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Use of Azadirachta Indica Firewood Reduces Acidity and Caffeine in Coffee

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Abstract
Coffee is known as an acidic drink, so it will make the stomach feel unpleasant. This research compares the roasting method with Azadirachta Indica firewood with machine and manual roasting processes. Each roasting method uses four maturity levels: light roast, medium roast, dark roast, and extra dark roast. The acidity test used a pH meter instrument, and the caffeine test used the spectrophotometric method, which was carried out at the Sucofindo Indonesia laboratory. The one-way ANOVA test analyzed each method's acidity and caffeine results statistically. It can be seen that the sig < 0.05 in one-way ANOVA results for pH (0.006) and caffeine (0.013) coffee tests. So, there are significant differences in the three coffee roasting methods in reducing acidity and caffeine levels at each coffee roasting level. The average results of coffee acidity using the Azadirachta Indica wood roasting method (5.6), machine roasting (5.1), and manual roasting (4.8). The average yield of coffee caffeine with the Azadirachta Indica wood roasting method (2.13), machine roasting (2.55), and manual roasting (2.90). The roasting way using Azadirachta Indica firewood is the most effective, and there is a significant difference in reducing the acidity and caffeine of coffee at each level of coffee roasting, and manual roasting (2.90). The most effective method of roasting is with Azadirachta Indica firewood, and there are significant differences in reducing the acidity and caffeine of coffee at each coffee roasting level and manual roasting (2.90). The most effective method of roasting is with Azadirachta Indica firewood, and there are significant differences in reducing the acidity and caffeine of coffee at each coffee roasting level.

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INTRODUCTION

Coffee is one of the most traded commodities in the world and is a popular drink (Huang et al., 2020). The coffee business is quite tempting because drinking coffee is a habit of eliminating drowsiness and has become a lifestyle (Widiyanti & Harti, 2021). Drinking coffee in the current era is very popular with various groups, both women and men, and this has led to many coffee shops developing coffee businesses in multiple variants. Technological developments have also made places to drink coffee very varied, including small-scale ones, namely just a shop at the end of an alley with long chairs or a shop near campus with fast Wi-Fi service, to large-scale gathering places such as in malls, star hotels, or cafes on the main street. Getting coffee drinks is easy because coffee sellers are getting closer to consumers by selling on strategic roads, inside or outside elite housing complexes, campuses, hospitals, or other busy places.

The distinctive taste and aroma of coffee are influenced by various factors, including the type of coffee beans used, geographical origin, and the processing process applied (Sunarharum et al., 2019). One of the essential stages in coffee processing is the roasting process. This process changes the coffee beans in terms of shape and colour and impacts the flavour profile, aroma, and other characteristics. The coffee roasting process involves heating the coffee beans at high temperatures and for a certain period (Farhaty & Muchtaridi, 2016). This process causes various chemical changes in the coffee beans that affect the final taste and aroma of the coffee product. Two critical aspects during the roasting process are pH reduction and changes in caffeine levels in coffee beans (Tarigan et al., 2022).

Coffee drinks are acidic because the natural content of coffee is acidic, so it appears from chemical reactions in the coffee beans when roasted or brewed (Mar'aty & Priyanto, 2022). The acid makes some people avoid drinking coffee because they fear its sour taste will affect their health. The acid content in coffee will make a person's stomach feel bad after drinking coffee (Rujiantie et al., 2018). Green coffee beans contain acid (Sari et al., 2021). The acid content in coffee can be lost during the roasting process, although it is not 100% (Cahyadi, 2020). The roasting process for coffee is essential because, in this process, the right balance can be found in the coffee. The roasting process will also determine the coffee's acidity, aroma, and body. One of the acids in coffee is chlorogenic acid, which can also be an antioxidant (Dewajanti, 2019). Chlorogenic acid will break down during the roasting process, so there will be chemical changes. Apart from the chlorogenic acid contained in coffee, there is quinic acid, which plays an essential role in coffee. In contrast to chlorogenic acid, which breaks down during the roasting process, quinic acid will emerge from the roasting process. Quinic acid appears when chlorogenic acid is reduced and lost in roasting. This acid functions to influence the taste of coffee drinks. Therefore, quinic acid is the acid most responsible for the taste of coffee drinks after brewing (Arbiyani et al., 2023).

