Extraction of Turmeric Essential Oil by Using Hydrodistillation

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Abstract-Curcuma longa or turmeric, of the Zingiberaceae family, has a great importance in the food, textile, and pharmaceutical industries. The aim of this work was to extract and compare turmeric essential oil from fresh turmeric rhizomes between two different sources which from Pasar Moden Seksyen 6 Shah Alam and Pasar Besar Klang and characterization of turmeric essential oil done by using FTIR. 200 grams of sample is used that were extract in hydro-distillation which Clevenger type distillation with 500 mL of distilled water. The time of extraction were set up to 2, 4, and 6 hours. . From the discussion sample from Pasar Moden Seksyen 6 Shah Alam give the highest yield which is 0.5445% at 6 hours of extraction while the other sample give 0.37% at 6 hours of extraction. FTIR prove the presence of Ar-curcumene in the essential oil by having benzene ring peak at 1617.61 cm^{-1} . The aromatic ring found was proved that Ar-Turmerone and Curlone were in the sample because of aromatic ketones found at the peak 1684.10 cm^{-1}. So, it can be prove that the oil analyze is turmeric essential oil because it should contain Curcumene and Turmerone in the essential oil.

Keywords*—Ar-curcumene, Ar-Turmerone, *Curcuma longa, Curlone, FTIR, hydro-distillation.

I. INTRODUCTION

Turmeric or its scientific name Curcuma Longa is a rhizomatous herbaceous perennial plant of the ginger family, which is Zingiberacaeae (Anna Carolina C, 2003) and it is said to be originated from subdivision of Indian continent and Southeast Asia. There are about as many as 133 species of Curcuma have been identified worldwide. Turmeric is growth around India, Asia and Central America. The largest producer of turmeric is India. India also is found to be the largest consumer and exporter of turmeric in the world. The plant could reach 4 feet in height and produces both a flower and a rhizomes or stem that is found underground. Moreover, turmeric has been used in Ayuverdic medicine long time ago which in South Asia for many conditions that includes breathing problems, serious pain, rheumatism and fatigue. (Araujo C., 2001)

Turmeric essential oil is in light yellow colour and have characteristic of aromatic odour of the spices. The yellow colour of turmeric is because the presence of curcuminoid in the oil. Curcumin, demethoxycurcumin and bisdemethoxycurcumin are the major non-volatile curcuminoids. (Shiyou Li, 2011)

Essential oil extraction is a chemistry separation process which occur isolation of oil in plant material such as root, wood, nuts, flowers and leaves. Essential oils are widely used in variety consumer products. So, technology in oil extraction is needed to improve yield and quality of essential oil. There are many ways to extract essential oil, most common used method is steam distillation. Some industry used solvent-based extraction method that involves chemical in the extraction. These methods are not considered to be therapeutic grade because they may not offer same benefits as essential oil that extracted by using steam distillation. Some chemicals used in solvent-based extraction can alter the properties and destroy the benefit of essential oils. Moreover, some way to extract essential oil is by using Superficial Carbon Dioxide Extraction, Hydro-distillation, Enfleurage and Maceration.

The problem of the traditional extraction techniques such as steam distillation need huge quantities of plant material, which are required to extract essential oils on commercial scale. Hydro-distillation method has been used to extract turmeric essential oil from turmeric leave and rhizome. Hydro-distillation is most method has been used in the manufacture and extraction of essential oil because it is simple and cheapest process of distillation. The advantages by using this method for extract oils are shorter processing time, higher oil yield and easy to setup the apparatus.

This research study is to improve current technology of extraction essential oil which has been used widely. The objectives of this research are to extract and compare turmeric essential oil from fresh turmeric rhizomes between two different sources by using hydro-distillation and characterize turmeric essential oil by using FTIR.

II. METHODOLOGY

A. Materials

Fresh turmeric rhizome was collected from two different location which are Pasar Moden Seksyen 6 Shah Alam and Pasar Besar Klang. The samples were washed with water to remove matter from the sample. Sliced fresh rhizomes were used for this experiment.

B. Methods

The method used to extract the turmeric essential oil is by using hydro-distillation which is Clevenger type distillation.

The extraction of oil is carried out in Clevenger-type apparatus with time of 2, 4 and 6 hours. 200 gram of slice fresh rhizome were mixed with 500 mL of distilled water into the 2000 mL round bottom flask. The oil and water were separated by using decantation technique. The turmeric essential oil was stored in dark place and at 4 ^{o}C.

