THE EFFECT OF RICE INCLUSION ON THE MEDIUM ROASTING PROFILE ON ACIDITY LEVELS AND CAFFEINE CONTENT OF SUMOWONO ARABICA COFFEE (COFFEA ARABICA)

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Abstrak

Arabica coffee, known for its rich flavor, is a key agricultural product in Indonesia, with Sumowono Arabica from Central Java being particularly renowned for its distinct aroma and acidity. The aim of this study is to investigate the impact of adding rice during the roasting process on the acidity and caffeine content of Sumowono Arabica coffee. Roasting plays a crucial role in determining coffee's chemical composition, particularly with respect to compounds such as chlorogenic acids and caffeine. By incorporating rice into the roasting process, significant alterations in the coffee's flavor profile and chemical composition were observed. Specifically, the addition of rice resulted in a reduction of both caffeine concentration and acidity. The starch content of rice interacts with caffeine and acids, potentially through absorption and buffering effects, leading to a decrease in the levels of these compounds. The study found that as the rice percentage increased, caffeine concentration decreased, while the pH (acidity) of the coffee rose, indicating a reduction in acidity. These results suggest that the addition of rice during the roasting process can optimize the sensory qualities of coffee, offering an innovative method for producers seeking to enhance flavor profiles while catering to consumer preferences for lower caffeine and acidity levels. This research provides valuable insights for the coffee industry, highlighting the potential of rice addition as a natural method for improving coffee quality and market appeal.

***Key words**: Sumowono coffee, coffee roasting, acidity, caffeine concentration*

INTRODUCTION

Arabica coffee is one of the most popular types of coffee globally. Indonesia, being one of the largest coffee-producing countries, boasts a variety of Arabica coffee with unique flavors, one of which is Sumowono Arabica coffee. This coffee originates from the slopes of Mount Ungaran in Central Java and is known for its fragrant aroma, full body, and distinctive acidity. The coffee roasting process significantly influences the acidity and caffeine levels in the final product. Various chemical transformations occur during roasting, specifically affecting compounds such as chlorogenic acids, which are essential in determining acidity. Roasting conditions play a crucial role in maintaining the balance of chlorogenic acid content in coffee beans, which is directly correlated with perceived acidity. As the roasting temperature and time increase, the degradation of these acids generally leads to a decrease in acidity (Tarigan et al., 2022). Furthermore, the roasting process also impacts caffeine concentrations. Rao and Fuller (2018) indicate that higher roasting temperatures can reduce caffeine levels, although this relationship is not linear and is influenced by factors such as the milling size and extraction methods. Additionally, Rao and Fuller (2018) found that brewing techniques, such as cold brewing, can also modulate the results of caffeine and acidity, leading to variable consumption experiences. The specific physicochemical properties of coffee, influenced by roasting, grinding, and extraction, ultimately determine the flavor profile of the drink (Cordoba et al., 2019). Understanding these transformations allows consumers and producers to obtain desired flavor characteristics in coffee.

As global coffee demand continues to rise, coffee producers and roasters are constantly exploring innovative techniques to enhance the flavor, aroma, and overall quality of their products. One method that has gained attention in the industry is the addition of rice during the roasting process (Suputra et al., 2023). Roasting coffee beans is a crucial step in the coffee value chain, where complex chemical reactions and physical changes occur, leading to the development of the characteristic roasted coffee flavor. The degree of roasting, controlled by factors such as temperature and time, is a delicate balance that can significantly impact the final sensory profile of the coffee.