The acid content in coffee can cause several disorders in the body, but for some people, drinking coffee has become part of their lifestyle. Coffee drinks contain various psychotropic substances, including caffeine, which can stimulate the production of two stimulating hormones, cortisone and adrenaline (Solikatun et al., 2015). However, in rural communities, especially in Madura, coffee is not only a lifestyle but has become a necessity every day. However, apart from this, coffee has benefits for its drinkers. A study conducted by Yuliarti (2009) for 13 years involving more than 400 thousand people conducted by the National Cancer Institute and published in the New England Journal of Medicine concluded that loyal coffee drinkers had a 16% lower risk of premature death.

Caffeine is a stimulant compound found in several foods and drinks. This ingredient has another name, trimethylxanthine (Gandasaputra, 2022). Caffeine has positive and negative impacts on the human body. Caffeine is a substance that works by stimulating the central nervous system. Caffeine will provide a stimulus, especially to the work of the heart, so that people who drink coffee will increase concentration and reduce drowsiness. However, too much caffeine in coffee will cause a high heart rate or palpitations (Bealer, 2010).

The acidity and caffeine levels in coffee can be adjusted according to the type of coffee beans for each variation. The types of coffee that are most commonly found and used by people are robusta and arabica coffee. These two types of coffee have different characteristics (Agustine et al., 2021). Robusta coffee has a robust taste, with a more bitter taste than Arabica coffee. The bitter taste of Robusta coffee shows that its sugar content is less than Arabica coffee, and it has a higher caffeine level (Alam et al., 2022). Arabica coffee is better known as coffee, which has a more sour taste than other types of coffee.

Apart from the type of coffee that can affect caffeine levels and acidity, the coffee roasting also greatly determines the level of acidity and caffeine in coffee. There are four coffee roasting levels: light roast, medium roast, dark roast, and extra dark roast. The higher the coffee roasting level, the lower the acidity and caffeine levels (Budiyanto et al., 2021). This will affect the taste of the coffee, which will taste more bitter and become thicker (more substantial). Each type of roasting has a unique taste level based on the coffee beans' maturity. Madura people often do the extra dark roast level, which has become a characteristic of the Madura region.

One of the characteristics of coffee in Madura is that it is robust in traditional processes. Madura people produce their coffee or sometimes buy it from outside Madura. It is known that one of the districts in Madura, namely Sumenep, has a coffee plantation that is famous for being unique and recently discovered. The coffee produced is arabusta mixed, a combination of arabica and robusta, which are mixed naturally starting at harvest. The traditional process here is related to the processing process. This is proven during the coffee-making process. The roasting process is carried out on a wood-burning stove. A wood-burning stove will produce a more robust aroma than a roasting machine.

Therefore, Madura people, especially Sumenep, often use a furnace roasting process. The process of roasting coffee using neem firewood is believed to increase the bitter taste of coffee. The bitter taste that results from roasting coffee using neem wood is due to the presence of alkaline compounds. Therefore, the acid compounds in coffee can be neutralized with alkaline compounds through roasting using a stove fueled by neem wood. The caffeine in coffee has been proven to provide several positive side effects that can support high levels of community activity to restore alertness, provide freshness, and even improve human cognitive abilities. The reason is what causes coffee to be popular with both urban and rural communities, of course with a cheap price and easy to obtain.

The Azadirachta Indica plant is a plant that grows abundantly in tropical areas in the lowlands (Hapsari et al., 2021). Indonesia is a very suitable area for this plant, especially on the islands of Java and Madura. This plant is easy to find in Madura, especially in the Pamekasan and Sumenep areas. Azadirachta Indica has different names in each region in Indonesia. On the islands of Java and Madura, this plant is better known as "neem," and outside Indonesia, it is known as "Margosier" or "Neem tree."

