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Study on influence of distillation duration on yield and composition of turmeric leaf essential oil

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ABSTRACT

Understanding the influence of distillation duration on yield and composition of turmeric leaf essential oil may help to improve the production and engineer the constituent of the oils as well as decrease the energy needed for distillation. In this study the influence of distillation duration on the yield and composition of turmeric leaf by hydrosteam distillation method was investigated. Six distillation times such as 1, 2, 3, 4, 5 and 6th hours were investigated. The maximum essential oil content (0.183 %) was achieved in the 1st hour of distillation, however, the minimum essential oil content (0.015 %) was observed after 3 hours of distillation and after that no oil was obtained. The chemical composition of the isolated essential oil was determined by gas chromatography (GC-MS) which revealed that the major compounds obtained were, á-phellandrene (25,341 %), paracymene (11.634 %) and Trans-mentha-1(7),8-dien-2-ol (10.72 %). The study also revealed that the highest contents of á-phellandrene paracymene and Trans-mentha-1(7),8-dien-2-ol were obtained at 1 hour distillation time.

Key words: *Turmeric, Leaf essential oil, Distillation*

Introduction

Turmeric (*Curcuma longa* L.), an important perennial plant of the Zingeberaceae family, is grown as an annual up to 1200 meters above mean sea level. It flourishes well in both irrigated and rain-fed habitats on light black, black clayey loams, and red soils. It is a short-stemmed, tufted, herbaceous perennial that can reach a height of 60 to 90 cm or more. India is the world's top exporter of turmeric, with 215 billion USD worth of exports in 2022. Around 11 lakh tonnes of turmeric are produced worldwide each year. India leads the global manufacturing scenario, producing 80 % of it, followed by China (8 %), Myanmar (4 %), Nigeria (3 %) and Bangladesh (3 %). However, in the process of producing this important spice, the above ground portions go as waste utilizing only the underground rhizomes. The turmeric leaf also contain essential oil rich in monoterpenes (Leela *et al*., 2002). The primary components of the leaf oil are turmerone, turmerone-, a-phellandrene (18.2 %), 1,8-cineole (14.2 %), and p-cymene (13.3 %). A wide range of insecticidal, antioxidant, and phytotoxic characteristics may be found in turmeric essential oil. According to Asghari *et al*. (2010), turmeric leaf essential oil is frequently used in aromatherapy, fragrances, and medicines. It has been shown that the immune response induced by á-phellandrene on normal mice cells is beneficial for in vivo treatment of neurodegeneration and

other inflammatory diseases, such as psoriasis (Ibanez and Blazquez, 2020). It can also be used as alternative fuel (Dhamale *et al*., 2017). As a result, it's important to turn leftover turmeric into valued goods such bioactive essential oils (Kumar *et al.*, 2011)

In this study we hypothesized the Influence of distillation duration on yield and composition of turmeric leaf essential oil. There is no previous comprehensive study on the effect of distillation duration for turmeric leaf although there are some analogous studies on oil yield and composition. The objective of this study was to use hydro steam distillation and subsequent gas chromatography (GC) analysis of the resulting essential oil to elucidate how the turmeric leaf oil yield and composition of turmeric oil might be affected by varying the distillation duration of the plant material. Knowledge of optimum distillation duration may help producers of these oils conserve energy and resources while improving oil quality and yield. Furthermore, it may be possible to use distillation duration as a tool for controlling and influencing essential oil composition. In addition, such study would provide the basis for comparison of published studies using different distillation durations.

Materials and Methods

The current study was conducted during 2022-23 under laboratory conditions in the of Department of Plantation, Spices, Medicinal and Aromatic crops, Kittur Rani Channamma College of Horticulture Arabhavi adopting completely randomized design (CRD) with four replications and six treatments viz., T_1- Distillation for 0-1 hour, T_2- Distillation for 1-2 hours, T_3- Distillation for 2-3 hours, T_4- Distillation for 3-4 hours, T_5- Distillation for 4-5 hours, T_6- Distillation for 5-6 hours using the freshly harvested above ground biomass of turmeric cv. Salem at 210 DAS. Approximately 10 kg of turmeric leaf biomass from each field of four different fields were harvested, weighed and prepared for distillation by cutting into small pieces and distilled in a hydro steam distillation apparatus of 50 litre still volume with approximately 10 kg herbage capacity (fabricated in compliance with the patented design of CSIR – Institute of Himalayan Bioresources Technology, Palampur), fitted with suitable heating coil and cold-water supply system. The distillation was continued for six hours, the essential oil was collected at hourly interval into glass flask separately further transferred into a borosilicate separation fennel and allowed to settle for 30 min after, water was separated from below followed by adding anhydrous sodium sulphate salt to absorb the remaining water molecules. The essential oil was then transferred to a clean amber glass bottle of known weight and stored under cool, dry and dark condition for further study and analysis through GC (Gas Chromatography). The mean data were statistically analysed following standard procedure as suggested by Panse and Sukhatme (1967).