The addition of seeds during the coffee roasting process can significantly impact flavor development, chemical reactions, and overall roasting dynamics. Roasters may incorporate grains such as barley or corn to modify flavor profiles or reduce production costs. Seeds from spices or herbs, such as cardamom or vanilla, can be added to impart distinctive flavors. The addition of various seeds can alter the Maillard reaction, which is essential for flavor and color development during roasting (Oliveira et al., 2009). For example, adding spices can introduce new aromatic compounds that enhance or complement the natural flavors of coffee (Tarigan et al., 2022). Different seeds possess varying thermal properties, which can affect heat distribution during roasting, potentially leading to uneven roasting if not managed properly (Beyer et al., 2024). The presence of additional seeds may necessitate adjustments in roasting time and temperature to achieve the desired flavor and aroma. The addition of seeds can cater to specific consumer preferences, particularly those seeking unique or flavored coffee experiences. However, it may also impact on the perception of quality among traditional coffee drinkers. Some seeds may introduce additional health benefits or concerns based on their nutritional profiles. For instance, seeds rich in antioxidants could enhance the health appeal of coffee. The growing trend of flavored coffees and specialty blends has led to increased experimentation with seed additions, influencing market offerings and consumer choices (Raveendran & Murthy, 2022).

Recent research has highlighted the potential benefits of incorporating rice into the roasting process. The addition of rice may help regulate temperature and control the roasting rate, allowing for more consistent and even development of the coffee's flavor compounds. Furthermore, rice may act as a buffer, absorbing excess heat and preventing the coffee beans from burning or becoming overly roasted, which can lead to bitterness and undesirable flavors (Gancarz et al., 2022). Additionally, the presence of rice during roasting may contribute to the formation of specific flavor compounds, such as those associated with toasted, nutty, or caramelized notes, potentially expanding the range of flavor profiles and catering to a wider variety of consumer preferences (Alstrup et al., 2020). While the specific mechanisms behind these potential benefits require further investigation, existing literature suggests that this technique may be a promising avenue for coffee producers and roasters to explore. By optimizing the roasting process and enhancing the sensory qualities of the final product, the addition of rice could improve customer satisfaction and increase market competitiveness. In addition to its potential role in temperature regulation, rice may also contribute to the overall aroma and flavor profile of the coffee (Santoso et al., 2021).

Some studies have suggested that the interaction between rice and coffee beans can result in the formation of specific volatile compounds, such as those associated with toasted, nutty, or caramelized notes (Pattaraprachyakul et al., 2023). Further research is needed to fully understand the mechanisms behind these flavor transformations and how they can be leveraged to create novel and desirable flavor profiles. The potential benefits of adding rice to the roasting process extend beyond just temperature control and flavor development. Rice may also serve as a natural buffer, absorbing excess heat and preventing coffee beans from becoming overly roasted or burnt, thereby mitigating the formation of undesirable bitterness and off-flavors that occur with excessive roasting. Overall, the incorporation of rice into the coffee roasting process appears to be a promising avenue for further exploration and research. By optimizing roasting conditions and enhancing the sensory qualities of the final product, the addition of rice could lead to improved customer satisfaction and increased market competitiveness for coffee producers and roasters (Grassi et al., 2023).

This study aims to examine the effect of rice addition during medium roasting on the acidity level and caffeine content of Sumowono Arabica coffee. The results of this research are expected to provide scientific insight into the impact of rice addition during the roasting process of Sumowono Arabica coffee and serve as a reference for coffee industry professionals in producing coffee with optimal quality.

EXPERIMENTAL SECTION

Materials

The instruments used in this study include a contemporary roasting machine equipped with a thermometer, grinder, screener, V-60 dripper, filter paper, funnel, Erlenmeyer flask, beaker, pH meter, separating funnel, burner, stirring rod, UV-VIS spectrophotometer, measuring flask, and thermometer. The materials used include Sumowono Arabica coffee green beans, rice from Sumowono, distilled water, chloroform (Merck), and 10% NaOH (Merck).

Coffee Roasting Procedure

Two hundred grams of Sumowono Arabica green coffee beans, dried for one week, were roasted to a medium profile at a temperature of 200°C, incorporating rice in varying proportions of 10%, 15%, 20%, and 25% of the total mass of the roasted coffee. A 1-gram sample was then taken from each treatment variable to assess the pH value and caffeine concentration of each experimental condition.

