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Compositional variation in the leaf, mace, kernel, and seed essential oil of nutmeg (*Myristica fragrans* Houtt.) from the Western Ghats, India

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SHORT COMMUNICATION

Compositional variation in the leaf, mace, kernel, and seed essential oil of nutmeg (*Myristica fragrans* Houtt.) from the Western Ghats, India

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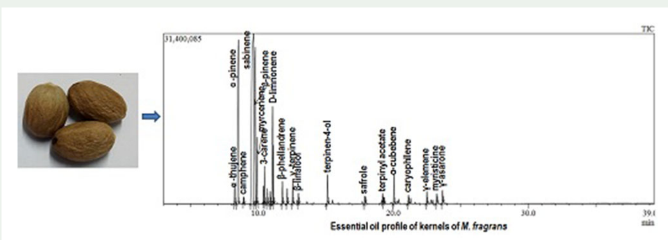
ABSTRACT

The essential oil (EO) from leaf, mace, kernel, and seed of *Myristica fragrans* Houtt. growing in the Western Ghats, India was investigated for the first time. The EO was extracted by hydrodistillation and analysed by GC-MS. The results revealed that yields of EO were 3.16%, 8.10%, 6.24%, and 5.21% for leaf, mace, kernel, and seed, respectively. The main fractions were found to be monoterpenes (53.77%–94.82%), phenylpropenes (1.96%–28.61%), and sesquiterpenes (1.21%–16.76%) and for all the four parts. The main constituents of leaf were sabinene (17.17%), eugenol (16.60%), myristicin (9.12%), caryophyllene (8.82%), and β-myrcene (4.74%). Sabinene (38.37%), α-pinene (8.16%), β-pinene (7.61%), D-limonene (7.07%), and 3-carene (5.05%) were predominant constituents of mace. The major constituents of kernel and seed were sabinene, α-pinene, β-pinene, and D-limonene. The major constituents of leaf, mace, kernel and seed of nutmeg can be utilised in the food, perfumery, aroma and pharmaceutical industries.



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1. Introduction

Nutmeg (*Myristica fragrans* Houtt.), family Myristicaceae is an evergreen tree indigenous to the Maluku Islands of Indonesia, is extensively distributed to Grenada, India, Mauritius, Sri Lanka, South Africa, and USA (Francis et al. 2019). In traditional Indian

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medicine, nutmeg has been used to treat indigestion, diarrhoea, parasites, plague, rheumatism paralysis, and other illness (Ziyatdinova et al. 2016). Several scientific reports say that nutmeg has potential antioxidant, antibacterial, antifungal, anti-inflammatory, antiulcerogenic, anticancer, aphrodisiac, and several other activities (Miyazawa et al. 1996a; Tajuddin et al., 2003; Gupta et al. 2013; Das et al. 2018; Hiranrat and Hiranrat 2019). The extraction methods for essential oil (EO) are hydrodistillation, steam distillation, supercritical fluid extraction, microwave, and ultrasound-assisted methods (Azwanida, 2015; Ashokkumar et al. 2020). Among these methods, hydrodistillation is most commonly used due to low-cost of Clevenger apparatus and solvent as water. The EO yield of nutmeg varied between 5% and 15% (Barceloux, 2009). *M. fragrans* EO has chiefly monoterpenes (sabinene, β-pinene, β-terpineol, p-menth-8-en-1-ol, and terpinen-4-ol), phynelypropene (eugenol, methyl eugenol, myristicin), sesquiterpenes (germacrene D, β-bergamotene) and other constituents (Miyazawa et al. 1996b; Atta-ur-Rahman et al. 2000; Dupuy et al. 2013; Francis et al. 2014). Several studies have been carried out on the EOs of the plant from various parts of the world (Atta-ur-Rahman et al. 2000; Ogunwande et al. 2003; Dupuy et al. 2013). As part of continuing interest and our knowledge, this study was the first report of EO compositions from leaf, mace, kernel, and the seed of nutmeg growing from Western Ghats, India. Therefore, this study aimed to assess the EO yield and its compositions from four different parts or tissues of *M. fragrans*.

