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Review Article


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# The essential oil constituents of *Artabotrys* species – A review

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## ABSTRACT

*Artabotrys* species which belongs to Annonaceae family are pleasant smelling and it is attributed to the presence of mono and sesquiterpenoids present in the essential oil of the plant. The objective of the present work is to review the chemical composition of the essential oils reported from twenty different *Artabotrys* species from various parts of the world. In the various *Artabotrys* species, the major compounds are monoterpene and sesquiterpene hydrocarbons and oxygenated sesquiterpenes. The frequently and most commonly identified constituents are β-caryophyllene, caryophyllene oxide, 3-Carene, cyperene, cyperenone and 1,5-epoxy-salvial4(14)-ene. Other constituents seems to be more specific to the respective *Artabotrys* species.

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## INTRODUCTION

Aromatic plants generally grown in subtropical and tropical countries possess essential oils. Various parts of these plants like barks, roots, rhizomes, seeds, buds, fruits flowers and leaves yield essential oils. Among the various methods available to obtain the essential oils like cold pressing, solvent extraction, hydrodistillation and supercritical fluid extraction, the preferable method is hydrodistillation [1]. Low molecular weight pleasant smelling aromatic and aliphatic compounds and terpenes/terpenoids are the major components of essential oils. Usually the essential oils will have two or three major compounds in relatively larger concentrations along with many minor compounds. The compounds present in larger amounts determine the biological activities of the essential oil [2].

The use of essential oils for medicinal treatment has reduced during the midway of the twentieth century when compared with their use in food and cosmetics industry, because of the coming up of synthetic medicinal compounds. However as a consequence of consumer's awareness about the toxic nature of the synthetic compounds, the demand for alternative and safe natural medicines has risen. As a result recently essential oils have gained more attention as a possible alternative and in the modern era they also finds their use in various products such as air fresheners, cosmetics, hygiene products, household cleaning products, food, and agriculture as well as in medical uses. Further they are used in aromapathey and in other para-medicinal practices. Essential oils possess various bioactivities like antimicrobial, anti-inflammatory, antioxidant, antiviral and ant carcinogenic. Consequently in an attempt to find alternative medicines, the pharmacological activities evaluation studies of the essential oils have become active in recent years [3].

*Artabotrys* species belongs to the Tropical Annonaceae family and comprises of about 105 species [4]. About 70% of the species are present in Asia and the remaining 30% of the species are found in Africa. Among the climbing climbers of Annonaceae family *Artabotrys* species are unique woody climbers. The uniqueness is due to the presence of special persistent flower hooks which helps them in climbing [5]. Leaves are simple and alternate, without hairs. The inflorescence often bear many flowers, but are single flowers in some species. To the best of our knowledge for 20 plants the composition of essential oils (Table 1) from the different parts of the plants have been investigated and reported in the literature. They are *A. hexapetalus*, *A. rupestris*, *A. ordratissimus*, *A. modestus*, *A. hongkongensis*, *A. vinhensis*, *A. lastoursvillensis*, *A. pallens*, *A. petelotii*, *A. intermedius*, *A. harmanddii*, *A. tayngyuyenensis*, *A. insignis*, *A. pierianus*, *A. rutus*, *A. thomsoni*, *A. jollyanus*, *A. oliganthus*, *A. velutinus* and *A. venustus*. Qualitative and Quantitative variations in chemical composition of the essential oils obtained from *Artabotrys* species cultivated in India and elsewhere. This may be ascribed to factors such as the age and nature of the plant, climatic conditions, and place of collection and handling procedures.

