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

Abstract

The present investigation entitled **"Effect of drying methods on yield and quality attributes of clove basil (*Ocimum gratissimum* L.) leaves essential oil"** 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 analyzed for oil yield and quality attributes of essential oil. Results revealed that drying methods significantly influenced essential oil yield ($p \leq 0.05$). Shade drying leaves (T_2) recorded the highest oil yield (0.90%), followed by fresh leaves (0.79%) and oven drying leaves (0.75%), which were statistically at par. Sun drying leaves (0.49%) and microwave drying leaves (0.29%) resulted in significantly lower yields. Quality attributes such as density, specific gravity and refractive index showed non-significant variation among treatments, whereas acid value differed significantly ($p \leq 0.05$), with the lowest value recorded under microwave drying (1.60 mg KOH g^{-1}). Overall, shade drying was found to be the most suitable method for obtaining higher essential oil yield while maintaining acceptable quality attributes of clove basil essential oil. However, limited information is available on the comparative effect of different drying methods on essential oil yield and quality attributes of clove basil, which the present study aims to address.

Keywords

Clove basil, Drying methods, Essential oil yield, Acid value, Quality attributes, *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 (EOs) are volatile odoriferous oils and secondary metabolites obtained from the volatile part of aromatic plants and are used by the plants as a defence mechanism against herbivore attacks (Blowman *et al*., 2018). 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. 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. Over 93% of the oil produced globally is produced using steam distillation, which is a common practice in the essential oil industry (Machado *et al*., 2020).

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). The stability, safety, and therapeutic effectiveness of the finished herbal product are all directly impacted by drying, a crucial post-harvest procedure in the processing of medicinal plants. Due to their affordability and ease of use, traditional drying methods like sun drying, shade drying, and air drying have been utilised extensively for generations, particularly in rural and low-resource areas (Tanko *et al*., 2005). While modern innovations like freeze drying, microwave drying, infrared drying, and hybrid techniques offer significant advantages in terms of preserving bioactive compounds and lowering post-harvest losses, mechanical methods like hot air, oven, and vacuum drying offer better control over drying parameters (Nwankwo *et al*., 2023).

In the case of clove basil (*Ocimum gratissimum* L.), information on the comparative effect of different drying methods on essential oil yield and quality attributes under Bastar agro-climatic conditions is limited. Therefore, the present study was undertaken to fill this knowledge gap by systematically evaluating the effect of various drying methods on essential oil yield and selected quality attributes of clove basil leaves.

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 Drying Treatments

Shade drying : Leaves were dried at ambient temperature (28–32 °C) under shade for 6–7 days until constant weight was achieved.

Sun drying : Leaves were dried under direct sunlight (35–40 °C) for 3–4 days.

Oven drying : Leaves were dried in a hot-air oven at 50 °C for 24 hours with intermittent weighing.

Microwave drying : Leaves were dried in a convection microwave oven operated at 180W power for a duration of 10 minutes, using 30–60 second intervals until brittle texture was obtained.

2.4 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.

2.5 Observations recorded:-

2.5.1 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:

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

2.5.2 Determination of Density

Density of clove basil essential oil was determined at 25 °C 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)

2.5.3 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:

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

2.5.4 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.

2.5.5 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

Statistical analysis

The data were analyzed using analysis of variance (ANOVA) under Completely Randomized Design (CRD). Treatment means were compared using Critical Difference (CD) at 5% level of significance ($p \leq 0.05$).

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.

The higher essential oil yield obtained under shade drying leaves (T_2) may be attributed to slow and gradual moisture removal, which minimizes the loss of volatile oil constituents. In contrast, rapid heating during microwave drying leaves (T_5) may lead to volatilization and degradation of essential oil components, resulting in reduced oil yield. Comparisons with previous studies were made primarily on the basis of the effect of drying treatments, particularly shade drying, rather than absolute yield values, considering broadly similar drying conditions. Similar results were reported by Mousa *et al.* (2008) in *Ocimum basilicum* and Gocher *et al.* (2022) in *Monarda citriodora*.

3.2 Quality attributes 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 but did not show significant variation among them, as indicated by ANOVA ($p > 0.05$). 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 stability of major volatile constituents, which are not substantially altered by the drying process. Since drying primarily removes moisture without affecting the inherent oil composition, density remained unchanged across treatments. Similar observations were also reported by 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 ($p > 0.05$).

The absence of significant variation 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 ($p > 0.05$).

This may be attributed to the stability of the chemical composition of major volatile constituents, as the drying methods primarily facilitated moisture removal without causing substantial alteration in the molecular structure of essential oil components. 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.

The higher acid value in fresh leaves (T_1) may be attributed to the presence of higher moisture content, which promotes the activity of lipolytic enzymes and enhances hydrolytic breakdown of esterified oil components, resulting in increased free fatty acid formation. In contrast, the lower acid value under microwave drying leaves (T_5) may be due to rapid moisture removal and thermal inactivation of these enzymes, which restricts hydrolysis and improves oil stability. 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**

Table 2. Quality attributes 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**

Study limitation

The present study was limited to evaluation of essential oil yield and selected physical quality attributes. Detailed chemical profiling of essential oil constituents using advanced analytical techniques such as GC–MS was not included, which may provide deeper insights into compositional changes due to 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 the most suitable method for achieving higher essential oil yield without adversely affecting the measured quality attributes under the conditions of the present study. Further studies are recommended to evaluated the effect of drying methods on the chemical composition and biological activities of clove basil essential oil.

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