Effect of various drying methods on essential oil yield and quality attributes of clove basil (*Ocimum gratissimum* L.) leaves.

Abstract

The present investigation entitled **"Effect of various drying methods on essential oil yield and quality attributes of clove basil (*Ocimum gratissimum* L.) leaves"** was conducted during 2024–25 at the Research Laboratory, K.D. College of Horticulture and Research Station, Jagdalpur (Chhattisgarh). The experiment was laid out in a Completely Randomized Design with five treatments and four replications, comprising fresh leaves (T_1), shade drying leaves (T_2), sun drying leaves (T_3), oven drying leaves (T_4) and microwave drying leaves (T_5). Essential oil was extracted by steam distillation and analysed for oil yield and physico-chemical properties of essential oil. Drying methods significantly influenced essential oil yield. Shade drying leaves recorded the highest oil yield (0.90%), followed by fresh leaves (0.79%) and oven drying leaves (0.75%), which were statistically at par, whereas sun drying leaves (0.49%) and microwave drying leaves (0.29%) resulted in significantly lower yields. The physico-chemical properties of essential oil such as density (0.906–0.984 g ml^{-1}), specific gravity (0.909–0.988) and refractive index (1.5258–1.5183) did not differ significantly among treatments. However, acid value showed significant variation, with the highest value in fresh leaves (5.61 mg KOH g^{-1}) and the lowest in microwave drying leaves (1.60 mg KOH g^{-1}).

Keywords

Clove basil, Drying methods, Essential oil yield, Acid value, Physico-chemical properties, *Ocimum gratissimum* L.

1. Introduction

Ocimum gratissimum L., also referred to as scent leaf, is one of the discovered medicinal plants that may be used as a source for a new medication or as an alternative therapy for a number of illnesses. It is an aromatic perennial herbaceous plant that is widely grown and economically successful. It is widespread in Africa, Asia, and South America and is a member of the Lamiaceae family (Tanko *et al*., 2008; Akara *et al*., 2021). Also known as clove basil, African basil, Tree basil or wild basil. This species' morphology helps distinguish it from other *Ocimum* species. *Ocimum gratissimum* L. is categorized into many chemotypes, including eugenol, thymol, and geraniol, among others, based on the main chemical components of essential oil (Vieira *et al*., 2001). Essential oils are a blend of different substances that are important for the defense and survival of the plants that contain them (Saini *et al*., 2000). Essential oils can be extracted using a wide range of techniques, including solvent extraction, CO_2 extraction, steam distillation, cold pressing, hydro-distillation, microwave-assisted hydro-distillation, and maceration. All of these techniques are employed to generate high-quality oil or oil with a notable output. However, it demonstrates that the quantity and quality of essential oils are affected differently by various techniques. It has been also reported that both the production cost and the extraction time may differ. One such conventional and widely used technique for extracting essential oils is hydro-distillation (Khan and Dwivedi, 2018). One of the oldest methods for maintaining the quality of aromatic and therapeutic plants is drying. It entails removing as much water as possible from the raw material to significantly reduce microbial spoiling and deterioration reactions (Rocha and Melo, 2011). Air drying, solar drying, oven drying, microwave drying, and freeze drying are some of the methods used to dry plant materials. The intended product determines the approach to be taken. For example, the hot air drying process can cause thermal damage and significantly change the colour and volatile composition of herbs (Antal *et al*., 2011).

2. Material and Methods

2.1 Experimental Site

The experiment was carried out during the year 2024-25 at Research laboratory , KDCHRS, Jagdalpur (C.G.).

2.2 Sample Collection

Fresh leaves of clove basil (*Ocimum gratissimum* L.) were collected from the nearby forest area of Jagdalpur, Bastar (Chhattisgarh) during May–June 2025. The collected leaves were washed thoroughly to remove dust and extraneous matter and used for fresh as well as drying treatments prior to essential oil extraction.

2.3 Essential Oil Extraction

Essential oil from clove basil leaves was extracted by steam distillation using a standard distillation apparatus. About 100 g of leaf material was subjected to distillation, and the vapours containing essential oil and water were condensed and collected. The separated oil layer was dried over anhydrous sodium sulphate to remove residual moisture and stored in airtight glass vials at 4 °C until further analysis. The same procedure was followed for both fresh and dried leaf samples.