### Essenttial oils from *Artabotrys* species

*A. hexapetalus*, commonly known in India as manoranjini is a shrub and its flowers are yellow in colour and have renowned

**Table 1: List of *Artabotrys* species for which the composition of the essential oils were determined by GC-MS**

| Plant Name | Plant part/method of extraction | Place | Volatile Compounds identified | Ref |
|---|---|---|---|---|
| *A. hexapetalus* | Flower/simple headspace-solvent trapping technique | Thailand | Ethyl acetate (47.3%), isobutyl acetate (26.8%), ethyl isobutanoate (9.2%) and ethyl butanoate (9.7%) | [6] |
| | Flower/Hydrodistillation Thailand | Thailand | β-gurjunene (30.0%), β- caryophyllene (10.1%), and globulol (13.8%) | [6] |
| | Flower/solvent extraction | Thailand | Isopentyl acetate (12.6%), 3-methylbutanol (5.7%), limonene (5.7%), linalool (7.7%), benzene ethanol (5.3%), 2-methylbutanol (3.9%), ethyl butanoate (3.1%), 2-methylbutyl acetate (7.7%) | [6] |
| | Flower/solid-phase microextraction | Thailand | Isobutyl acetate (39.5%), Ethyl acetate (12.8%), ethyl isobutanoate (4.9%), ethyl 2-methyl butanoate (2.3%), ethyl isovalerate (11.3%), ethyl 3-methyl-2-butenoate (6.8%), isobutyl isovalerate (2.1%) and βcaryophyllene (5.4%) | [6] |
| *A. hexapetalus* | Flower/hydrodisttillation | Vietnam | Caryophyllene oxide (31.5%) and β-caryophyllene (11.4%) | [10] |
| *A. hexapetalus* | Stem bark/ Hydrodistillation | Tanzania | Elemene (5.57%, β-caryophyllene oxide (45.62%,), 1,3,3-trimethyl-2-(2-methylcyclopropyl)-cyclohexene (8.62%), 4à,8dimethyl-2-(1-methylethylidene)naphthalene (7.97%) | [11] |
| | Leaves/ Hydrodistillation | Tanzania | cadinol (10.89%), βcaryophyllene oxide 11hexadecynal (8.41%), | [11] |
| *A. hexapetalus* | Stem bark, | Vietnam | Caryophyllene oxide (36.2%), α-copaene (10.9%), β-caryophyllene (7.8%) and β-asarone (6.1%) | [12] |
| *A. rupestris* | Root/ Hydrodistillation | Tanzania | First two fractions:6-(p-tolyl)-2-methyl-2-heptanol (44.49% and 42.25%, respectively), 7,11,15-trimethyl-3-methylene-hexadeca1,6,10,14-tetraene (25.36%) Third fraction: (-)-spathulenol. (43.6%) 1-(1,5-dimethyl-4hexenyl)-4-methyl-benzene (22.11%) | [11] |
| *A. ordratissimus* | Leaves/ Hydrodistillation | Bangalore | 3-Carene (44.91%), β-caryophyllene (19.17%), αhumulene (8.78%), α-copaene (6.59%) and caryophyllene oxide (5.55%) | [13] |
| *A. ordratissimus* | Fruit & leaves/ Hydrodistillation | South India | β-caryophyllene (14.7 %,), trans nerolidol (8.2%, δ-cadinene (7.3%), α-copaene (6.4%), trans, trans-α-farnesene (5.8%), τ-cadinol (4.3%) and caryophyllene oxide (3.2%) | [14] |
| *A. ordratissimus* | Leaves/ Hydrodistillation | South India | β-caryophyllene (17.3%), trans nerolidol (1.9%), δ-cadinene (4.2%), α-copaene (9.3%), trans, trans-α-farnesene (7.4%), τ-cadinol (2.9% and caryophyllene oxide (6.8%) | [14] |
| *A. ordratissimus* | Leaves/ Hydrodistillation | India, Calicut | Terpinen-4-ol (38.6%), βCaryophyllene oxide (11.8%) Linalool (11.2%) (20.5% sesquiterpenes) | [15] |