Results and Discussion

The distillation duration statistically influenced the turmeric leaf essential oil content and yield (Table 1) and its qu0ality (Table 2), marking the maximum essential oil content during the first hour of distillation (T_1) with 0.183 % and yield was 18.25 g/10 kg herbage followed by 2nd hour of distillation (T_2) with 0.120 % and 12.00 g. The essential oil content decreased to 0.015 per cent during third hour of distillation and there after it was nil. The percentage of oil obtained during the first hour of distillation may appear higher because this initial fraction contains a higher proportion of the more volatile compounds.

Table 1. Influence of distillation duration on content and yield of turmeric leaf essential oil

Treatments	Essential oil content (%)	Essential oil yield (g/10kg)
T1 - Distillation for 0-1 hour	0.183(1.087)	18.25(4.383)
T2 - Distillation for 1-2 hours	0.120(1.058)	12.00(3.604)
T3 - Distillation for 2-3hours	0.015(1.007)	1.500(1.573)
T4 - Distillation for 3-4 hours	0.000(1.000)	0.000(1.000)
T_5 - Distillation for 4-5 hours	0.000(1.000)	0.000(1.000)
T_6 - Distillation for 5-6 hours	0.000(1.000)	0.000(1.000)
Total	0.318	31.75
S.Em ±	0.002	0.070
CD at1%	**0.007**	**0.211**

Table 2. Quality of turmeric leaf essential oil as influenced by different distillation durations

Sl. No.	Compounds	Area (%)		
		T_1	T_2	T_3
1	α-pinene	1.012	0.051	0.002
2	β-pinene	2.36	0.227	0.035
3	α-phellandrene	25.341	11.092	10.253
4	1,8 cineole	1.008	0.026	0.005
5	Para cymene	11.634	7.14	2.114
6	Trans sabinol	1.036	2.852	4.568
7	Delta-2-carene	7.595	10.721	12.845
8	Delta-3-carene	4.439	3.301	5.658
9	Trans-mentha-1(7),8-dien-2-ol	10.725	9.43	8.568
10	4-methyl penta-2-enolide	3.432	4.965	6.958
11	Iso-ascaridole	3.864	5.246	9.258

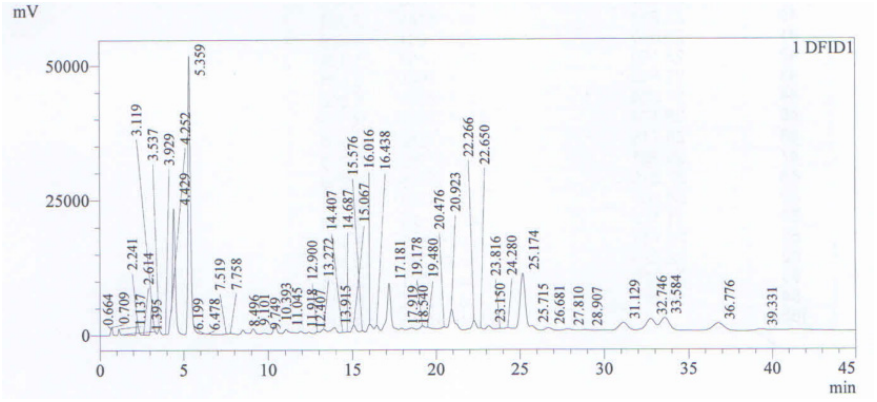

Fig. 1. Gas Chromatogram Profile of 1st hour of turmeric leaf essential oil

These lighter compounds, which have lower boiling points, tend to vaporize at lower temperatures and are collected first during the distillation process. Similar kind of results also obtained in palmarosa by Canon *et al*. (2013) in which they concluded that maximum essential oil yields were obtained at a distillation time of 20 minutes as higher distillation time did not improve oil yields. Quality analysis of turmeric leaf essential oil through GC (Table 2 and Fig. 1) revealed that the á-phellandrene was the major constituent throughout the distillation (25.341 %, 11.092 % and 10.253 % respectively) the concentration of which steadily decreased followed by paracymene in first hour (11.634 %), Delta -2- carene in second hour (10.721 %) and third hour (12.845 %) of distillation. The low boiling compounds were extracted first followed by the high boilers as the time duration increased. Similar findings were also found by Nikkah *et al*. (2009) in thyme.

Conclusion

Based on the present experiment results, it is concluded that the turmeric leaves has to be distilled for three hours in hydro steam distillation unit to complete the distillation process by obtaining 0.318 percent essential oil yield on fresh weight basis with the maximum of 0.183 per cent in 1st hour.

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Conflict of interest

The authors declare that no conflict of interest exists.

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