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Extraction of Turmeric Oil by Continuous Water Circulation Distillation

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Abstract

Spices are the products from plant origin, used for seasoning of food to give flavor and aroma. Turmeric is most widely used as food additive in curries because of its medicinal properties. Spices, when used in raw forms does not impart their total flavor and more often lose their aromatic constituents partially (because of their volatile nature) when finely grounded. In the present study the process adopted is a combination of continuous water circulation with steam distillation for isolation of Turmeric oil. An apparatus for continuous operation has been work out to obtain turmeric oil from leaves and rhizomes .The yield of turmeric oil obtained from leaves ranges between 2.75-2.83% and from rhizomes ranges between 2.38-2.48. The obtained yield is 13% more in rhizome oil and 29% in leaves oil as compare to conventional processes. Seven major compounds, bisabolene (0.4%), ar-curcumene (2.3%), zingiberene (4.01%), dehydrocurcumene (2.0%), ar-temerone (15.8%), termeroen (4.4%) and
oil obtained from rhizome.

Keywords: *Turmeric, Steam Distillation, Rhizomes, Spices, leaves.*

1. Introduction

In ancient and medieval times, India has a record history of foreign trade sustained mainly by spices. India often called as the “land of spices” has about 63 spice crops being grown in the country at present. Spices may be either bark buds, flowers, fruits, leaves, rhizomes, roots, seeds, stigmas and styles or the entire plant.

Curcuma longa L. (family: Zingiberaceae), also known as turmeric, was highly esteemed by the ancient Indo-European people, for its golden-yellow dye resembling sunlight. The brilliant-yellow color of turmeric, which is resistant to very high dilutions, found its way to commercial use as a coloring agent for various items including cotton, silk, paper, wood, foodstuffs and cosmetics [1]. In Ayurveda, turmeric has been used as stomachic, tonic, blood purifier, treatment of skin diseases, jaundice and urinary tract diseases. Curcuma, a genus in the family Zingiberaceae consists of many hundreds of varieties of species of rhizomatous herbs, grown extensively in East and Southeast Asia. The important considerations for the grower to obtain good commercial quality of turmeric include the selection of variety according to the following criteria:

1. Color
2. Aroma
3. Yield
4. Resistance to diseases

The curcumin content of commonly grown Indian varieties varies from 2.5% to 8.1% on dry matter basis, while volatile oil content which provides aroma varies from 1.8% to 5.6% on dry matter basis. Green turmeric is cured and dried for commercial use.

Processing treatments of green turmeric include boiling of turmeric ranging from 30 min. to 3 hours (this reduces the drying time without affecting color or volatile oil content) or peeling and slicing followed by drying.

The long established image of turmeric as a commercial dye stuff and component of curry

was partly responsible for overshadowing its importance as a medicinal herb [2, 4]. Dried rhizome of Curcuma longa L., which has been used for centuries as a spice, food preservative and a coloring agent, has been found a rich source of phenolic compounds or curcuminoids [2, 4, 5, 6, and 7].Few works on turmeric oil extraction is summarized below:
The rhizomes of Curcuma longa L. harvested in north Indian plains was hydro-distilled by Garg S.N. et al. [8].The essential oil was evaluated for its major terpenes.

Raina V.K et.al [9] performed hydro –distillation of leaves and rhizomes and obtained 2.2% oil yield and more than 80 compounds.

Gujrathi D.B et.al [11] was the first to suggest the novel idea of continuous water circulation distillation for separating volatile components from complex mixture or natural sources.

2. Materials and Methods

2.1 Plant Raw material

Semi dried leaves and fresh Rhizomes were collected from the research farm, Department of Horticulture, C.S.A. University Kanpur. Rhizomes are 1.5 year (18 month) matured. The leaves of turmeric plant of 2-4 feet in high with short stem. Sliced fresh Rhizomes were used as a raw feed for the present work.

2.2 Method

The most important production method for essential oils is distillation. The basic principle of distillation is the same but it is carried out in different ways depending on the botanical material and the condition of the material. Three types of distillation are used:

1. Water
2. Water and Steam
3. Direct steam

Water distillation is used when the plant material has been dried and will not be damaged by boiling. The material comes into direct contact with the boiling water and much care needs to be taken that the water does not boil away and cause the plant material to burn. Water and steam distillation is used for either fresh or dried plant material that would be damaged by boiling whereas in direct steam process, steam is passed through plant material which can be anything from wood to flowers, and which has been pressed tightly and evenly in a still. Here modified steam distillation is used which is termed as continuous water circulation process as condensed water goes back to the still.