| *A. modestus* | Stem bark/ Hydrodistillation | Tanzania | cadinol, cubenol, β-Caryophyllene oxide, (-) spathulenol and 7-methyl-4-methylene-1-(1methylethyl)-naphthalene. | [16] |
| *A. hongkongensis* | Leaves/ Hydrodistillation | Vietnam | Spathulenol (13.1%), cadinene (6.3%), β-caryophyllene (6.6%), δ -γ-elemene (6.3%) and benzyl benzoate (5.6%). | [17] |
| *A. vinhensis* | Leaves/ Hydrodistillation | Vietnam | Germacrene D (14.4%), α-pinene (16.7%), limonene (15.4%), benzyl benzoate (8.8%) and β-pinene (7.5%). | [18] |
| *A. lastoursvillensis* | Stem bark/Hydrodistillation | Gabon | Cyperene (25.9%), cyperenone (11.1%), caryophyllene oxide (6.7%), P-elemene (5.5%) and P-guaiene (5.0%), cadalene (5.6%) | [8] |
| *A. pallens* | Leaf/ Hydrodistillation | Vietnam | α-phellandrene (20.1%), α-gurjunene (21.9%) and bicycloelemene (9.6%), with significant proportions of α-pinene (5.2%), (E)-β-ocimene (4.4%) and isoledene (3.6%) | [19] |
| *Artabotrys petelotii* | Leaf/hydrodistillation | Vietnam | Elemol (19.4 %), cis-β-guaiene (9.2 %), δ-elemene (5.5 %) and δ-cadinene (8.4%) | [20] |
| | Stem bark/ hydrodistillation | | Elemol (32.7 %), δ-cadinene (11.9 %) and spathulenol (9.6 %) | [20] |
| *A. intermedius* | Leaf/ hydrodistillation | Vietnam | δ-3-carene (19.1 %), α-gurjunene (10.7 %) and α-zingiberene (6.3 %) | [20] |
| | Stem bark/ hydrodistillation | | δ-3-carene (29.9 %), germacrene D (15.1 %) and α-amorphene (8.0 %) | [20] |
| *A. harmanddii* | Leaf/ hydrodistillation | Vietnam | spathulenol (17.4 %), aromadendrene epoxide (12.2 %), γ-elemene (7.1 %) and isospathulenol (5.6 %) | [20] |
| *A. taynguyenensis* | Leaves/ hydrodistillation | Vietnam | valencene (40.1%) along with δ-selinene (8.8%), α-pinene (6.7%), α-muurolene (5.1%) and α-panasinsene (5.1%) | [21] |
| | Stem bark/ hydrodistillation | | bicycloelemene (25.1%), bicyclogermacrene (23.7%) and spathulenol (12.8%) | [21] |
| *A. insignis* | Root bark/ hydrodistillation | Zaire | Caryophyllene oxide (31.4%), 6-cadinol (10.7%), caryophyllenol (8.2%), 1 ,5-epoxy-salvial4(14)-ene (8.1%), camphene (9.4%), p-elemene (2.4%), cyperenone(4.4%) | [22] |
| | Stem bark/ hydrodistillation | Zaire | camphene(5.1%),1 ,5-epoxy-salvial4(14)-ene (27.3%), widdrol (7.5%), spathulenol (4.7%), 6-cadinol(4.3%),linalool (3.4%), cyperenone (3.2%) | [22] |
| *A. pierianus* | Stem bark/ hydrodistillation | Zaire | Cyperene (13.6%), caryophyllene oxide (9.4%), cadalene(6.4%), cyperenone (13.5%) | [22] |
| *A. rufus* | Root bark/ hydrodistillation | Zaire | a-copaen-1 1 -0l (6.3%), p-caryophy Ilene (20.5%), caryophyllene oxide (22.6%), 1 ,5-epoxy-salvial4(14)-ene (12.7%), caryophyllenol (5.2%) | [22] |
| *A. thomsoni* | Stem bark/ hydrodistillation | Zaire | Camphene (9.6%), cyperene (3.4%), palustrol (7.9%), spathulenol (6.9%), 1,5-epoxy-salvial4(14)-ene (12.1%), 6-cadinol (4.7%), cyperenone (7.7%) | [22] |
| *A. venustus* | Stem bark/ hydrodistillation | Malaysia | Camphene (10.1%), ledol (7.3%), 1 ,5-epoxy-salvial4(14)-ene (34.5%), β-caryophy Ilene (3.8%), caryophyllene oxide (3.9%) | [22] |