Azadirachta Indica is often used as a medicinal plant, especially for its leaves. It is usually used in making traditional herbal medicine in Madura (Zaman, 2009), especially for treating fungal infections and malaria drugs. Herbal medicine that has very bitter characteristics will arise from the use of the leaves of this plant. The wood of this plant has a complex and rough character, so it is usually used for building materials and firewood by the Madura people. The use of firewood in this plant has a unique characteristic, namely that it will produce very thick smoke. If this smoke comes into contact with the eyes, it will cause eye irritation. Due to the unique characteristics of the wood of this plant, it will provide unique features if used as firewood in the coffee roasting process.

The use of firewood in the coffee roasting process is one of the methods in the coffee roasting process. This process will give the coffee drink a distinctive taste. From this description, research was carried out on the method of roasting coffee using Azadirachta indica firewood to reduce the acidity and caffeine of coffee.

METHOD

This research is experimental, using a completely randomized design (CRD) arranged in a factorial manner with two repetitions. Treatment factors include roasting method and roasting time. The research variables are manipulation variables, namely the coffee roasting process; control variables, namely types of coffee; and response variables, namely pH and caffeine in coffee. This study uses Robusta coffee because the general public often uses it, and its prices tend to be economical. This research will use three roasting methods: Azadirachta Indica firewood, machine roasting, and manual roasting. Several factors affect the method of roasting coffee beans, including roasting temperature and duration. The longer and hotter the coffee beans are roasted, the darker and more bitter the coffee will taste. Therefore, each roasting method uses four maturity levels: light roast, medium roast, dark roast, and extra dark roast. The combination of treatments in this study consisted of two factors.

Factor I: Roasting method
M1 = Azadirachta Indica firewood
M2 = roasting machine
M3 = manual roasting

Factor II: Roasting Level
L1 = light roast
L2 = medium roast
L3 = dark roast
L4 = extra dark roast
The combination of the two treatment factors can be seen in table 1.

Table 1. Combination of treatment factors

	M1	**M2**	**M3**
L1	M1L1	M2L1	M3L1
L2	M1L2	M2L2	M3L2
L3	M1L3	M2L3	M3L3
L4	M1L4	M2L4	M3L4

The ready coffee grounds are then tested for pH and caffeine content. Testing was carried out using the services of the Sucofindo laboratory in Indonesia. Coffee pH testing is done in a 10% solution in water using a pH meter instrument. Caffeine testing uses SNI 2983:2014, using the spectrophotometric method. The following is the formula for calculating the percentage of caffeine:

$$Caffeine\ (\%) = \frac{C}{W}\ x\ V\ x\ f_p\ x\ 100\%$$

Information:
C= caffeine concentration from calibration curve (µg/mL)
V= final solution volume (mL);
W= sample weight (g);
Fp= dilution factor .

The accuracy of this test is the range of results for two repetitions, a maximum of 5% of the average value of the caffeine content results. The test must be repeated if the range exceeds 5%. The pH and caffeine tests for each roast method were statistically analyzed based on the research design. This test uses the Analysis of Variant (ANOVA) test calculation in coffee's acidity and caffeine product categories. This test's results will show whether there is a significant difference in the three roasting methods for decreasing acidity and caffeine with the four roasting levels.

RESULTS AND DISCUSSION

The results of the study used three roasting methods, namely Azadirachta Indica firewood, machine roasting, and manual roasting, with each method using four levels of maturity, namely light roast, medium roast, dark roast, and extra dark roast, resulting in different research data from each method. Meanwhile, at the four maturity levels, constant data is generated based on the maturity level of each method but affects each test. The coffee roasting method significantly influences the pH of the coffee produced (Joaquim et al., 2023). When coffee beans are roasted, the high temperatures applied will result in physical changes and chemical reactions that change the components in the coffee beans. One of the main changes is decreased pH (Maulana, 2016). Roasted coffee, longer and darker, will tend to have a lower pH. Therefore, the results of a darker coffee roast tend to be more acidic so that it can give a distinctive taste characteristic.

