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EFFECT OF SOLVENT AND EXTRACTION TIME VARIATION ON THE COFFEE OIL EXTRACTION RESULTS

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Abstract
The traditional coffee with the greatest taste is called arabica. One of the ingredients made from coffee beans and used for air freshener is coffee oil. The Soxhlet extraction method, a separation technique that is often used to separate one or more compounds from a solid or liquid by adding a solvent, is one of the processes for making coffee oil. This research has been done before, but a comparison of different types of solvents and inclusion of differences in extraction time has not been done. The purpose of this research is to understand how the difference in extraction time and the comparison of solvent types affect the yield, density, and acid number produced. Extraction of hexane and ethanol by distillation for 120 minutes is a research technique. Extraction times were 90, 120, 150 and 180 minutes. In this study, the largest extraction with ethanol solvent was produced within 120 minutes of 25.75%, while the highest percent yield of coffee oil with hexane solvent was obtained within 120 minutes of 17.3%. The maximum specific gravity for 180 minutes with ethanol solvent is 0.94 gr/ml, while for 180 minutes with hexane solvent is 0.91 g/mL. Coffee oil with hexane solvent produced an acid value between 3.2 and 7 mg KOH/g, while coffee oil with ethanol solvent produced an acid value between 4.6 and 11.2 mg KOH/g.

Keywords: *Coffee; Extraction; Distillation; Hexane; Coffee oil*

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INTRODUCTION

Indonesia is the third largest coffee producing country in the world [1]. Compared to other plantation crops such as cocoa and areca nut, coffee is one of the plantation products that has quite high economic value and is used as currency [2]. Apart from being a source of income, coffee serves as a medium of exchange. With over 60 percent of all coffee produced worldwide, arabica coffee is currently the most widely produced variety. Oval-shaped coffee beans with a good taste, high perfection of taste, moderate aromatic aroma and strong acidity are produced by Arabica coffee from the Coffea arabica type. Usually, this tree species inhabits highland areas [3], [4].

The best tasting traditional coffee is Arabica coffee. This type of coffee bean is often used to make coffee. Arabica coffee is currently grown all over the world, from Latin America, Central Africa, East Africa and India [5]. Arabica coffee was originally grown in Ethiopia. Usually, Arabica coffee is grown in tropical or subtropical areas of the world [6], [7]. The altitude of this coffee is between 1200 and 2000 meters above sea level. If the situation is favorable, Arabica coffee plants can survive up to 3 meters. The ideal life range is between 18 and 26 °C. The size of the coffee beans produced ranges from green to dark red, being very small.

Triglycerol dominates the composition of coffee oil, which also contains various aromatic compounds. 10-15% percent coffee oil is present in coffee beans. Coffee beans, whether roasted or not, are used to make coffee oil. Robusta coffee beans contain 10%, while Arabica coffee oil contains about 15% [8], [9]. Indonesia has not developed much coffee oil. The molecules of caffeine, palmitic acid, linoleic acid, stearic acid, etc. are all present in the coffee oil. Both the coffee industry and other industrial areas depend heavily on coffee oil. When coffee oil is sprayed on the first coffee grinds in instant coffee, one of its uses is to freshen up the room. Furthermore, coffee oil can be used in various cosmetic products such as scrubs which are beneficial for skin health. There are several methods you can use to extract coffee oil from coffee beans, including the Soxhlet method, the supercritical liquid method, and the pressing method . The soxhlet extraction method is the removal of one or more molecular components from certain solids or liquids using a solvent. This research has been done before, but a comparison of different types of solvents and inclusion of differences in extraction time has not been done [10]–[17].

Based on the definition above, this study aims to investigate "The effect of solvents and variations in extraction time on the extraction of coffee oil" by producing coffee oil from Arabica coffee beans can add to the economic value of Arabica coffee beans.

RESEARCH METHODS

Materials

The materials used are arabica coffee beans, hexane, ethanol, distilled water, and KOH. All chemicals

were purchased from local chemical stores ans were used without further purification.

Equipments

The equipment used was a blender, oven, thermometer, sokhlet, reflux condenser, three neck flask, Erlemeyer, 50 mesh sieve, beaker glass, scales, pipettes, aluminum foil, measuring cups, burettes, hot plates, statives and clamps, glass funnels, stir bar and pycnometer.

Procedure

Preparation of raw materials for Arabica coffee powder, the extraction process, the distillation process, and the analysis stage are the four stages in this study. Two solvents, ethanol with time variations (90,120,150,180) minutes and hexane with time variations (90,120,150,180 minutes) are used in the manufacture of coffee oil.