*(Contd...)*

**Table 1:** *(Continued)*

| Plant Name | Plant part/method of extraction | Place | Volatile Compounds identified | Ref |
|---|---|---|---|---|
| *A. jollyanus* | Leaves/ hydrodistillation | southern Côte d'Ivoire, Brazil | Trans-calamenene (15.7%), -copaene (14.8%), -cubebene (10.4%), cadina-3,5-diene (10.3%), (E)- caryophyllene (6.3%) and cadina-1,4-diene (6.1%). | [22] |
| *A. oliganthus* | Leaf/ hydrodistillation | Brazil | Δ-3-carene (60.2 %), myrcene (10.6 %), β-selinene (1.9 %). β-pinene (5.9 %), α-pinene (4.6 %) and γ-terpinene (4.6 3 %) | [23] |
| | Stem bark oil/ hydrodistillation | Brazil | Δ-3-carene (57.2 %), β-selinene (5.7 %), myrcene (2.8 %). β-pinene (7.7 %), α-pinene (6.1 %) and γ-terpinene (5.3 %) | [23] |
| | Fruit/ hydrodistillation | Brazil | Myrcene (59.2 %), Δ-3-carene: 16.3 %), β-farnesene (3.7 %) and β-selinene (2.2 %) | [23] |
| *A. velutinus* | leaves | Bonou | benzyl benzoate (61.2%) and E-β-caryophyllene (9.1%). | [9] |

**Table 2: Classification of *Artabotrys* species based on their major compounds**

| S. No. | Major compounds | Artabotrys species |
|---|---|---|
| 1 | β-caryophyllene and caryophyllene oxide | *A. hexapetalus* (Vietnam) flower<br>*A. hexapetalus* (Tanzania), stem bark, leaves<br>*A. ordratissimus* (South India), leaves & Fruits<br>*A. modestus* (Juma), stem bark |
| 2 | 6-(p-tolyl)-2-methyl-2-heptanol | *A. rupestris* (Tanzania), root |
| 3 | (-)-spathulenol | *A. rupestris* (Tanzania), root<br>*A. hongkongensis* (Vietnam),<br>*A.harmanddii* (Vietnam), leaves & stem bark<br>*A. taynguyenensis* root & stem bark |
| 4 | 3-Carene | *A. ordratissimus* (India-Bangalore), leaves<br>*A.intermedius*(Vietnam), leaf and stem bark<br>*A. oliganthus* (Brazil), leaves,stem bark, fruit |
| 5 | Terpinen-4-ol | *A. ordratissimus* (India-Calicut), leaves |
| 6 | cyperene and cyperenone | *A. lastoursvillensis* (Gabon)<br>*A. insignis* (Zaire), root, stem bark<br>*A. pierianus* (Zire), stem bark<br>*A. thomsoni* (Zaire), root, stem bark |
| 7 | α-gurjunene | *A. hexapetalus*(Thailand)<br>*A. pallens* (Vietnam),leaves |
| 8 | elemol | *A. petelotii* (Vietnam), leaf |
| 9 | trans-calamenene | *A. jollyanus* (Brazil) leaves |
| 10 | benzyl benzoate | *A. velutinus* (Bonou) leaves |
| 11 | α -pinene | *A. vinhensis* |
| 12 | 1 ,5-epoxy-salvial4(14)-ene | *A. rufus* (Zaire), root bark<br>*A. venustus* (Malaysia) stem bark<br>*A. thomsoni*<br>*A. insignis* (Zaire), root, stem bark |

exotic fragrance. In the beginning the flowers are green in colour and on ageing it turns yellow and are long lasting with pleasant fruity smell. When young it is a shrub and after attaining a height of 2 meters it turns into a climber. Flowers and the essential oil possess antifungal activity and are used in the perfume industry, for preparing tea like beverage, in aromapathy and even it is used as a substitute for Ylang Ylang oil.