The test carried out was on the acidity level of coffee because coffee drinks are acidic, so they tend to increase stomach acid. This test uses the pH meter method by making a 10% solution in water. Based on the research results conducted on each roasting method and maturity level, the pH test results are obtained in Figure 1.

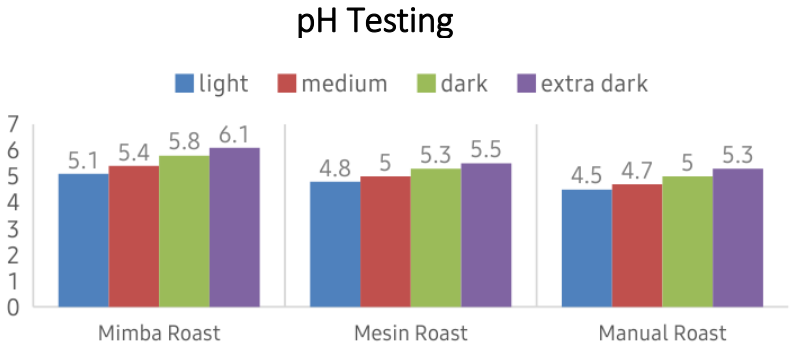

Figure 1. The results of the combined pH test for each method and maturity level

Based on the results of this study, there is a higher reduction in acidity in coffee roasted using Azadirachta Indica firewood (neem roast) compared to other roasting methods. Meanwhile, using the machine roast method is better than manual roast in reducing acidity in coffee. The recommended coffee acidity for stomach safety is in the pH range of 6-7. Therefore, using Azadirachta Indica firewood (neem roast) is a more effective roasting method in reducing the acidity of coffee drinks. Meanwhile, the four maturity levels in the roasting process also affect the coffee's acidity reduction. The longer the roasting time, the lower the acidity level in the coffee; even the extra dark roast maturity level is almost close to normal pH. The result is related to the level of acid in coffee beans, which decreases with increasing maturity (Aini et al., 2021). Coffee blends with appropriate acidity values will not interfere with stomach performance, so reducing the acidity of coffee based on the length of roasting time and the

roasting method used needs to be considered. Increasing acidity reduction in coffee accompanied by long roasting time can reduce acidity. The longer the roasting time, the lower the acidity level. Based on the results of the research on the pH test on coffee, reducing the acidity value using the neem roast method and the extra dark roast roasting time can reduce the highest acidity, reaching a value of 6.1. The higher the reduction in acidity in coffee, the lower the acidity level. It means the public can consume coffee without worrying about stomach acid.

Apart from coffee being known as an acidic drink, coffee is also known as a drink that contains high caffeine. One of the factors for the effect of caffeine is that it will increase the work of the heart so that after people drink coffee, they will be more enthusiastic about their activities. However, if the public consumes too much, it will harm the heart organ. The caffeine content in coffee must be minimized to be safe for the heart's working system. In addition, the little caffeine content in coffee will keep the heart rate stable when someone is drinking coffee and will not cause poor heart performance. Based on the research results conducted with three roasting methods combined with four maturity levels, the caffeine test results are obtained in Figure 2.

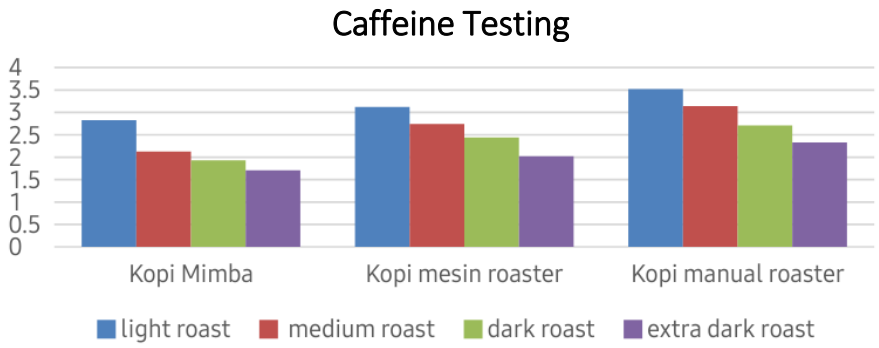

Figure 2. Caffeine test results for a combination of each method and maturity level