The coffee beans are dried in the oven before being placed in a blender, crushed, then sifted through a 50-mest strainer to prepare the raw material. The assembly of extraction equipment such as three neck flask, sokhlet, reflux condenser, thermometer, hot plate, stand, and clamps is carried out at the stage of making coffee oil. Put in 300 ml of hexane solvent with the appropriate ratio, 100 gr of coffee is added to the extractor. Heat for the specified time at 65 °C. The extract is made from a combination of coffee bean oil. It is distilled for 120 minutes. For the next variant, the process is repeated using an ethanol solution. The characteristics of coffee oil were analyzed based on the yield value, specific gravity, and acid number.

RESULTS AND DISCUSSION

Effect of Solvent and Extraction Time on Coffee Oil Yield

This study examines the effect of solvents and the amount of time spent producing coffee oil from Arabica coffee. Hexane and ethanol solvents were changed in this study for 90, 120, 150, and 180 minutes. Analysis of yield, specific gravity, and acid number based on research conducted.

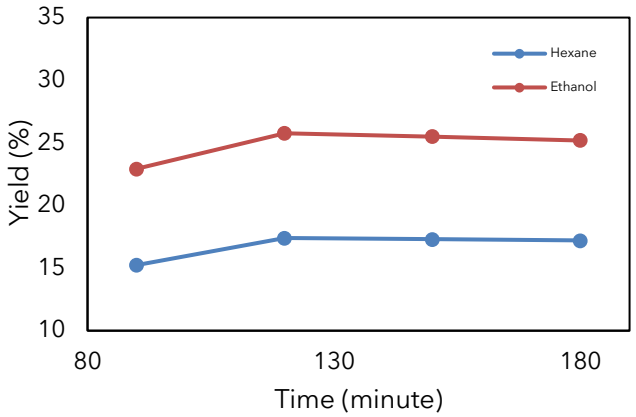

Figure 1. Effect of Solvent and Extraction Time on Coffee Oil Yield

According to these factors, mostly based on different types of solvents and the duration of the extraction process. Extraction of coffee beans yields varying percentages, as shown in Figure 1. The yield of hexane solvent extraction is between 15.2 and 17.4%. While the percentage of yield varies from extraction with ethanol solvent, which ranges from 22.93-25.76%. The maximum extraction with ethanol solvent was obtained for 120 minutes at 25.76%, while the best results with hexane solvent were obtained for 120 minutes at 17.4%.

Effect of solvent and extraction time on the density of coffee oil

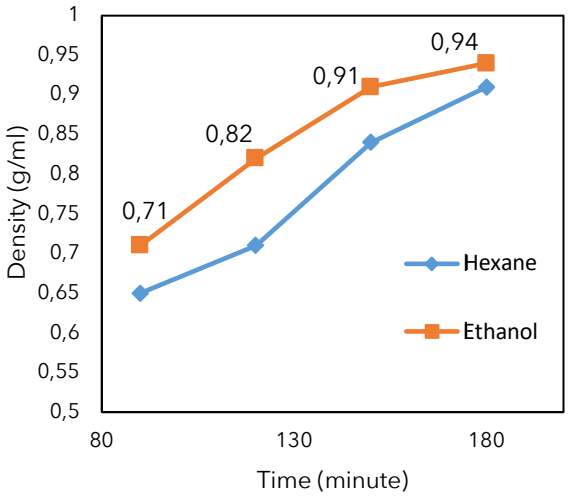

Figure 2. Effect of solvents to the density of the coffee oil

The specific gravity value of extraction using ethanol solvent is higher than the specific gravity value of extraction using hexane, as shown in Figure 2. The resulting oil specific gravity value is affected because ethanol has a higher specific gravity value than hexane. Because ethanol is also semi-polar, water is still present in the coffee oil. Specific gravity yields for ethanol solvent extraction ranged from 0.65-0.91 gr/ml. When compared with the specific gravity value of extraction using hexane solvent, which is 0.71-0.94 g/ml, the specific gravity value of extraction using ethanol solvent is greater. The maximum specific gravity yields, namely 0.94 g/ml for ethanol and 0.91 g/ml for hexane, were achieved using this solvent at an interval of 180 minutes. The specific gravity value obtained increases with a longer extraction time.

The density of coffee oil refers to its mass per unit volume and is typically expressed in grams per milliliter (g/mL) or kilograms per liter (kg/L). The density of coffee oil can vary depending on various factors, including the specific type of coffee bean used, the method of extraction, and the level of refinement.