2.4 Observations recorded:-

2.4.1 Determination of Essential oil yield (%)

The essential oil was extracted from fresh and dried leaf samples using steam distillation. The extracted oil was separated from the aqueous phase, dried over anhydrous sodium sulphate and weighed. Oil yield was calculated on weight basis using the following formula:

$$Essential\ oil\ yield(\%) = \frac{weight\ of\ essential\ oil\ obtained}{Initial\ weight\ of\ leaf\ sample} \times 100$$

2.4.2 Determination of Density

Density of clove basil essential oil was determined at 25 ℃ using an oil pycnometer. The weight of a known volume of oil was recorded and density was calculated as:

$$Density = \frac{Wo}{Vo} \times 100$$

Where,
Wo= Weight of oil (g)
Vo = Volume of oil (ml)

2.4.3 Determination of Specific gravity

Specific gravity was determined using a specific gravity bottle by comparing the weight of oil with the weight of an equal volume of distilled water at the same temperature:

$$Specific\ gravity = \frac{weight\ of\ oil}{weight\ of\ equal\ volume\ of\ water}$$

2.4.4 Refractive Index

Refractive index of essential oil samples was measured using an Abbe refractometer after proper calibration. Readings were taken at room temperature to assess the optical properties of the oil.

2.4.5 Acid Value

Acid value was determined by titrating the oil sample dissolved in neutral alcohol against 0.1 N potassium hydroxide using phenolphthalein as indicator. Acid value was calculated using the formula:

$$Acid\ value = \frac{V \times N \times 56.1}{Wo}$$

Where,

V = Volume of KOH used (ml)

N = Normality of KOH

Wo = Weight of oil in mg

3. Result and Discussion

3.1 Essential oil yield

The data presented in Table 1 indicated that drying methods significantly influenced the essential oil yield of clove basil leaves. Shade drying leaves (T_2) recorded the highest oil yield (0.90%), followed by fresh leaves (T_1) (0.79%) and oven drying leaves (T_4) (0.75%), while sun drying leaves (T_3) (0.49%) and microwave drying leaves (T_5) (0.29%) resulted in lower yields. Higher yield under shade drying may be attributed to gradual moisture removal and better retention of volatile constituents, whereas rapid heating during microwave drying possibly caused volatilization losses. Similar results were reported by Mousa *et al.* (2008) in *Ocimum basilicum* and Gocher *et al.* (2022) in *Monarda citriodora*.

3.2 Physico-chemical properties of clove basil essential oil

3.2.1 Density

The data presented in Table 2 indicated that the density of clove basil essential oil ranged from 0.906 to 0.984 g ml^{-1} under different drying methods. Although a slight increasing trend was observed from fresh leaves to microwave drying leaves, all treatments were found to be statistically at par. The non-significant variation in density may be due to the fact that drying methods primarily remove moisture from the leaf material but do not substantially alter the intrinsic chemical composition of the essential oil. Similar observations were also reported by Parganiha *et al.* (2012) in patchouli and Huong *et al.* (2020) in *Ocimum gratissimum* essential oil.

3.2.2 Specific gravity

The data presented in Table 2 indicated that the specific gravity of clove basil essential oil varied from 0.909 to 0.988 among different drying methods. However, the differences among treatments were statistically non-significant. The uniformity in specific gravity values suggests that the inherent chemical composition of the essential oil remained largely unaffected by the drying methods. Comparable observations were reported by Mustapha (2018) on lemon grass and basil leaves essential oil and Olayemi *et al*. (2018) on *Cymbopogon citratus* essential oil.

3.2.3 Refractive index

The data presented in Table 2 indicated that the refractive index of clove basil essential oil ranged from 1.5258 to 1.5183 under different drying methods. A slight decreasing trend was observed from fresh leaves (T_1) (1.5258) to microwave drying leaves (T_5) (1.5183); however, all values were found to be statistically at par. This indicates that drying methods had minimal influence on the optical properties of the essential oil. Similar observations were reported by Huong *et al.* (2020) in *Ocimum gratissimum*.

3.2.4 Acid value

The data presented in Table 2 indicated significant variation in acid value among drying methods. The highest acid value (5.61 mg KOH g^{-1}) was recorded in fresh leaves (T_1), whereas the lowest (1.60 mg KOH g^{-1}) was observed in microwave drying leaves (T_5). Shade drying leaves (T_2) (3.93), sun drying leaves (T_3) (3.83) and oven drying leaves (T_4) (3.65) were statistically at par. Higher acid value in fresh leaves may be attributed to active lipolytic enzymes under higher moisture conditions, whereas rapid heating during microwave drying may have reduced free fatty acid formation. Similar observations were reported by Mustapha (2018) and Mulyati *et al.* (2023).