C. Estimation of oil yield

The mass of turmeric essential oil and the volume of essential oil obtained were recorded. The essential oil yield from turmeric rhizomes was estimated by using equation 1.

$$\%Oil\ yield = \frac{mass\ essential\ oil\ obtained \times 100}{Fresh\ feed\ weight} \quad (1)$$

D. Analysis

1. Fourier-transform Infrared Spectroscopy

The FT-IR spectrum of the turmeric essential oil is obtained by using FT-IR spectrometer that found in the faculty. Then, the functional group were determined with the aid of IR correlation charts. The IR spectra were display in %transmittance. The wave number region for the analysis is used from 4000-400 cm^{-1}.

III. RESULTS AND DISCUSSION

A. Essential oil yield

The result for sample collected at Pasar Moden Seksyen 6 Shah Alam (sample A) and Pasar Besar Klang (sample B) are shown in this section. The example for calculation of essential oil yield shown below:

$$\%\ oil\ yield = \frac{0.713\ gram}{200\ gram} \times 100$$
$$= 0.3565\ \%$$

1. Pasar Seksyen 6 Shah Alam sample.

The result of mass of oil, % essential oil yield and volume of oil are obtained. From the extraction of slice fresh turmeric oil sample, the % oil yield for 2, 4 and 6 hours are 0.3565%, 0.415% and 0.5445%. The % of oil yield for this sample increase gradually with time from 2 to 6 hours. This can be seen in the figure 4.1, the graph show % essential oil yield against time. Based on this result the higher the extraction time the higher the % oil yield of essential turmeric oil which the highest % oil yield at 6 hours extraction time at 0.5445%. Next, the turmeric essential oil obtained for 2, 4 and 6 hours are 0.5 mL, 0.8mL and 1.0mL which can be seen in Figure 4.2. This show that the extraction can produce more essential oil after 6 hours of extraction because it does not show decreasing of % oil yield at 6 hours of time extraction.

Table 4.1: mass of essential oil in grams

Sample name	Time (hour)	Mass of oil (gram)
A1	2	0.713
A2	4	0.83
A3	6	1.089

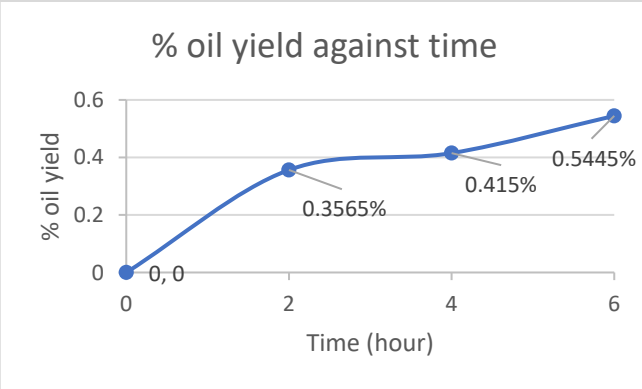

Figure 4.1: % essential oil against time

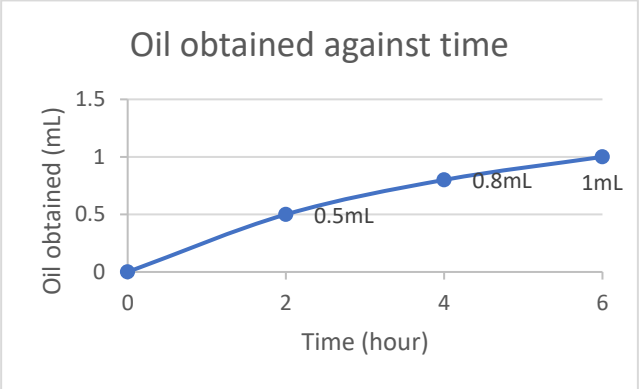

Figure 4.2: Volume of oil obtained against time

2. Pasar Moden Klang sample.

The result of mass of oil, % essential oil yield and volume of oil are obtained. From the extraction of slice fresh turmeric oil sample, the % oil yield for 2, 4 and 6 hours are 0.324%, 0.368% and 0.37%**.** The % of oil yield for this sample increase and show no significant increase in % essential oil yield starting at four hours of operation. After 4 hour the yield start to constant at 0.37% yield This can be seen in figure 4.3, the graph show % essential oil yield against time. Based on this result the higher the extraction time the higher the % oil yield of essential turmeric oil which the highest % oil yield at 6 hours extraction time at 0.37% but it starts to constant around 4 to 6 hours (Avinash Chandra, 2016). So, based on the result we can conclude that at 4 hours is the optimum time for extraction. Next, the turmeric essential oil obtained for 2, 4 and 6 hours are 0.55 mL, 0.7mL and 0.85mL are shown in Figure 4.4.