Coffee oil is derived from the extraction of oils present in coffee beans. It is primarily composed of triglycerides, which are fatty acid molecules attached to a glycerol backbone. The presence of different types of fatty acids, such as palmitic acid, stearic acid, oleic acid, and linoleic acid, can affect the density of the oil [18], [19].

The density of coffee oil typically ranges from 0.92 g/mL to 0.95 g/mL. However, it's important to note that these values are approximate and can vary slightly depending on the specific characteristics of the oil. The density of coffee oil is of interest in various applications, such as the production of coffee-flavored products, cosmetics, and pharmaceuticals. Understanding the density allows for appropriate formulation and blending with other ingredients to achieve desired properties and consistency in the final products [11].

Effect of solvent and extraction time on the acid number of coffee oil

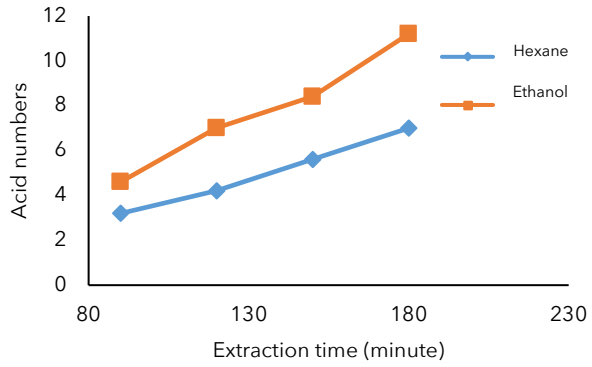

Figure 3. The effect of solvent and extraction time on the acid number of coffee oil.

The fatty acid or oil number shows how much free fatty acid (ALB) is in the substance. The acid number shows how many milliliters of KOH are used to normalize free fatty acids (ALB) in one gram of fat or oil. Coffee oil produced from hexane solvent has an acid number between 3.2-7 mg KOH/g. The resulting ethanol solvent coffee oil has an acid number varying from 4.6-11.2 mgKOH/g.

Oxidation can occur due to heat. The oxidation process is more active for a longer extraction time. Fatty acids containing double bonds undergo oxidation, which results in a reduction in the number of double bonds. Therefore, the acid number obtained increases with a longer extraction time.

The acid number of an oil is an important analytical parameter that provides information about the oil's acidity or the presence of acidic compounds. It is a measure of the amount of acidic substances, such as free fatty acids, present in the oil. The acid number is typically expressed as the amount of potassium hydroxide (KOH) in milligrams required to neutralize one gram of the oil [20]. The importance of the acid number of oil lies in several key areas

Quality assessment

The acid number helps in assessing the quality and purity of the oil. Oils with high acid numbers indicate a higher degree of degradation, which can lead to rancidity and off-flavors. It is particularly important in edible oils and fats, where excessive acidity can render the oil unsuitable for consumption [19].

Stability and shelf life

The acid number can be an indicator of the oil's stability and shelf life. High acid numbers suggest that the oil is prone to oxidation and hydrolysis, leading to the formation of free fatty acids. This degradation process can result in decreased product quality, diminished nutritional value, and shortened shelf life [14].

Processing and refining

The acid number also important in monitoring the effectiveness of oil processing and refining operations. During the refining process, impurities, including free fatty acids, are removed to improve the oil's quality and stability. By measuring the acid number before and after refining, the extent of purification and removal of impurities can be determined [21], [22].

Lubricant and industrial applications

Acid number is also important in the assessment of lubricating oils and industrial oils. It provides an indication of the oil's corrosive potential and can help determine its suitability for specific applications. High acid numbers in lubricating oils can lead to increased wear and damage to machinery. By monitoring the acid number, manufacturers, processors, and users of oils can make informed decisions regarding product quality, processing conditions, and storage requirements. It allows them to ensure that the oils meet the required standards, perform optimally, and maintain their desired properties over time [23].

CONCLUSION

Coffee oil extraction using hexane solvent for 120 minutes gave a yield of 17.3%, while ethanol solvent gave a yield of 25.75% at the same extraction time. The highest density value of coffee oil was 0.94% with ethanol solvent and 180 minutes, while with hexane solvent with the same time it was 0.91 g/ml. The specific gravity value obtained increases with increasing extraction time. Coffee oil produced from hexane solvent has an acid number between 3.2-7 mg KOH/g while coffee oil extracted with ethanol has an acid value of 4.6-11.2 mgKOH/g, in general the quality of coffee oil extracted using hexane is higher. good because the acid number is lower even though the yield and density are low.

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