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Comparative study on seasonal yield dynamics of leaves essential oil of *Vitex negundo* from Sangam area of Prayagraj

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Abstract

Vitex negundo (Nirgundi) is a significant medicinal shrub in Ayurveda, known for its diverse secondary metabolites. This study investigated the impact of seasonal changes on the essential oil yield of *V. negundo* leaves collected from Sangam Area (Swaraj Van Aral Ghat, Prayagraj). Over a two-year period (2023-2024), essential oil was extracted monthly using hydro-distillation via a Clevenger-type apparatus. The results indicate significant monthly fluctuations, with the highest oil yields recorded during the late autumn and early winter months (November and December). These findings suggest that harvesting time is a critical factor for maximizing the industrial and medicinal output of *V. negundo* essential oil.

Keywords: Essential oil, seasonal changes, *V. negundo*

Introduction

The genus *Vitex*, derived from the Latin *vieo* ("to tie or bind") in reference to its remarkably flexible stems, comprises approximately 270 species distributed across tropical and temperate regions. Among these, *Vitex negundo*—traditionally known as "Nirgundi" or the "five-leafed chaste tree"—holds a prestigious position in Ayurvedic medicine, cited across all major *Samhitas* as a "protector of the body." Established by Linnaeus in 1753 within the Verbenaceae family, this species is defined by its distinctive palmate leaves and a rich profile of over 120 bioactive compounds, including flavonoids, terpenoids, and phenols.

While *V. negundo* is utilized extensively in folk medicine across South and Southeast Asia for its anti-inflammatory and analgesic properties, its therapeutic efficacy is dictated by the concentration of its secondary metabolites. Specifically, the essential oil extracted at a modest yield of 0.05% from fresh leaves—contains vital constituents such as viridifloral and caryophyllene. Because the synthesis of these volatile oils fluctuates according to plant phenology and environmental conditions, this study aims to evaluate the monthly variation in essential oil yield. Identifying the optimal harvest window is essential for maximizing the medicinal and economic potential of *V. negundo* extracts.

Materials & Methods

Fresh leaves of *Vitex negundo* were sourced from a superior population at Swaraj Van Aral Ghat, Prayagraj (Location: 25°25'13.253" N, 81°52'47.081" E). To evaluate seasonal fluctuations in phytochemical yield, samples were collected at monthly intervals throughout the calendar years 2023 and 2024. Upon transport to the laboratory, the leaves were meticulously separated from the stalks, washed to remove impurities, and comminuted into small fragments. The isolation of the essential oil was performed via hydro-distillation using a Clevenger-type apparatus. 400 g of fresh leaf material was charged into a round-bottom flask containing 1500 ml of distilled water. The flask was seated in an appropriately sized heating mantle and coupled to the distillation assembly, consisting of a Clevenger apparatus and a condenser. To maintain an airtight system, all ground-glass joints were sealed with a thin layer of grease. The mixture was heated until boiling commenced, after which the temperature was strictly regulated to 90 °C to maintain a state of controlled distillation. Following the distillation period, the oil was separated from the hydrosol.

The aqueous layer was carefully discharged through the stopcock of the separating funnel until the meniscus reached the calibration mark, leaving the concentrated oil layer. This extract was subsequently dried over anhydrous sodium sulphate Na_2SO_4 to remove trace moisture. The purified oil was transferred into a pre-weighed vial, covered with punctured aluminum foil, and allowed to stabilize overnight. Final mass measurements were recorded using an electronic

analytical balance, where the net mass of the oil was determined by subtracting the weight of the empty vial from the total weight of the vial and oil. Colour and aroma of the oil samples were recorded by visual observations and smell. The percentage yield was calculated based on the fresh weight of the sample using the formula established by Tum *et al.* (2021) ^[4]: Yield of oil (%) = Weight of oil / weight of sample $\times 100$

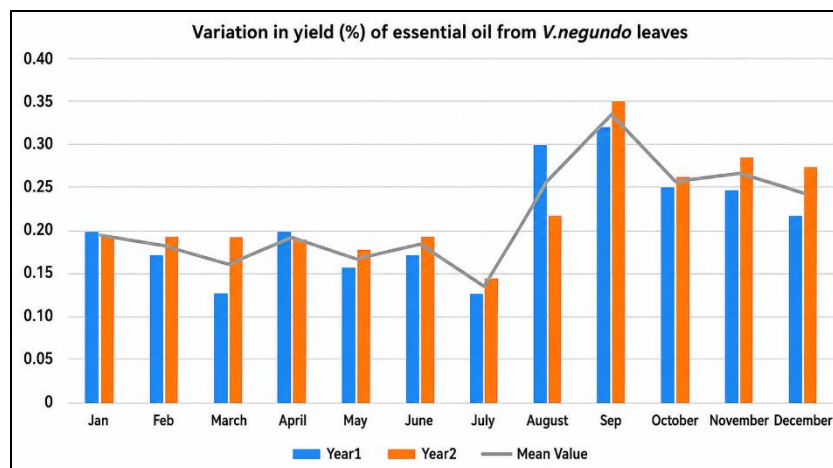


Fig 1: Variation in yield (%) of essential oil from *V. negundo* leaves

Results and Discussion

The data reveals a distinct seasonal trend in essential oil content of *V. negundo* leaves throughout the year (Fig 1). The highest oil content was observed in the month of September (0.34%) followed by a decreasing trend in the months of October to December with values of 0.25-0.27%. Further, Fig 1 indicates that the minimum amount of oil was found in the month of July (0.14%) followed by 0.17-0.20% in January to June in two consecutive years. The variations between both years can be attributed to annual fluctuations in rainfall and temperature. The low yields observed in months like July suggest that high humidity or heavy monsoon rainfall may dilute the concentration of volatile secondary metabolites or trigger different metabolic pathways in the plant (Rana and Dayal, 2003) ^[2].

While some literature suggests that harvesting between February and June (pre-monsoon) is economically viable for certain regions (Manika *et al.*, 2012) ^[1], our findings indicate that for the Prayagraj region, the post-monsoon to early winter window (specifically September) is the most favorable period for harvesting *V. negundo* leaves. This discrepancy highlights that oil yield is not a fixed trait but a dynamic response influenced by the interplay of location, soil composition, plant age, and specific microclimates (Sefidkon *et al.*, 2009) ^[3]. Consequently, timing the harvest to coincide with the September peak can significantly optimize the industrial and medicinal extraction of *V. negundo* essential oil. These extreme environmental parameters—specifically temperature, relative humidity, and photoperiod—are known to dictate the quantitative and qualitative profile of extracted oils. This is mirrored in other tree species; for instance, *Eucalyptus cinerea* has been shown to reach its peak oil content in September, while dropping to minimum levels in January.

Conclusion

The investigation confirms that the essential oil yield of *Vitex negundo* is highly dependent on the season of harvest. For the Prayagraj region, the late autumn to early winter

period (September–December) is the optimum time for harvesting leaves to ensure maximum essential oil recovery. Seasonal variations in essential oil content and composition are influenced by factors like temperature, rainfall, and the plant's developmental stage. Generally, higher oil yields and specific chemical compositions are observed during certain seasons, often the favourable winter season, while other seasons may yield lower quantities and different compositions. This data provides a valuable baseline for pharmaceutical industries and local farmers to schedule harvesting for peak efficiency.

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