Table 1. Essential oil yield at various drying methods

Treatment	Oil yield %
T_1	0.79
T_2	0.90
T_3	0.49
T_4	0.75
T_5	0.29
C.D.	**0.025**
SE(m)±	**0.008**
C.V.	**2.588**

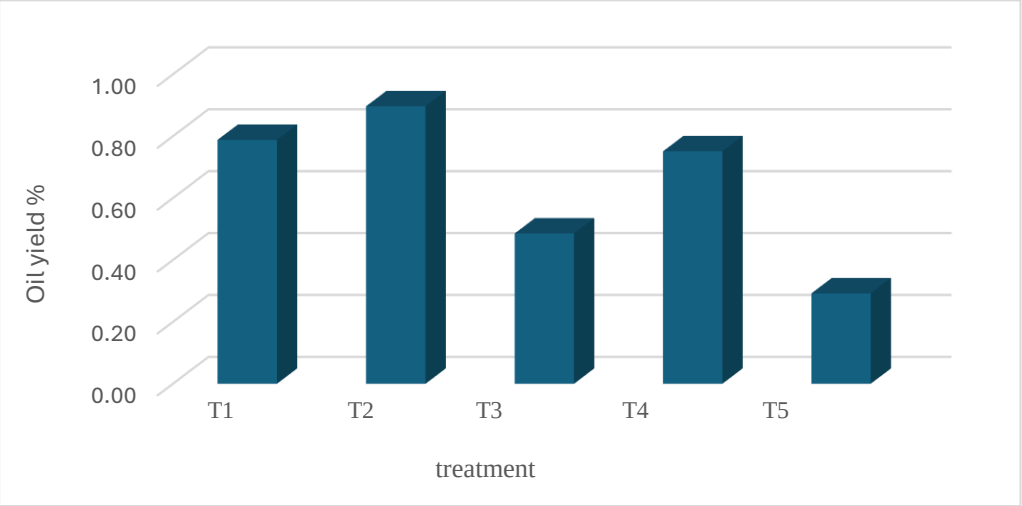

Fig. 1. Essential oil yield at various drying methods

Table 2. Physico-chemical properties of clove basil essential oil at various drying methods

Treatment	Density	Specific gravity	Refractive index	Acid Value
T_1	0.906	0.909	1.5258	5.61
T_2	0.922	0.925	1.5224	3.93
T_3	0.940	0.943	1.5208	3.83
T_4	0.972	0.977	1.5203	3.65
T_5	0.984	0.988	1.5183	1.60
C.D.	**0.029**	**0.030**	**NS**	**0.180**
SE(m)±	**0.009**	**0.010**	**0.017**	**0.059**
C.V.	**2.010**	**2.058**	**2.254**	**3.176**

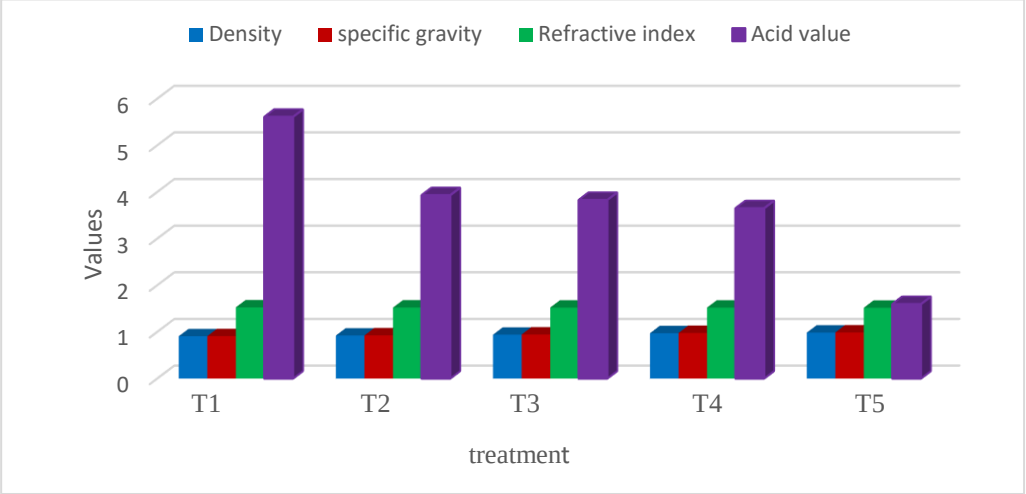

Fig. 2. Physico-chemical properties of clove basil essential oil at various drying methods

