL indicating that it contained very active antioxidants. This also went hand in hand with the opinion of Sato *et al.* (2011) which stated that IC₅₀ chlorogenic acid had higher antioxidant activity than caffeine that were 41.0 µg/mL. Therefore, although the addition of a slight amount of spices (cloves and ginger) into the coffee formulas most likely produced

higher antioxidant activity. The optimum antioxidant activity of functional coffee was in F₃ formula of 22.42 µg / mL among other formulas. The higher antioxidant activity of the coffee with added the more cloves and ginger is getting better.

Conclusion

The formula with the lowest proportion of spices was considered as the optimal formula based on the moisture content, ash content, and the extract content. However, based on its antioxidant activity, the formula with the highest proportion of spices was considered the best formula. The more the proportion of spices in the formula, the better the antioxidant status, although less optimum in its chemical properties tested. It is hoped that the spiced coffee formula could potentially serve as a functional beverage for the community.

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