Based on this study's results, caffeine was reduced in coffee roasted using Azadirachta Indica firewood (neem roast), which reduced caffeine more than other roasting methods. The machine roast method is better than manual roasting in reducing caffeine in coffee. Meanwhile, the four maturity levels in the roasting process also affect caffeine reduction in coffee. The longer the roasting time, the lower the level of caffeine in coffee.The increase in caffeine reduction in coffee is directly proportional to the length of roasting time. The longer the roasting time, the lower the caffeine level. Based on the research on caffeine testing in coffee, reducing caffeine using the neem roast method and extra dark roasting time can reduce caffeine best to produce coffee drinks that are low in caffeine. People can consume low-caffeinated coffee drinks without worrying about excessive heart performance, but it can also increase enthusiasm for activities.

It was determined that each test's results must be analyzed. The tests carried out in this research were the results of the pH and caffeine tests. The pH test results on coffee are analyzed statistically to find information that can be used for decision-making. In this research, data analysis was carried out to determine the appropriate method for reducing pH in coffee by comparing several roasting methods. The reason is that the level of maturity in coffee tends to be stable in each method but still influences each level of maturity, so the difference is the method used. Based on the results of this research, the coffee pH test can be analyzed based on the results of the statistical description in Table 2.

Table 2. Description of coffee pH test results pH

	N	Means	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Neem	4	5,600	0.4397	0.2198	4,900	6,300	5.1	6.1
Machine	4	5.150	0.3109	0.1555	4,655	5,645	4.8	5.5
Manuals	4	4,875	0.3500	0.1750	4,318	5,432	4.5	5.3
Total	12	5,208	0.4582	0.1323	4,917	5,499	4.5	6.1

Based on the results of the study, it shows that the acidity level of coffee will decrease if the coffee roasting maturity level is higher. In theory, to reduce the acidity of coffee, it is enough to adjust the coffee roasting level used. This is proven by the maturity level of coffee, showing stable results in reducing acidity in coffee. However, the method used in the roasting process also dramatically affects the reduction of the acidity value in coffee, so the roasting method dramatically affects the pH of the coffee. The results showed that the three methods succeeded in reducing the acidity and caffeine of coffee at each level of coffee maturity. The average yield of coffee acidity with the Azadirachta Indica wood roasting method (5.6), machine roasting (5.1), and manual roasting (4.8).

Based on the results of this descriptive analysis, it is necessary to analyze the influence of the three roasting methods used in reducing the pH of coffee at each coffee roasting level. Analysis of the coffee roasting method was carried out to determine whether or not there was an influence between the three roasting methods at each coffee roasting level so that it could be used as a reference in reducing the level of acidity in coffee based on the method and level of maturity. The analysis of the influence between the three roasting methods at each level of coffee roasting can be seen in Table 3.

Table 3. Coffee pH ANOVA test results pH

	Sum of Squares	Df	MeanSquare	F	Sig.
Between Groups	1,072	2	0.536	3,897	0.006
Within Groups	1,238	9	0.138		
Total	2,309	11			

Based on the one-way ANOVA calculations using $\alpha = 0.05$, the results obtained in Table 3 show that the sig. < 0.05 on the pH test results, namely 0.006. A hypothesis will be accepted if the p-value is smaller than the α value. Based on the results of these calculations, it can be proven that there is an influence between the three roasting methods used in reducing the pH of acidity in coffee. So, there is a significant difference in the three coffee roasting methods for reducing acidity at each coffee roasting level. In addition to the pH test on coffee, the caffeine test needs to be analyzed to determine the research results' conclusions. The results of the caffeine test on coffee were statistically analyzed to find information that could be used as a basis for decision-making. This study analyzed data to determine the appropriate method for reducing caffeine in coffee by comparing several roasting methods. The reason is that the level of maturity in coffee tends to be stable in each method but still influences each level of maturity, so the difference is the method used. Based on the results of this study, the coffee caffeine test can be analyzed based on the results of the statistical description in Table 4.