CONCLUSION

The research results showed that drying methods significantly influenced the essential oil yield and acid value of clove basil (*Ocimum gratissimum* L.) leaves. Among the different methods, shade drying leaves resulted in higher essential oil yield, whereas microwave drying leaves produced lower oil yield with reduced acid value. These variations may be attributed to differences in moisture removal rate and enzymatic activity during drying, which affect oil retention and free fatty acid formation. Overall, shade drying was found to be a suitable method for obtaining better essential oil yield with acceptable physico-chemical properties.

Reference

Akara, E. U., Emmanuel, O., Ude, V. C., Uche-Ikonne, C., Eke, G. and Ugbogu, E. A. 2021. *Ocimum gratissimum* leaf extract ameliorates phenylhydrazine-induced anaemia and toxicity in Wistar rats. Drug metabolism and personalized therapy, 36(4): 311–320.

Antal, T., Figiel, A., Kerekes, B. and Sikolya, L. 2011. Effect of Drying Methods on the Quality of the Essential Oil of Spearmint Leaves (Mentha spicata L.). Drying Technology, 29(15): 1836–1844.

Gocher, M., Gochar, R., Katare, A. K. and Bhanwaria, R. 2022. Impact of Drying Methods on Qualitative and Quantitative of *Monarda citriodora* Cerv. ex Lag. Essential Oil Yield. Journal of Essential Oil Bearing Plants, 25: 1268-1280.

Khan, F. and Dwivedi, A. K. 2018. A Review on Techniques Available for the Extraction of Essential Oils from Various Plants. International Research Journal of Engineering and Technology, 5(5): 1100-1103.

Mousa and Attia, N. G. 2008. Effect of some drying methods on the quality of basil plant (*Ocimum basilicum*, L.)..J. Agric. Sci. Mansoura Univ., 33(12): 8667 – 8675.

Mulyati, H. S., Yanti, R. and Supriyadi, S. 2023. Physicochemical Properties and Antioxidant Activity of Essential Oil from Fresh, Wilted, and Dried Leaves of Holy Basil (*Ocimum tenuiflorum* L.) Planted in Yogyakarta. agriTECH, 43(3): 218-229.

Mustapha, A. 2018. Comparative analysis on the extraction of essential oil from lemongrass and basil leaves. International Journal of Innovative Science, Engineering and Technology. 5(11).

Huong, N. C., Ngan, T. T. K., Anh, T. T., Le, X. T., Lam, T. D., Cang, M .H., Huong, T. T. T. and Pham, N. D. Y. 2020. Physical and Chemical Profile of Essential oil of Vietnamese *Ocimum gratissimum* L.. IOP Conference Series: Materials Science and Engineering. 736. 062010.

Olayemi, R., Jawonisi, I. O. and Samuel, J. A. 2018. Characterization and physico-chemical analysis of essential oil of *Cymbopogon citratus* leaves. Bayero Journal of Pure and Applied Sciences, 11: 74-81.

Parganiha, D. 2012. Process technology for extraction of essential oil from Patchouli

(*Pogostemon cablin* Benth.) (M.Tech thesis). IGKV, Raipur, Chhattisgarh.

Rocha, P. R. and Melo, E. C. 2011. Influence of drying process on the quality of medicinal plants: A review. J. Med. Plants Res, 5: 7076–7084.

Saini, A. C., Sampaio, A., Souza, M., Heriques, M. and Ramos, M. 2000. Oleos essentials: potential, antifungul, anti inflamatorio, Biotechnologia cienc desenvolv, 16: 38-43.

Tanko, Y., Magaji, G. M., Yerima, M., Magaji, R. A. and Mohammed, A. 2008. Anti-nociceptive and anti-inflammatory activities of aqueous leaves extract of *Ocimum gratissimum* (Labiate) in rodents. African journal of traditional, complementary, and alternative medicines : AJTCAM, 5(2): 141–146

Vieira, R. F., Grayer, R. J., Paton, A. and Simon, J. E. 2001. Genetic diversity of *Ocimum gratissimum* L. based on volatile oil constituents, flavonoids and RAPD markers. Biochemical Systematics and Ecology, 29: 287-304.