Preparation of Sample Solution for Measuring Caffeine Concentration and pH

One gram of the sample was added to 50 ml of distilled water at a temperature of 80°C and agitated until the mixture was evenly distributed. The pH was then measured. The mixture was filtered using filter paper, and the filtrate was adjusted to a pH of 8 by adding 10% NaOH. The filtration was subsequently combined with 50 ml of chloroform, and extraction was performed using a separating funnel. The tap at the bottom of the separating funnel was opened to extract the water from the chloroform extract. The caffeine extract was isolated from the solvent by evaporating chloroform at 50°C using a rotary evaporator until a solvent-free caffeine extract was obtained. A 0.1 g sample of the caffeine extract was then dissolved in 100 ml of distilled water at 80°C. The absorbance value of the sample was measured using a UV-VIS spectrophotometer at a wavelength of 205 nm.

Preparation of Standard Caffeine Solution

A 100 mg sample of caffeine was dissolved in 1000 ml of distilled water at a temperature of 80°C to produce a standard caffeine solution with a concentration of 100 ppm. A series of standard solutions with concentrations of 25 ppm, 30 ppm, 35 ppm, 40 ppm, 45 ppm, and 50 ppm were prepared by diluting the 100-ppm standard caffeine solution. These standard solutions were used to establish a standard curve for determining the linear regression value.

RESULTS AND DISCUSSION

The Effect of Adding Rice on Caffeine Concentration

Figure 1 illustrates the relationship between the percentage of added rice and caffeine concentration (ppm). The general trend shows a gradual decline in caffeine concentration as the percentage of rice increases. The caffeine concentration decreases from approximately 11 ppm to around 9 ppm as the rice content increases from 0% to 25%. This decline in caffeine concentration with increasing rice content suggests that rice may be absorbing or otherwise interacting with the caffeine in the solution, reducing its measurable concentration.

Several factors could explain this trend. The starch in rice may act as a binding agent, absorbing caffeine molecules or preventing them from being fully dissolved in the solution. Studies on the interaction between starches and alkaloids, such as caffeine, suggest that starch molecules can form complexes with these compounds, thus reducing their free concentration in the solution (Zhu etal., 2024). The addition of rice may also cause a dilution effect. As the percentage of rice increases, the overall volume of the solid matrix increases, possibly diluting the available caffeine concentration in the liquid phase. This is like findings in research by Liu et al. (2017), where cereal-based additives caused a dilution of certain solutes in aqueous solutions. Rice's buffering capacity may also play a role in reducing caffeine concentration. By interacting with acidic components in the coffee, rice could alter the solubility of caffeine, effectively reducing its measured concentration. This is supported by research showing that certain starches can alter the solubility of caffeine under different pH conditions (Zhu et al., 2024). It is also possible that the surface of rice particles, particularly in unpolished or minimally processed varieties, provides adsorption sites for caffeine molecules. Similar findings have been reported in studies where plant-based materials were shown to adsorb alkaloids and other organic compounds, thereby reducing their concentration in solution (Liu et al., 2017).

The observed trend aligns with research that has explored the use of plant-based materials in reducing alkaloid concentrations in beverages. El Halal et al. (2019) and Navneet et al. (2024) demonstrated that starches and cereal grains could interact with caffeine, forming complexes that reduce its free concentration in solution. Canto-Pinto et al. (2022) reported similar effects when studying the impact of cereals and grains on the solubility of caffeine in beverage systems, suggesting that the fiber and starch content in plant materials can alter the measurable concentration of caffeine.

The observed reduction in caffeine concentration with rice addition could have applications in creating low-caffeine or decaffeinated coffee options without the need for chemical processes. This method could provide a more natural approach to moderating caffeine content in beverages, making it appealing to health-conscious consumers or those with caffeine sensitivity. Additionally, understanding how rice and other cereals interact with caffeine could aid in formulating functional foods and beverages where controlled caffeine release is desired.