Table 4. Description of coffee caffeine test results Caffeine percentage

	N	Means	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Neem	4	2.1350	0.47120	0.23560	1.3852	2.8848	1.71	2.80
Machine	4	2.5500	0.46547	0.23274	1.8093	3.2907	2.00	3.10
Manuals	4	2.9000	0.51640	0.25820	2.0783	3.7217	2.30	3.50
Total	12	2.5283	0.54684	0.15786	2.1809	2.8758	1.71	3.50

Based on the study's results, coffee caffeine will decrease if the coffee roasting maturity level is higher. It is enough to adjust the coffee roasting level to reduce coffee caffeine. However, apart from adjusting the level of maturity during roasting, the research results show that the three methods successfully reduce coffee caffeine at each level of coffee maturity. The average yield of coffee caffeine with the Azadirachta Indica wood roasting method (2.13), machine roasting (2.55), and manual roasting (2.90). The roasting method using Azadirachta Indica wood is the most effective, and there is a significant difference in reducing coffee caffeine at each level of coffee roasting.

Based on the results of this descriptive analysis, it is necessary to analyze the influence of the three roasting methods used in reducing coffee caffeine at each coffee roasting level. Analysis of the coffee roasting method was carried out to determine whether or not there was an influence between the three roasting methods at each coffee roasting level so that it could be used as a reference in reducing the level of caffeine in coffee based on the method and level of maturity. The analysis of the influence between the three roasting methods at each level of coffee roasting can be seen in Table 5.

Table 5. Coffee Caffeine ANOVA test results Caffeine percentage

	Sum of Squares	Df	MeanSquare	F	Sig.
Between Groups	1,173	2	0.587	2,495	0.013
Within Groups	2,116	9	0.235		
Total	3,289	11			

It is based on the one-way ANOVA calculations using $\alpha = 0.05$. The results obtained in Table 5 show that the sig. < 0.05 in the caffeine test results in coffee, namely 0.013. A hypothesis will be accepted if the p-value is smaller than the α value. Based on the results of these calculations, it can be proven that there is an influence between the three roasting methods used in reducing caffeine in coffee. So, there are significant differences between the three coffee roasting methods in reducing caffeine levels at each coffee roasting level.

This research was to test the effect of using Azadirachta Indica firewood in the coffee roasting process on more effective coffee acidity and caffeine. The use of firewood in the cooking process is part of traditional culture. The use of firewood will impact the taste of the food. In Madura, there is a culture of roasting coffee using firewood. This process has been carried out for generations by the Madura people. The roasting process will give the coffee beans their taste. The use of plant types for firewood is very diverse. Generally, all wood can be used as firewood. The most important thing is that the wood must be dry. The use of Azadirachta Indica firewood as firewood in the roasting process goes through several stages. Neem wood is cut

first before use. Then, it is not directly used as firewood but is dried to become firewood so that the impact can be optimal, the process are obtained in Figure 3 and 4.

Figure 3. The process of cutting wood

Based on the figure 3, azadiratcha indica wood cannot be directly used as firewood to reduce acidity and caffeine in coffeeThis wood requires several processes before it becomes firewood when roasting coffee, such as cutting and drying the wood first. The process of cutting into small pieces of wood is very necessary to expand the surface of the wood during the burning process. The drying process is carried out so that the wood burns easily and produces maximum density compared to wet wood. This process requires drying the wood for several days for top drying results. The dry condition of the wood also makes the quality of the fire for roasting stable so that the level of maturity in the coffee can be even. However, before using it as fuel, the wood is cut as shown in the picture to make it easier to use, but in terms of the reduction concept, there is no effect due to the pieces of wood used. Cutting wood to produce fuel is to make it easier to use. After drying and cutting the Azadiractha indica wood, the roasting process is carried out, as can be seen in Figure 4.