2.3 Estimation of percentage moisture content and oil yield

Weighted plant material was kept in the oven at 105˚C for 4 hours. The loss of weight gives % moisture content.

$$\% \text{ moisture} = \frac{[Initial\ weight - final\ weight] \times 100}{Initial\ weight\ of\ sample} \quad (1)$$

Essential oil yield from leaves and rhizomes of turmeric was estimated by using following expression.

$$\% \text{ Oil yield} = \frac{Essential\ oil\ obtained \times 100}{Fresh\ feed\ weight \times (1 - \%\ moisture\ content/100)} \quad (2)$$

2.4 Experimental Setup

The entire setup was made of glass/glass fittings. Flask A, flask B, condenser D and column F were purchased on standard glass accessories (Borocil) where as column C and collector E were fabricated.

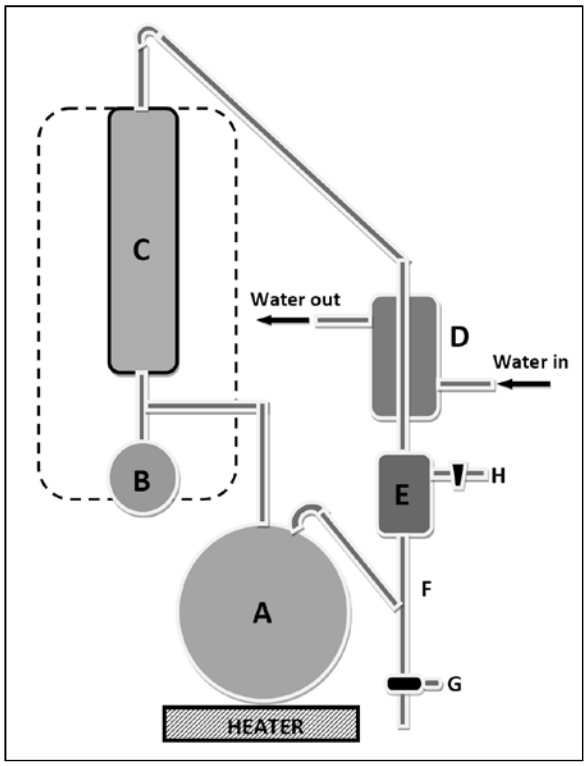

Fig.1: Experimental setup

Table 1: Specifications of experimental setup

Flask A	3 liter
Flask B	500 ml
Column C	Height 25 cm, OD 7 cm
Condenser D	Bulbs type(25 cm in height, 1.25 liter)
Collector E	150 ml
Column F	10 ml
Tap G	
Vent H	

The steam is continuously produced in flask A through electrical heating and passed through column containing random packing of cut turmeric leaves in first phase of the operation. In the second phase, cut leaves were replaced by random packing of longitudinal slices of turmeric rhizomes in the column. In both the cases the runs were taken at different weight. The empty top portion of the column was filled with glass wool. The vapors rising from the column mainly comprising of water vapors and lighter components of turmeric oil were passed through a condenser D, where the water vapors and condensed components were taken into the collector E. The oil being lighter remained in the collector as top layer, whereas condensed water layer along with and small fraction of water-soluble components of oil, remained as bottom layer. In the continuous operation loss of water by way of boiling was compensated continuously from column F. Finally after 6 hours operation, heating was stopped and the product (essential oil) was drained through column F from a tap G. Vent H was provided for periodically release of uncondensed gases and excessive pressure.