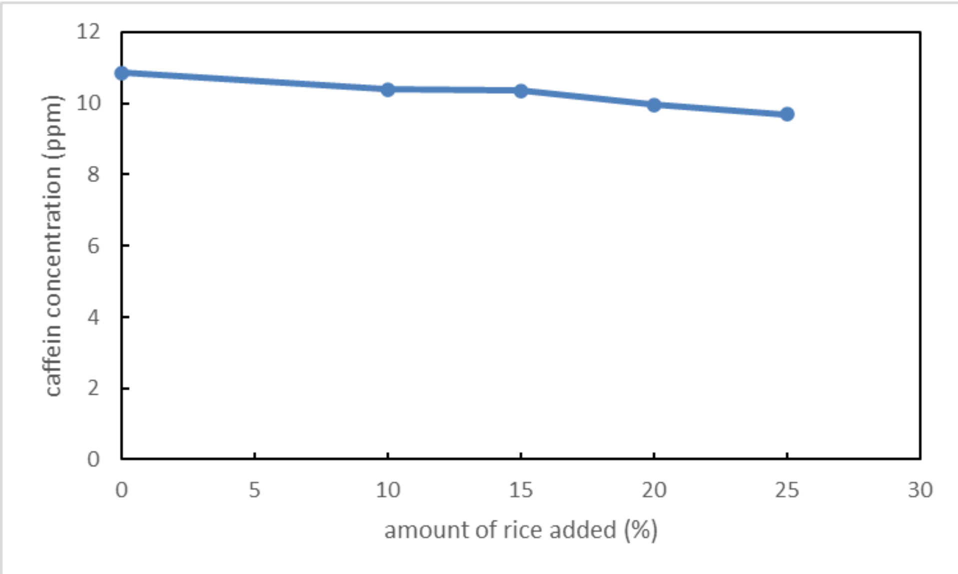

Figure 1. The effect of rice added on coffee roasting process to caffein concentration

The Influence of Adding Rice on the Acidity of Coffee

Figure 2 illustrates the relationship between the percentage of added rice and the pH (acidity) of the sample. The general trend suggests that as the percentage of rice increases, the pH level also increases, indicating a reduction in acidity (as the pH increases, the sample becomes less acidic). The pH starts at approximately 4.2 when no rice is added and rises steadily to around 4.5 when the rice content reaches 25%. This trend indicates that the addition of rice has a neutralizing effect on the sample's acidity.

The increase in pH with the addition of rice could be attributed to the buffering capacity of rice or its ability to neutralize certain acids present in the sample. This is consistent with other studies that have observed similar effects of certain food components, such as starch-rich materials (like rice), in reducing acidity levels.

Research by Gałkowska et al. (2023) shows that the addition of starch materials in food processing can reduce the overall acidity of beverages due to starch's capacity to absorb and interact with acidic components. Similarly, a study by Müller et al. (2021) indicates that cereals and grain-based materials, when mixed with acidic liquids, tend to exhibit a buffering effect due to their complex carbohydrate structure. The findings in this study, aligning with those in these studies, suggest that rice plays a significant role in balancing acidity levels in various food and beverage systems.

Moreover, in food product development, reducing acidity through natural ingredients like rice is often preferred over chemical neutralizers. Such a process can enhance the sensory qualities of the product without compromising safety, as seen in the work of Aparicio-García et al. (2021), who explored natural pH control methods in beverage production.

The trend observed in this study could prompt further research into the use of rice as a natural agent to control pH in various food products. Future research could expand on how different types of rice or processing techniques affect pH levels, especially in relation to other beverage or food matrices.