Figure 4. Roasting process with Azadiractha indica firewood

The roasting process uses Azadirachta indica firewood, using traditional tools such as a frying pan, scoop, and stirring so that the level of maturity is even. The roasting time takes longer than the other two another method to reach a more concentrated (dark) roast level. However, the structure of azadiracta indica wood is rigid, making fuel using this wood more durable and lasts longer than other firewood, making it cheaper to use as fuel for roasting coffee. In this study, the Azadirachta Indica plant was used as firewood. This plant has a characteristic stem with thick and rather rough skin. These morphological properties make wood from Azadirachta Indica suitable as fuelwood. This wood will cause thick smoke from other types of firewood.

In addition, the smoke will cause more irritation if it gets into the eyes. The biological effect is toxicity, which can cause eye and soft tissue irritation and possibly cause conjunctivitis and inflammation.

The coffee roasting process dramatically affects the acidity and caffeine content of coffee. From the results of this study, it is clear that there is a reduction of acid and caffeine in coffee. This research focuses on the roasting process and the fuel used. Coffee beans and other treatments in this research process were controlled. In control coffee and neem coffee, it is clear that the roasting process using firewood can reduce the coffee's acidity and caffeine. Cooking with Azadirachta Indica firewood will indeed affect the food taste in Madura. The results of interviews with the Madura people said the food will taste bitter if the public uses Azadirachta Indica firewood. Scientifically, the smoke from burning wood affects the taste of the food. The smoke from Azadirachta Indica firewood is known to be thick and very painful if it gets in the eyes. Azadirachta Indica firewood is used to make traditional herbal medicine in Madura.

One of the acids in coffee is chlorogenic acid, which can also be an antioxidant. These acids break down during the roasting process. Besides chlorogenic acid, coffee also contains quinic acid, which is essential in coffee. Quinic acid appears from the roasting process. Quinic acid mysteriously appears when chlorogenic acid is reduced and lost in roasting. This acid will influence the taste of the drink. Quinic acid is the acid most responsible for the taste of our coffee. The Azadirachta Indica firewood factor causes a reduction in the acidity of coffee.

The firewood factor of Azadirachta Indica also causes a decrease in caffeine in coffee by forming an aromatic heterocyclic organic compound, which consists of a pyrimidine ring and an imidazole ring side-by-side. Caffeine is one of two groups of nitrogen bases. Caffeine is a group that forms nitrogen bases, including both groups of nucleic bases. The caffeine content in coffee will be reduced by a potent reducing agent, such as the thio sulfate (S_2O_3) group of compounds. The factor of smoke content in the burning process of Azadirachta Indica firewood acts as a reducing agent to reduce coffee's caffeine content while roasting coffee beans.

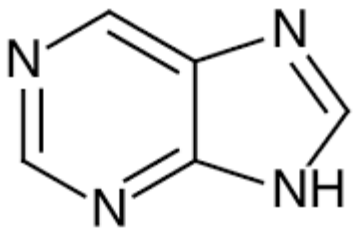

Figure 5. Heterocyclic 7H-purine of the pyrimidine ring and 1H-imidazole

Based on the description above, it is explained that the results of this study can provide benefits for the coffee roasting process because it has been proven in laboratory tests that the use of Azadirachta indica firewood can reduce acidity and caffeine levels in coffee more effectively than other roasting methods. This research presents a convenient improvement, especially in using Azadirachta Indica firewood to reduce the acidity and caffeine of coffee.

Research conducted by (Ruwanto& Fortuna., 2016) states that the maturity level of coffee when it has been roasted has a physical effect on the colour of the coffee powder produced. The higher the roasting level, the colour of the coffee beans will be close to black. Coffee that

goes through the roasting process experiences a decrease in caffeine content compared to the caffeine content of dry (green) coffee. Increasing the maturity of coffee also has an impact on the water content produced. The higher the maturity level, the resulting water content will decrease. This is because the heat of the roasting process causes a decrease in the water mass of the coffee beans. Changes in the mass of water occur when the water content in coffee has reached a saturated condition, causing the water contained in the material to change from the liquid phase to vapor.

