Antioxidant Activity and Total Phenolic Compounds of Arbica and Robusta Coffee at Different Roasting Levels

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Abstract. The roasting process will determine the flavor in which chemical reactions occur and changes in components in coffee beans. Changes can occur in phenol compounds that contribute to antioxidant activity. This study aims to study the effect of roasting levels on Arabica and Robusta coffee beans on the content of phenol compounds and their antioxidant activity. The roasting process is carried out at three levels, namely light, medium, and dark. The analysis was carried out on the total phenol content and antioxidant activity expressed in the radical capture activity of the compound 2,2-diphenyl-1-picrylhydrazyl (DPPH). The results show that increasing the roasting level causes a decrease in antioxidant activity as indicated by increasing IC$_{50}$, EC$_{50}$ values. Meanwhile, ARP and AAI are decreasing. This corresponds to the phenol content which decreases with increasing roasting levels. This finding also proves that Robusta coffee has higher antioxidant activity than Arabica. This corresponds to a greater total phenol robusta content than arabica.

1. Introduction

Arabica and Robusta coffee is a commodity that is widely traded in the world. These two varieties have different content of bioactive compounds including polyphenols and antioxidant compounds. Arabica green beans contain greater trigonelline than Robusta. Besides, the caffeine and chlorogenic acid content of Robusta is greater than Arabica (Jeszka-Skowron et al., 2016).

The roasting process will change the physical, chemical and sensory characteristics of green coffee beans (Hasbullah et al., 2018a; Vignoli et al., 2014; Chung et al., 2013). Roasting also influences the content of antioxidant compounds in roasted beans (Priftis et al., 2015). During roasting degradation of chlorogenic acid, trigonelline, amino acids, and sugar compounds produce coffee flavor compounds (Yeretzian et al., 2002; Jeszka-Skowron et al., 2016).

The roasting levels are generally distinguished by the color of roasted beans, namely light, medium and dark. This level of roasting will have differences in roasting time and temperature during roasting (Hasbullah et al., 2018). This affects the content of antioxidant compounds in roasted beans. The antioxidant compounds present in green beans will be degraded during roasting. However, on the other hand, antioxidants are also produced after roasting such as melanoidin, furfural, and hydroxyl methyl furfural (Vignoli et al., 2014).

So far, many studies have focused on the formation of coffee flavor after roasting at three levels of roasting. This study aims to study the effect of roasting levels on antioxidant activity and polyphenol
content in Arabica and Robusta coffee. Antioxidant activity is indicated by the value of inhibitory concentration (IC$_{50}$), efficiency concentration (EC$_{50}$), antiradical power (ARP), and antioxidant activity index (AAI).

2. Method

Arabica and robusta coffee beans are obtained from Gunung Kelir, Central Java, Indonesia. The chemicals used are compounds 2,2-diphenyl-1-picrylhydrazyl (DPPH) (Sigma-Aldrich), methanol (Sigma-Aldrich), Folin-Ciocalteu (Sigma-Aldrich), sodium carbonate (Sigma-Aldrich), phenol standard (Sigma-Aldrich).

Green beans roasted with a roaster machine (Eureca IPX1-Italy). The roasting is done at three roasted levels, namely light, medium and dark. The starting temperature is 180°C and ends according to the roasting level. Light ends when the first crack occurs, the medium terminates when the second crack starts, dark ends when the second crack is done (Hasbullah et al., 2018b). The roasted bean is then pulverized with a grinder (RT-02A Rong Tsong Precision Technology Co.). Samples were stored in valves aluminum foil at room temperature until analyzed.

Analysis of antioxidant activity using the DPPH method (Scherer and Godoy, 2009; Mishra et al., 2012; Sánchez-Moreno et al., 1998). Coffee powder is extracted using water at 98°C for 50 minutes while stirring 100 rpm. Then centrifuged for 15 minutes and continued with vacuum filtration. A total of 4 ml of extract sample with several series of concentrations was reacted with 0.5 ml DPPH 0.6 mM, then vortex and incubated in a dark room for 30 minutes. The absorbance samples were measured with a UV-Vis Spectrophotometer (Spectroquant® Prove 600, Merck) at λ 517 nm. Antioxidant activity is expressed by inhibitory concentration (IC$_{50}$), efficiency concentration (EC$_{50}$), antiradical power (ARP), and antioxidant activity index (AAI). EC$_{50}$ = IC$_{50}$/DPPH concentration. ARP = 100/EC$_{50}$. AAI=DPPH/IC$_{50}$ concentration.

Phenol analysis using the Folin-Ciocalteu method (Vignoli et al., 2014). A 500 μL coffee extract was reacted with 2.5 mL Folin-Ciocalteu 0.2 M for 4 minutes. Furthermore, it was reacted with 2 mL of sodium carbonate 0.7 M and incubated for 120 minutes in a dark room. The absorbance samples were measured with a UV-Vis Spectrophotometer (Spectroquant® Prove 600, Merck) at λ 760 nm. Reference compounds using standard phenols. Total phenol is expressed in milligrams of equivalent phenol (mg PE) / g sample weight. Data were analyzed with ANOVA followed by DMRT at the 95% significance level with SPSS software.