The essential oil was extracted from the flowers, leaves and stem bark of A. *hexapetalus* from countries like Thailand, Vietnam and Tanzania. The volatile constituents are dominated by sesquiterpene hydrocarbons and oxygenated sesquiterpenoids and mainly consists of β-caryophyllene oxide and or β-caryophyllene.as the common constituent. An attempt was made to match the odour of the flowers from A. *hexapetalus* [6] from Thailand for which they extracted the volatile constituents by four different methods. Seventeen components were obtained from Simple headspace-solvent trapping technique and they are dominated by ethyl and isobutyl esters, 47.3% ethyl acetate, 9.2% ethyl isobutanoate, 26.8 % isobutyl acetate and 9.7 % ethyl butanoate. By hydrodistillation method thirty one components were identified of which β-caryophyllene, β-gurjunene and globulol (10.1, 30.0 and 13.8% respectively) are the major compounds. By solvent extraction method thirty one components were identified comprising of benzene ethanol (5.3%), limonene (5.7%), linalool (7.7%), 3-methylbutanol (5.7%), isopentyl acetate (12.6%) and 2-methylbutyl acetate (7.7%),) are the major compounds. By solid phase micro extraction method, thirty-nine components were identified with a chemical composition of 12.8% Ethyl acetate, 4.9% ethyl isobutanoate, 39.5% isobutyl acetate, 2.3 % ethyl 2-methyl butanoate, 11.3% ethyl isovalerate, 6.8% of ethyl 3-methyl-2-butenoate, 2.1 % isobutyl isovalerate and 5.4% βcaryophyllene (5.4%). The odour of the solution from this technique was similar to that of the fresh flower.

A. *odoratissimus* is also a large woody climber originated in India, Philippines, South China and Burma (Myanmar). Its flowers are either solitary, or in clusters of two or three, axillary and turns greenish yellow in color on ageing. Its name in Bengali is 'Kanthali champa' (jackfruit-champa) since it gives a strong smell resembling that of ripened jackfruit. The flowers are available throughout the year. Because of its huge size it is not suitable for small gardens. It is used as an anti-depressant, mood elevator, hypotensive and as a hair vitalizer. The oil is also extensively used in deodorants, perfumes, shampoos, beauty soaps, hair and skin lotions and creams, hair oils etc., in blends or alone. Essential oil constituents were reported from the leaves and fruits of A. *odoratissimus* from three different locations Tamilnadu, Calicut and Bangalore in India. The major compounds identified are 3-Carene (44.91%), β-caryophyllene (17.3%) and Terpinen-4-ol (38.6%) from the essential oils from Tamilnadu, Calicut and Bangalore respectively. β-caryophyllene and caryophyllene oxide are the two other common compounds present from these three essential oils.

A. *rupestris* from Tanzania was collected and three different fractions of the essential oil was obtained at interval of 50 min using hydrodistillation method. In the first two fractions 6-(p-tolyl)-2methyl-2-heptanol was the major component (44.49% and 42.25%, respectively) and in the third fraction spathulenol (43.60%) was the major compound. It also contains a high amount of alcoholic and unsaturated sesquiterpenes. Essential oil from an endemic species A. *modestus*, from Tanzania consists of cadinol, β - Caryophyllene oxide, cubenol, 7-methyl-4-methylene-1-(1methylethyl)-naphthalene, (-)spathulenol and it was commercially exploited for its mosquito repellence activity. Spathulenol (13.1%), δ-cadinene (6.3%), benzyl benzoate (5.6%), β-caryophyllene (6.6%) and α-elemene (6.3%) were reported from A. *hongkongensis*. Germacrene D (14.4%), α-pinene (16.7%), limonene (15.4%), benzyl benzoate (8.8%) and β-pinene (7.5%) were found to be richer in the oil of A. *vinhensis*. The essential oil from the leaves of Ivoirian A. *jollyanus* consists largely of sesquiterpene hydrocarbons like trans-calamenene, copaene, cubebene and 7-hydroxycalamenene. When the composition of the essential oil was analysed during its phonological cycle, the same sesquiterpenes remains as the dominant compounds but the quantity of the component varies. Another Ivoirian species A. *oliganthus* differs from the essential oil from the leaves of A. *jollyanus* by dominating in monoterpenes like 3-carene, 60.2% and myrcene, 10.6% [7]. In turn, these two oils vary considerably from the oils obtained from the bark of Gabonese A. *lastourvillensis* Pell consisting of cyperene, 25.9% and cyperenone, 11.1% as the major compounds [8] and Beninese A. *velutinus*. [9] which is richer in aromatic components (62.6%) and sesquiterpene hydrocarbons (29.9%). It consists of 30 compounds representing 98.9% of the oil and the major components are benzyl benzoate (61.2%) and E-β-caryophyllene (9.1%).