The maturity level of coffee is very influential on the quality of coffee. Coffee maturity can be controlled using a roster machine using a temperature controller (Bastian et al., 2021). Roasting coffee (coffee roasting) is the process of removing water from the coffee, drying and developing the beans, reducing the weight, and giving the coffee its aroma. When coffee is cooked, a chemical reaction accompanies it so that the character of the coffee beans changes. The longer the coffee beans are cooked, the more the chemical characteristics change. When coffee is roasted, the coffee turns brown. Therefore, the longer the roasting process, the darker the coffee beans will be. Coffee bean roasting is divided into three maturity levels: light, medium, dark, and extra dark.

At the light roast maturity level, the taste produced by coffee drinks tends to be sour. The distinctive aroma of coffee produced at this level of maturity is less pronounced. The light roast maturity level is the earliest maturity level, with the characteristics of the coffee beans starting to turn light brown. Because the roasting process is not too long, the maturity level of light roast is also categorized as a half city, cinnamon. In light roast conditions, the oil produced by coffee is not visible, and the coffee beans have a dry character. The roasting temperature of coffee beans with light roast maturity ranges from 180℃ to 205℃. Maturity with a light roast level is marked by the first cracks in the coffee beans (Fachruddin et al, 2021).

At the medium roast level, the resulting taste tends to be sweet. The aroma of roasting coffee smells very sharp. The maturity level of the medium roast is the same as that of the light roast. The coffee beans still need to look greasy. The colour of coffee beans tends to be dark brown. At medium roast maturity, it is also categorized as full city maturity, full city, Vienna full city. The maturity of a medium roast ranges from 210℃ to 230℃ after the first crack and before the second crack occurs. At this level of maturity, the caffeine content in coffee beans is lower than the maturity level of a light roast. Maturity at this level is widely used. At the most mature level is dark roast or can also be categorized as French, nearly black. The coffee beans start to get oily, and the colour of the coffee beans tends to be black. The resulting taste tends to be bitter. Maturity at this level ranges from around 240℃ with a marked second crack in the coffee bean (Ariyanti et al, 2023).

The pH of coffee has an essential role in determining the taste of coffee. Coffees with a lower pH level tend to have a more sour taste, while coffees with a higher pH tend to have a flatter or bitter taste. Therefore, roasting methods that produce coffees with different pHs can provide a unique taste experience. Caffeine is one of the most recognized components of coffee and has a stimulating effect. The amount of caffeine in coffee can affect the energy level provided by coffee. Coffees with less caffeine may be more suitable for people who want to avoid the side effects of excessive caffeine consumption.

In comparison, coffees with more caffeine can provide a more significant energy boost but can affect health. Different roasting methods result in changes in the pH of the coffee, with darker coffees tending to have a lower pH. Meanwhile, the level of maturity of the coffee roasting process also affects pH and caffeine. The higher the maturity level of roasted coffee, the higher it tends to have a pH close to normal. It will make coffee better for health and reduce caffeine. Understanding the effect of the roasting method and the degree of ripeness of the coffee beans

on pH and caffeine is essential for coffee connoisseurs who wish to experience a taste that suits their preferences. It can also assist the coffee industry in producing various types of coffee that cater to various consumer tastes. Understanding the effect of the roasting method and the degree of ripeness of the coffee beans on pH and caffeine is essential for coffee connoisseurs who wish to experience a taste that suits their preferences. The coffee can also help the coffee industry produce various types of coffee that meet various consumer tastes. Understanding the effect of the roasting method and the degree of ripeness of the coffee beans on pH and caffeine is essential for coffee connoisseurs who wish to experience a taste that suits their preferences. The coffee can also help the coffee industry produce various types of coffee that meet various consumer tastes.

CONCLUSION

The process of roasting coffee using Azhadiracta indica firewood is more effective and significant in reducing the acidity and caffeine of coffee. The average coffee acidity results using Azadirachta Indica firewood (5.6), machine roasting (5.1), and manual roasting (4.8). The average caffeine yield of coffee with Azadirachta Indica firewood (2.13), machine roasted (2.55), and manual roasted (2.90).

RECOMMENDATIONS

This research is to support the culture of traditional coffee roasting processes originating from the island of Madura. It is hoped that these results can be a reference in serving coffee, especially in terms of caffeine character and coffee acidity.

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