3. Results and Discussion

3.1 Essential oil yield: leaves

Table 2: Variation of % oil yield with time

Sample Number	Time (hr)	% oil yield
	0	0
S_1	1	0.69
S_2	2	1.34
S_3	3	2.19
S_4	4	2.78
S_5	5	2.81
S_6	6	2.81
S_7	7	2.81
S_8	8	2.81

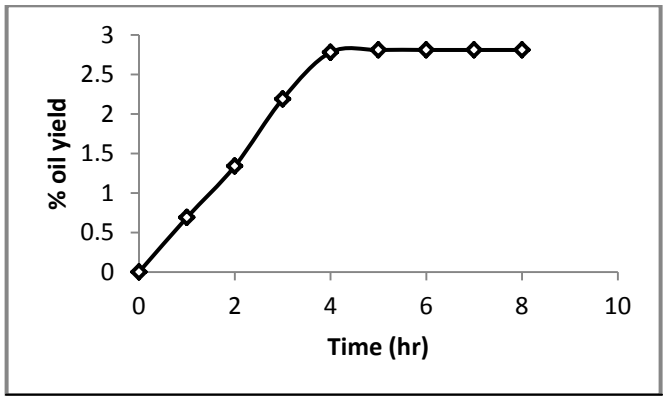

Fig.2: Variation of % oil yield with time

Table 3: % moisture content in different of samples of same weight

Sample No.	% Moisture Content
S_9	69.70
S_{10}	68.70
S_{11}	68.90
S_{12}	68.00
S_{13}	68.02
S_{14}	69.17
S_{15}	68.44
S_{16}	67.71
S_{17}	67.98
S_{18}	68.23

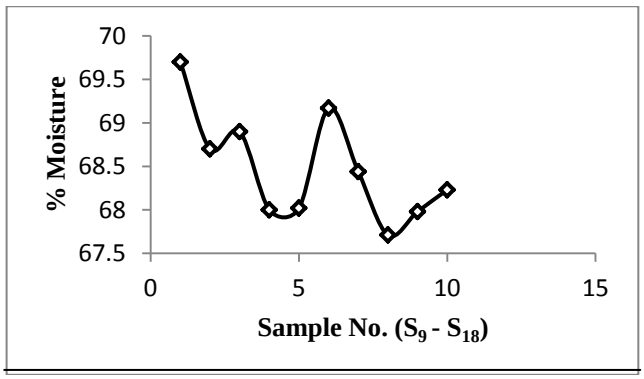

Fig.3: Percent moisture content in leaves

Table 4: Variation of essential oil obtained with different weight of samples of leaves

Sample Number	Sample Weight (gm)	Oil obtained (ml)
S_{19}	50	0.44
S_{20}	100	0.90
S_{21}	150	1.36
S_{22}	200	1.80
S_{23}	250	2.26

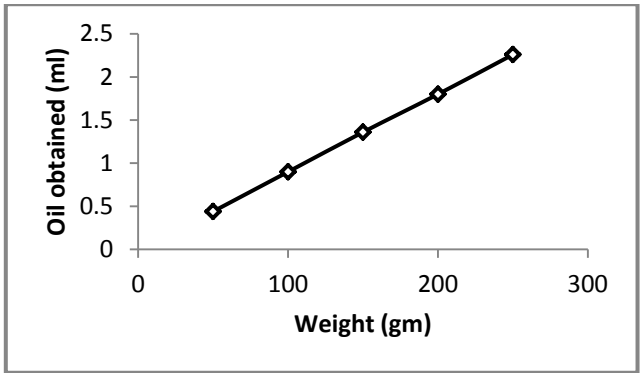

Fig.4: leaves weight vs oil obtained

3.2 Essential oil yield: Rhizomes

Table 5: Variation of % oil yield with time

Sample Number	Time(hr)	% Oil Yield
S_{24}	1	0.52
S_{25}	2	1.14
S_{26}	3	1.95
S_{27}	4	2.38
S_{28}	5	2.43
S_{29}	6	2.43
S_{30}	7	2.43
S_{31}	8	2.43

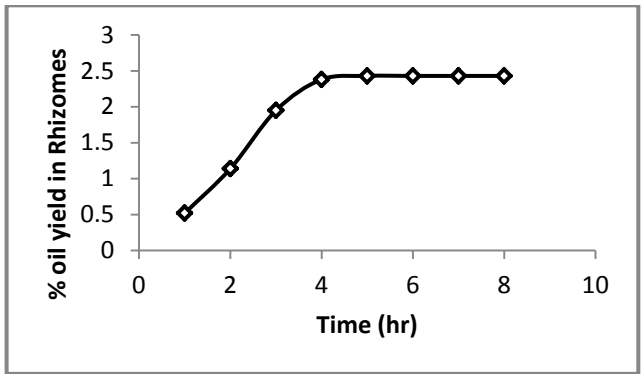

Fig.5: Variation of % oil yield with time

Table 6: % moisture content in different samples of same weight

Sample No.	% Moisture content
S_{32}	78.89
S_{33}	78.46
S_{34}	79.00
S_{35}	79.00
S_{36}	78.80
S_{37}	79.11
S_{38}	78.80
S_{39}	79.00
S_{40}	78.43
S_{41}	78.71