2. Results and discussion

2.1. EO extraction

The present study four different parts of *M. fragrans* used for the determination of EO yield using hydrodistillation method. An average yield of three separate analyses was 3.16%, 8.10%, 6.24%, and 5.21% (vol/wt) in leaf, mace, kernel, and seed accordingly (Table S1). The oil yield of kernel (6.24%) was higher than the Nigeria grown nutmeg kernel (1.46%), (Ogunwande et al. 2003). However, seed oil yield (5.21%) was lower that grown in Brazil (Valente et al. 2014). The higher and lower level of oil content observed might be due to change in soil type, location, origin, extraction methods and environmental conditions (Ashokkumar et al. 2019).

2.2. GC-MS analysis

The obtained oils were analysed by GC-MS, which resulted in the identification of 33 total compounds, comprising 99.67%–99.97% of all the parts of *M. fragrans* (Supplementary Table S1). The leaf oil was characterised by high concentration of monoterpene hydrocarbons (48.16%) followed by oxygenated phenylpropenes (28.61%), oxygenated monoterpenes (21.65%) and sesquiterpene hydrocarbons (16.76%). The main monoterpenes were sabinene (17.17%), β-pinene (6.44%), D-limonene (5.03%) and β-myrcene (4.74%). In the phenylpropene group, represented primarily dominated by eugenol (16.60%) and myristicin (9.12%). The main sesquiterpene constituents of leaf oils were caryophyllene (8.82%) and germacrene D (2.95%). Mace EO had 24 constituents; of them, eleven were monoterpene hydrocarbons, which comprise 81.34% of total concentration. Among them, sabinene (38.37%) were predominant followed by α-pinene, β-pinene, β-myrcene, 3-carene, 4-carene, β-phellandrene, and D-limonene. Among the phenylpropene (12.43%), the major constituents were myristicin (5.90%), and safrole (3.90%). The EO profile of the leaf, mace, kernel and seed of *M. fragrans* and molecular structures of identified major constituents were presented in Supplementary Figures S1 and S2 (available online only), respectively.

Kernel (without shell) EO had 24 constituents; of them, twelve were monoterpene hydrocarbons, which comprised 89.41% of total concentration. Among them, sabinene, α-pinene, β-pinene, D-limonene, and β-myrcene and the corresponding concentration were 38.04%, 19.22%, 14.91%, 7.52%, and 3.37%. However the concentration was greater than previously reported 11.8% (sabinene) 4.9% (α-pinene), and 4.6% (β-pinene) in kernel oil (Atta-ur-Rahman et al. 2000). Moreover, other types of volatiles oxygenated monoterpenes, sesquiterpene hydrocarbons, oxygenated phenylpropenes and aromatic hydrocarbons were detected at 4.73%, 2.89%, 1.96%, and 0.72% respectively, of total concentration. In the case of the seed (with shell) oil, twenty-five chemical constituents identified of them, thirteen were monoterpene hydrocarbons and comprised 84.11% of total concentration. Among them, sabinene (27.65%), α-pinene (21.78%), β-pinene (18.23%), D-limonene (6.35%), and β-myrcene (2.91%) were predominant constituents. The earlier reported values of sabinene (25%) and D-limonene (6.30%) in seed oil corroborate our findings (Valente et al. 2014). Four phenylpropene constituents were identified, of them, γ-asarone (2.27%) were predominant followed by myristicin, methyl eugenol and safrol. Two sesquiterpene hydrocarbon constituent germacrene D (0.92%) and α-bergamotene (0.63%) were also identified, of these, α-bergamotene were accumulated only in the seed EO, which is not detected other parts of *M. fragrans*. Additionally, the present study gave wide variation in the chemical composition of EO constituents compared to earlier reports. The EO compositions differ according to local factors among them were growing condition, harvesting methods and time, oil extraction method, and storage conditions.

3. Conclusion

A comparative study of the EOs composition from leaf, mace, kernel, and seed of *M. fragrans* was carried out for the first time. The chemo-profiling of GC-MS analysis reveals that there were thirty-three phytochemical constituents that represent approximately 99.9% for all four EOs. Monoterpene concentration was predominant in EO of all the four parts. Sabinene, eugenol, caryophyllene and myristicin are major constituents of leaf EO, while mace oil sabinene and α-pinene were predominant. Both kernel and seed EOs were predominantly accumulated with sabinene, α-pinene, β-pinene, and D-limonene. The presence of these biologically active molecules as major constituents in the EO of four different parts of *M. fragrans* serves as a new potential source for monoterpenes, phenylpropene, and sesquiterpenes which can be used in food, aroma, and pharmaceutical applications.

Disclosure statement

No potential conflict of interest was reported by authors.

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