Table 4.4: mass of essential oi in grams.

Sample name	Time (hour)	Mass of oil (gram)
B1	2	0.648
B2	4	0.736
B3	6	0.74

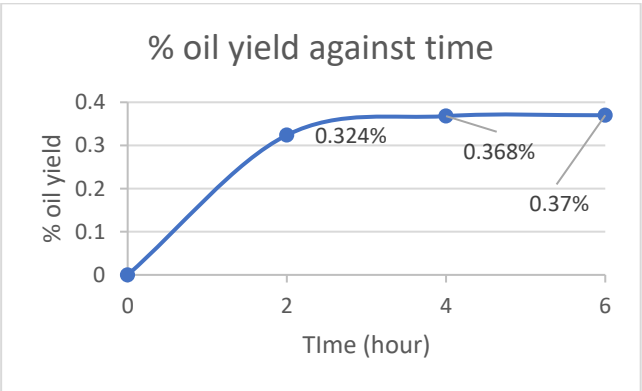

Figure 4.3: % essential oil against time

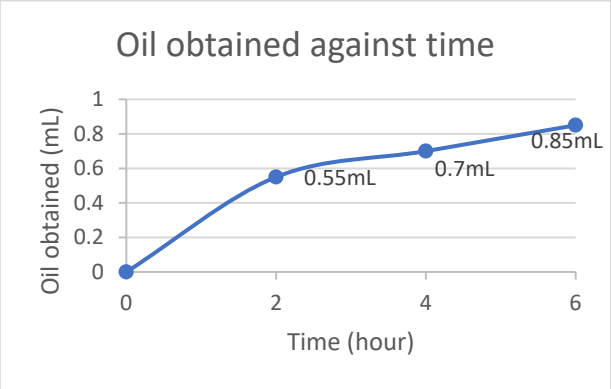

Figure 4.4: Volume of oil obtained against time

B. Characterization by Fourier-transform Infrared Spectroscopy

The FT-IR spectrum of the turmeric essential oil is obtained by using FT-IR spectrometer that found in the faculty. Then, the functional group were determined with the aid of IR correlation charts. The IR spectra were display in % transmittance. The wave number region for the analysis is used from 4000-515 cm^{-1}.

Figure 4.5 show the IR spectra of turmeric essential oil. FT-IR analysis show the complex formation and interaction of major functional groups in the essential oil. The identity of curcumin which found in turmeric essential oil was confirmed by FT-IR. IR spectrum of turmeric essential oil show a characteristic of stretching band O-H at 3460.26 cm^{-1}. The peak at 2961.19 cm^{-1} represent C-H Streching and 1683.04 cm^{-1} peak was assigned to C=C symmetric aromatic ring stretching. The peak at 1513.73 cm^{-1} represents C=O, while enol C-O peak was obtained at 1244.12 $cm^{-1}$and benzoate trans-C-H vibration was at 1036.24 cm^{-1}. This spectrum proof benzene group that Ar-curcumene exist in the turmeric essential oil with present of benzene ring at 1617.61 cm^{-1}. The highest peak in this essential oil is at 1617.61 cm^{-1} show that more bond of benzene ring in the oil. The aromatic ring found was proved that Ar-Turmerone and Curlone were in the sample because of aromatic ketones found at 1684.10 cm^{-1}. The FT-IR spectrum are from turmeric rhizome collected from Pasar Seksyen 6 Shah Alam is shown in figure 4.5.