3. Result and Discussion

3.1 Antioxidant Activity

3.1.1 Inhibitory concentration (IC$_{50}$)

![Figure 1. IC$_{50}$ Arabica and Robusta coffee at three roasted levels. Different letter notations show significant differences at $\alpha$ 0.05. Data is presented with a standard deviation line.](image-url)
Increasing the roasting level causes the IC$_{50}$ value to increase significantly (Fig. 1). This indicates a decrease in antioxidant activity with increasing roasting levels. This event is possible because the longer roasting causes a decrease in total chlorogenic acids, total caffeoylquinic acids, and 5-O-caffeoylquinic acid (Budryn et al., 2015). The IC$_{50}$ value of Arabica coffee is lower than Robusta. This indicates that Arabica coffee has greater antioxidant activity than Robusta. The roasting caused an increase in IC$_{50}$ in Arabica and Robusta coffee. Ethanolic extracts from arabica green beans have greater total phenol and chlorogenic acid compared to Robusta (Kiattisin et al., 2016).

3.1.2 Efficiency concentration (EC$_{50}$)
Increasing the roasting level causes the EC$_{50}$ to significantly increase (Fig. 2). This indicates the effectiveness of the work as an antioxidant that decreases. Robusta coffee has a higher EC$_{50}$ value than Arabica. This proves that the effective work of antioxidant coffee is lower than Arabica. EC50 values of Arabica and Robusta coffee were still greater than ginger (19.1), oregano (8.4), rosemary (3.86), and thyme (6.4) (Mariutti et al., 2008).

![Figure 2. EC$_{50}$ Arabica and Robusta coffee at three roasted levels. Different letter notations show significant differences at $\alpha$ 0.05. Data is presented with a standard deviation line.](image)

3.1.3 Antiradical power (ARP)
ARP illustrates the antioxidant power in coffee. ARP values decrease with increasing roasting levels (Fig. 3). ARP coffee Robusta is lower than Arabica. This shows that the strength of antioxidants will decrease with increasing roasting levels. Besides, the antioxidant power of Arabica coffee is greater than Robusta. The decrease in ARP value also occurs in several types of malt with the decreasing content of phenol compounds (Moreira et al., 2013).
3.1.4 Antioxidant activity index (AAI)

AAI shows extract groups based on their antioxidant strength. AAI values below 0.5 indicate weak antioxidant activity, values between 0.5 and 1 indicate moderate antioxidant activity, values between 1 and 2 indicate strong antioxidant activity, values above 2 indicate very strong antioxidant activity (Scherer and Godoy, 2009). AAI values decrease with increasing levels of roasting (Fig. 4). Arabica coffee AAI is greater than Robusta. This indicates that the increasing level of roasting causes the less concentration of DPPH needed to be neutralized by the extract at a certain concentration. Based on the AAI value, it can be classified that Arabica coffee powder and Robusta in various roasting classified as having weak antioxidant strength. This is due to the coffee powder is a complex of many compounds
contained therein. In contrast to pure compounds that have large AAI values such as chlorogenic acid, caffeic acid, gallic acid (Scherer and Godoy, 2009).

3.2 Total Phenol Compounds

The content of phenols in coffee green beans consists of the most chlorogenic acid compounds. During the roasting, there will be degradation of many compounds to produce new phenol compounds such as caffeine, caffeic acid, quinic acid, ferulic acid, gallic acid (Yeretzian et al., 2002). Increasing the roasting level causes a decrease in the total polyphenols in coffee (Fig. 5). This happens because the increasing level of roasting will increase the temperature and the reaction of the phenol compound to become more intensive coffee flavor (Priftis et al., 2015). The total polyphenol arabica coffee is greater than Robusta. This is possibly related to the trigonelline and caffeine content in arabica green beans which are greater than robusta, while the chlorogenic acid content is the opposite (Martin et al., 1998). However, other researchers stated that the caffeine content in green beans robusta is greater than arabica (Jeszka-Skowron et al., 2016). During roasting, most of the phenol compounds will be damaged (Vignoli et al., 2014). Other researchers convey that the phenol content in roasted beans robusta is greater than arabica (Vignoli et al., 2014). The difference in the results of this study is possible because of differences in the location of growth that causes differences in the content of compounds in green beans that have an impact on roasted beans.

![Figure 5. Total phenol of Arabica and Robusta coffee at three roasted levels. Different letter notations show significant differences at α 0.05. Data is presented with a standard deviation line.](image)

4. Conclusion

The difference in the roasting level will affect the antioxidant activity and the total phenol of Arabica and Robusta coffee. Light arabica coffee has the highest antioxidant activity and the highest total phenol content.

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