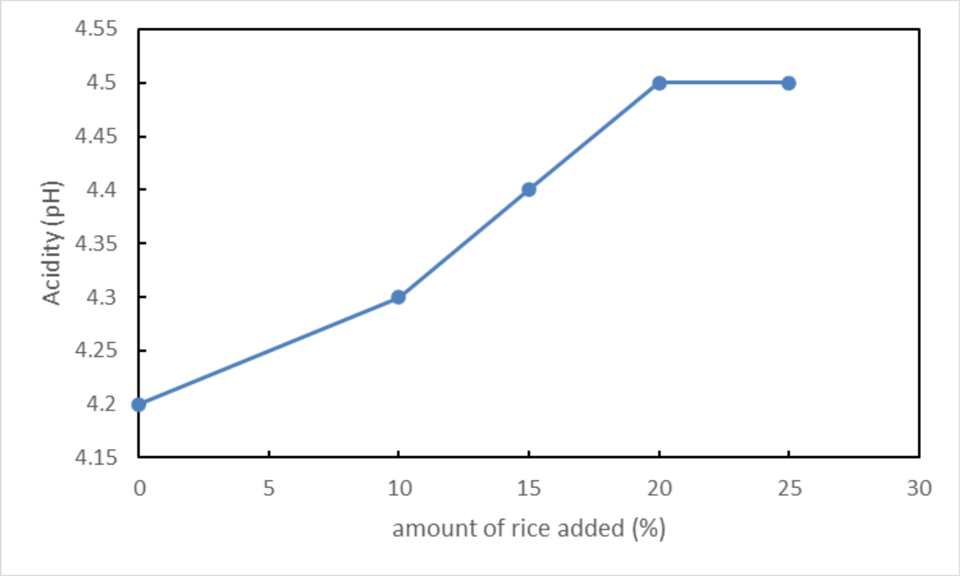

Figure 2. The effect of rice added on coffee roasting process to acidity

The Effect of Rice on Caffeine Concentration and Acidity in Coffee

Rice, particularly in its unprocessed form (such as brown rice), contains a significant amount of starch. Starch can act as a natural buffer when introduced into acidic solutions, such as coffee. When rice is added to coffee, it can absorb some of the acids present, potentially reducing the perceived acidity. The complex carbohydrates in rice, especially amylose, are known to interact with acids, creating a buffering effect that moderates pH changes. According to Park et al. (2023), high-starch foods can have a neutralizing effect in acidic environments, and rice starch may serve this function if integrated into the coffee brewing process.

Rice also contains trace amounts of minerals such as potassium, magnesium, and calcium, which have alkaline properties. These minerals can react with acidic compounds in coffee, neutralizing some of the acids and resulting in a reduction of acidity. A study by Okonwu et al. (2022) demonstrated that cereals and grains with a high mineral content, like rice, can exhibit a mild alkalizing effect when mixed with acidic solutions, helping to reduce acidity.

Additionally, rice, particularly brown rice, contains proteins that could contribute to a reduction in the acidity of coffee. Proteins can interact with acids to form salts, thereby reducing the concentration of free hydrogen ions (which contribute to acidity). This process could slightly raise the pH of coffee, making it taste less acidic. The bran layer of brown rice contains fiber and other phytochemicals that could help absorb or interact with acidic compounds. This layer, often removed in white rice, can help buffer the acids in coffee, like how it neutralizes acids in other food products.

While rice can reduce acidity, several factors should be considered. Adding rice to coffee might alter the flavor profile, potentially making it more neutral or bland. It could also introduce a slightly starchy flavor, depending on the amount used. Moreover, coffee's acidity level can vary significantly depending on the type of beans (e.g., Arabica vs. Robusta), roast level, and brewing method. Therefore, the effectiveness of rice in reducing acidity might vary across different types of coffee.

CONCLUSION

The addition of rice results in a measurable decrease in caffeine concentration, likely due to a combination of absorption, dilution, and surface interactions. This finding aligns with other research highlighting the potential of starch and plant-based materials to reduce the concentration of active compounds such as caffeine. Future studies could investigate the specific mechanisms in more detail and explore the potential for using rice in the production of low-caffeine coffee beverages.Rice can also reduce acidity in coffee due to its starch, mineral, and buffering properties. When used appropriately, it can help neutralize the acidic compounds in coffee, resulting in a smoother, less acidic beverage. However, the type of rice, the method of incorporation, and the characteristics of coffee will influence the effectiveness of rice in reducing acidity.

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