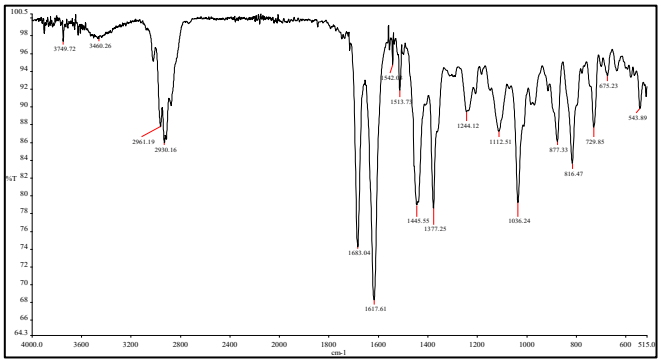

Figure 4.5: characterization of turmeric essential oil by FTIR at 2 hours extraction

Figure 4.6 show the IR spectra of turmeric hydrosol that collected from extraction of turmeric oil. The IR spectrum of hydrosol show a characteristic of stretching band O-H of carboxylic acid at 3308.33 cm^{-1}. The peak at 1647.32 cm^{-1} represent C=C symmetric aromatic ring stretching. This prove that Ar-curcumene exist in the hydrosol because of present of aromatic benzene ring in the sample. The peak at 1496.72 cm^{-1} represents C=O, while enol C-O peak was obtained at 1195.12 $cm^{-1}$and benzoate trans-C-H vibration was at 1077.79 cm^{-1}. Based on the result, it show the presence of water in hydrosol but the presence of Ar-curcumene give the hydrosol an odour of turmeric.

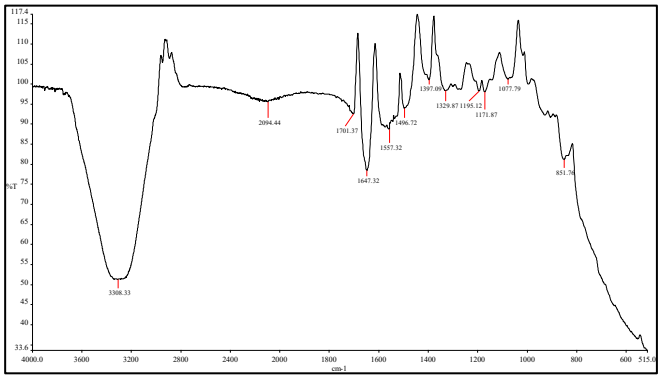

Figure 4.6: characterization of turmeric hydrosol by FTIR at 2 hours extraction

IV. Conclusion

The objective of this research is to extract and compare turmeric essential oil from fresh turmeric rhizomes between two different sources which collected from Pasar Moden Seksyen 6 Shah Alam (sample A) and Pasar Besar Klang(sample B) by using hydro-distillation and characterize turmeric essential oil by using Fourier-transform Infrared Spectroscopy. From the discussion sample A give the highest yield which is 0.5445% at 6 hours of extraction. Based on the result discussed, samples from Pasar Seksyen 6 Shah Alam obtained more turmeric essential oil compared to samples from Pasar Besar Klang. Sample from Pasar Seksyen 6 Shah Alam obtained about 1 mL of essential oil after 6 hours extraction while for sample from Pasar Besar Klang was only at 0.85 mL for 6 hours extraction. Based on % yield, samples from Pasar Shah Alam shows highest yield compared to sample from Pasar Besar Klang which at 0.5445% compared to 0.37%. The result show that the sample from Pasar Shah Alam can produce more turmeric essential oil from 200 grams from both samples compared. The % oil yield for sample of Pasar Besar Klang start to constant at 4 hours is due to less oil contain in the the turmeric rhizome. So, it will less produce oil after 4 to 6 hours of extraction. Based on the comparison between two samples, the best quality of turmeric essential oil is from Pasar Moden Seksyen 6 Shah Alam because it produce high amount of turmeric essential oil and high % yield of turmeric essential oil.

FTIR prove the presence of Ar-curcumene in the essential oil by having benzene ring peak. The aromatic ring found was proved that Ar-Turmerone and Curlone were in the sample because of aromatic ketones found. So, it can be prove that the oil analyze is turmeric essential oil because it should contain Curcumene and Turmerone in the essential oil.

Acknowledgment

First, I am grateful to God for giving good health and wellbeing. I want to express my deepest appreciation to my supervisor, Madam Asdarina Yahya who sharing expertise, guidance and encouragement extended to me. I am grateful to the Faculty of Chemical Engineering, Universiti Teknologi Mara for the opportunity to conduct this work.

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