Total phenols content of green coffee (*Coffea arabica* and *Coffea canephora*) in East Java

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**Abstract.** Green coffee is coffee that has been peeled and not roasted. Green coffee is a source of natural antioxidants in the form of polyphenol compounds, where the main component is chlorogenic acid. Two green coffee beans varieties that are commercially available include *Coffea arabica* (Arabica) and *Coffea canephora* (Robusta). The purpose of this study was to determine the effect of differences in location and type of green coffee on the total phenols content of green coffee beans. Randomized Block Design with two factors was employed in this study. The first factor consists of 2 levels of green coffee varieties (i.e. Robusta and Arabica) and the second factor of consists of 4 levels of green coffee location (i.e. Malang, Jember, Bondowoso and Banyuwangi). Total phenol content of green coffees was examined by UV-Vis Spectroscopy method. The results found that the types of coffee (*Coffea arabica* and *Coffea canephora*) and the location of coffee cultivation had a significant influence on the phenol content, but there was no interaction between the two. Green coffee with the highest phenolic compound was Robusta Green coffee from Jember with total phenol value of 35.6703 mgGAE /g of material.

1. Introduction

Coffee is one of the eight main commodities in Indonesia having a large enough area and is a very promising export commodity [1]. According to data from the Ministry of Agriculture in 2012-2016, East Java had coffee production of 5.13% with an average production of 32,772 tons of coffee beans per year. The largest coffee bean production centres come from Malang, Banyuwangi, Bondowoso and Jember Regencies. Two coffee species that are often cultivated and provide economic value are Arabica and Robusta coffee [2].

Green coffee is coffee that has been peeled and not roasted (International Coffee Agreement). Green coffee is sources of natural antioxidants for the human body enable to protect body organs from the influence of free radicals [3]. The antioxidant content such as polyphenol compound in Arabica coffee beans varies between 6-7%, while in Robusta is about 10% [2]. The main polyphenol compound in green coffee is the Chlorogenic acid with the values up to 90%. Chlorogenic acid levels in Arabica seeds vary between 6-7%, while Robusta coffee beans are around 7-11%. The level increased with the level of...
maturity and it has a bitter taste like caffeine [4]. Spiller [5] stated that the caffeine contained in Robusta dry coffee beans was 1.16-3.27% on dry basis, while the caffeine contained in roasted coffee beans was 2% on dry basis.

The potential availability of the Chlorogenic acid as an antioxidant in green coffee is not widely used, because producers are focused on roasted black coffee to produce delicious flavours. It was suggested that coffee is consumed by consumers not as a source of nutrition but as a refreshing drink [6]. Many studies and articles put more focus on caffeine in coffee. On the other hand, other beneficial compounds such as polyphenols and the Chlorogenic acid in coffee have not been widely studied. Therefore, study on characterisation of the quality of green coffee in East Java (i.e. for Arabica and Robusta green coffee) is necessary to investigate any medicinal properties or benefits.

A study in Manado city reported that each 1 g of different powder coffee samples has varied in the caffeine content, for example 13.81 mg (sample A), 13.63 mg (sample B), 12.33 mg (sample C), 10 mg (sample D), 10.13 mg (sample E), and 9.53 mg (sample F) [7]. Not only the flavours found in coffee, total phenolic compound and antioxidant activity may also vary in each coffee-producing region. Thus, it is necessary to investigate the total phenol content and antioxidants from several green coffee-producing regions in East Java, including Malang (Dampit), Banyuwangi (Telemung), Bondowoso (Gunung Ijen-Raung), Jember (Argopuro). The characterisation study is expected to determine the content of phenol compounds and antioxidant activity from various types of green coffee based on their chemical properties, in which the results can be used as a reference for further utilisation as functional industrial products.

2. Material and Method
2.1. Material
The raw materials used were Robusta and Arabica green coffee beans from Malang, Banyuwangi, Bondowoso and Jember.

2.2. Sample collection
Green beans from each type and location were taken as much as 2 kg. The particle size reduction of green coffee beans is done by milling, followed by sieving with 60 mesh sieves. Then 1 g of each green coffee sample was used in each test.

2.3. Experimental design
Arabica and Robusta green coffee from Malang, Banyuwangi, Bondowoso, and Jember were characterised by conducting quantitative tests on the total phenol content, antioxidant activity and caffeine levels. This study was arranged using a Completely Randomized Block Design (CRBD) with two factors. The first factor was the type of coffee consisting of 2 levels (Robusta and Arabica) and the second factors was coffee locations consisted of 4 levels (Malang, Banyuwangi, Bondowoso, and Jember). All treatments were carried out in triplicate with the total 24 experimental units.

2.4. Extraction of green coffee
One gram of coffee powder was added with 10 ml of distilled water and macerated for 24 hours at room temperature (25 °C) without stirring. The green coffee extract was then filtered to remove suspended particles and stored in container [8].