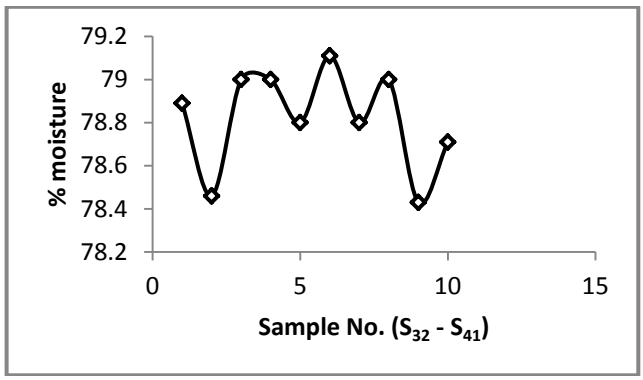

Fig.6: Percent moisture content in Rhizome

Table 7: Variation of essential oil with different weight of samples

Sample Number	Sample weight (gm)	Oil obtained (ml)
S_{42}	50	0.25
S_{43}	100	0.51
S_{44}	150	0.78
S_{45}	200	1.02
S_{46}	250	1.29

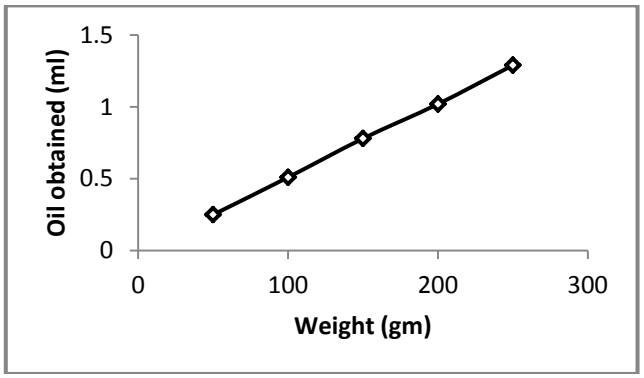

Fig.7: Rhizome weight vs oil obtained

The plot (Fig.2) between % oil yields with operation time (hour) is showing the constant yield of 2.81% after 5 hour operation. Although there is no significant increase in % oil yield during 4-5 hour so 4 hour operation time was taken as optimum time.

Fig 3 & 6 shows percent moisture content in the leaves and rhizomes under prescribed experimental condition which is almost constant in all samples and has value of 68% for leaves and 79% in rhizomes. The minor differences may be due to random packing of cut leaves and rhizomes every time.

The plot between oil obtained vs weight of leaves and rhizomes (fig.4 & 7) is showing linear variation. This implies in proportional increase of oil obtained for different weight of leaves and rhizomes, which are quite obvious.

GC followed by GC-MS of rhizome oil was carried out At RSIC, CDRI Lucknow. In Gas Chromatograph about 25 compounds were identified while in GC-MS only 20 mass spectra's were obtained. Identification of compounds has been done by comparing mass spectra fragmentation pattern and retention time. The Yield of identified compounds are given in Table .8

Table 8: Yield of identified compounds in the oil obtained from rhizome.

Identified Compound	Composition (%)
bisabolene	0.4
ar-curcumin	2.3
zingberene	4.01
dehydro curcumene	2.0
ar-Turmirone	15.8
termerone	4.4
curlone	5.6
Unidentified	65.49

4. Conclusion

In present investigation, the emphasis was laid on the designing of continuous water circulation process, to increase the yield from turmeric leaves and rhizomes.

The total oil yield obtained from the leaves and rhizomes is 13% more in rhizome and 29% more in leaves when compared with oil yield by plant grown in the plains of North India (2.2%) Seven major compounds were identified by GC-MS analysis in oil obtained from rhizome.

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