2.5. Total phenol analysis
The total phenolic compound was measured by the UV-Vis Spectroscopy method following the standard testing procedures [9].
2.6. Data analysis
Data from the experimental results were analysed using software SPSS17 statistics with variance analysis (ANOVA) for each green coffee sample. If there was significant difference from the test results, then continued with a Honestly Significance Difference (LSD) test.

3. Results and Discussion
The total phenol value of green coffee based on the type and location of coffee is shown in Table 1. It can be seen that the total phenol of green coffee samples were in the range of 3.8619 - 35.6703 mgGAE / g. Green coffee sample with the highest total phenol content was Jember Robusta coffee with a value of 35.6703 mgGAE / g. This indicates that each 1 g of Jember Robusta coffee powder contains total phenol which equivalent to 35.6703 mg of gallic acid. Coffee with the lowest total phenol content was Malang Arabica coffee with a value of 3.8619 mgGAE / g. This also indicates that each 1 g of Malang Arabica coffee powder contains total phenol which equivalent to 3.8619 mg of gallic acid Coffee contains 80.9 ± 3.3mg / 100mL phenolic acid, which the main component is Chlorogenic acid by 90%, and another phenolic acid (i.e. ferulic acid) at concentration of 8% [10]. Polyphenol levels in Arabica coffee beans was vary between 6-7%, while in Robusta was around 10%.

| Type of coffee | Location | Total phenol (mgGAE/gr) |
|---------------|----------|------------------------|
| Arabica       | Malang   | 3.86                   |
|               | Jember   | 33.21                  |
|               | Bondowoso| 21.88                  |
|               | Banyuwangi| 7.68                   |
| Robusta       | Malang   | 5.24                   |
|               | Jember   | 35.67                  |
|               | Bondowoso| 31.01                  |
|               | Banyuwangi| 9.34                   |

The results of ANOVA showed that the type and location of green coffee had a significant effect ($\alpha = 0.05$) on the total phenol concentration, but no significant interaction between both factors was observed. Further LSD analysis on the growth’ location of green coffee taken based on the total phenol values. Table 2 shows the statistical location classification of green coffee growth with different letter notations from LSD test ($\alpha = 0.05$).

| Location | Total phenol (mgGAE/gr) | Notation |
|----------|------------------------|----------|
| Malang   | 4.55                   | a        |
| Jember   | 34.43                  | c        |
| Bondowoso| 26.44                  | b        |
| Banyuwangi| 8.50                   | a        |

Statistically, the growth’ location of green coffee was divided into 3 groups was divided into 3 groups include low, medium and high total phenol levels. The growth’ location of green coffee with the lowest total phenol values includes Malang and Banyuwangi areas, with an average value of 4.5509 and 8.5073
mgGAE / g. These values were not significantly different, therefore classified into the same classification. The growth’ location of green coffee with a moderate total phenol value of 26.4442 mgGAE / g was Bondowoso area. The growth’ location of green coffee with the highest total phenol value was from Jember area, with the average total phenol value of 34.4385 mgGAE / g.

Robusta coffee is able to adapt to its environment better than Arabica coffee [11]. Currently, Robusta coffee is widely cultivated in Central Java, East Java, Lampung and Aceh [12]. In this study, it can be seen that Robusta coffee from Jember has the highest total phenol content. Jember has ideal criteria for the growth of Robusta coffee. Water content of the coffee plant is contributing as one of the important factors influencing the total phenol. Optimum rainfall can provide and meet the water needs of plants. Water deficits in plants can affect the vegetative growth of plants [13]. Water is needed by plants to carry out various processes, such as the formation and filling of organ cells, regulating cell turgidity to run the mechanism of organ movement (opening and closing stomata), solvents of solids, reactants in the process of photosynthesis, and temperature control of all plant organs [14]. Thus, lack of water in plants will directly or indirectly affect all metabolic processes in plants, which may disrupt the growth process [15].

In coffee cultivation, especially in Coffea robusta, sufficient water is required enabling the plants to grow properly. Robusta coffee seeds are also known to be more susceptible to drought than that of Arabica coffee seeds. The function of secondary metabolites is to defend themselves from less beneficial environmental conditions, for example, to overcome pests and diseases, pull the pollinator, and as a signal molecule. Most of the producing secondary metabolite compounds utilise these compounds to defend themselves and compete with other living organism. Plants can produce secondary metabolites (such as quinones, flavonoids, phenols, tannins, etc.) that make other plants unable to grow around them.

4. Conclusion
The type and the growth’ location of green coffee have a significant effect on the total phenol content. The interaction between those factors did not have a significant effect on total phenol. The best quality coffee from all aspects of testing was Robusta coffees from Jember which produced the highest total phenol with a value of 35.67 mgGAE / g.

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