The oil of A. *pallens* comprised of 39.8% monoterpenes and 58.0% sesquiterpenoid compounds with significant proportions of α-phellandrene (20.1%), α-gurjunene (21.9%), bicycloelemene (9.6%), α-pinene (5.2%), (*E* )-β-ocimene (4.4%) and isoledene (3.6%). The oils of A. *intermedius* and A. *oliganthus* are similar with respect to having a high content of δ-3-carene (19.1-29.9% and 57.2-60.2% respectively) but differ due to its low content of myrcene (0.7 -0.8% and 15.7-59.2% respectively). One of the chemotypes of A. *ordratissimus* also consists of 3-carene (44.91%), as the major compound. From A. *harmandii* forty-one compounds comprising of seven monoterpene hydrocarbons (6.5%), five oxygenated monoterpenes (2.8 %), nineteen sesquiterpene hydrocarbons (35.8 %), nine oxygenated sesquiterpenes (44.1%) and a non-terpene (3.6%) was reported in the leaf oil. The major compounds are aromadendrene epoxide (12.2%), spathulenol (17.4%), γ-elemene (7.1%) and isospathulenol (5.6%).

### Classification of Essential Oils

Based on the above data the following chemical patterns of essential oils from *Artabotrys* oils may be arrived at.

1. Oils mainly with sesquiterpenes,
2. Oil dominated by monoterpenes
3. Oils consisting mainly of monoterpenes and sesquiterpenes.
4. Oils with 1,5-epoxysalvial-4-(14)-ene as the main compound.
5. Oils with cyperene and cyperenone as the main compounds

Oils dominated by sesquiterpenes are from A. *hexapetalus*, A. *odoratissimus*, A. *lastoursvillensi*, A. *insignis*, A. *pierreanus*, A. *rufus*, A. *thomsoni*, A. *venustus*, A. *hongkongensis*, leaf and stem oils of A. *petelotti* and leaf oil of A. *harmandii* .

Oils rich in both monoterpenes and sesquiterpenes are from A. *vinhensis*, the leaf and stem oils of A. *intermedius*. Oils consisting of 1,5-epoxysalvial-4-(14)-ene is in a significant amount are from A. *pierianus*, A. *thomsoni*, and A. *venustus*. Oils with considerable quantity of cyperene and cyperenone are from the bark oil of A. *lastourvillensis* from Gabon (cyperene (25.9%) and cyperenone (11.1%) and leaf and stem bark oils from A. *insignis*, A.*rtabotrys pierianus*, A. *thomsoni*, and A. *venustus*.

The chemical patterns of both the leaf and stem oils of A. *petelotti* are similar to first chemical class with a dominance of sesquiterpene compounds. Also, could be classified into the third class due to the abundance of mono- and sesquiterpene as the major compounds. The leaf oil of A. *tayngyyenensis* Ban was richer the sesquiterpenoid valencene (40.1%) along with α-pinene (6.7%), δ-selinene (8.8%), α-panasinsene (5.1%) and α-muurolene (5.1%). However, bicycloelemene (25.1%), spathulenol (12.8%) and bicyclogermacrene (23.7%) are the principal compounds in the stem oil. Further based on the presence of the major compound responsible for the activity of *Artabotrys* species can be classified as in table-2. If sufficient number of data are available then it can be narrowed down.

## CONCLUSIONS

We have presented an overview of all the published reports on the chemical composition of the essential oils from twenty different *Artabotrys* species. The essential oils from *Artabotrys* species have been extensively studied during the last decades, because they are richer in chemical compounds of interest in the perfume and food industries. We have restricted to the main constituents identified in the oils. The study will be useful to the fragrance, cosmetics and food industry to monitor quality and consumer safety by developing species biomarkers. In addition traceability, adulterations of drugs and foods and other quality control aspects could be better addressed by using the present work.

## AUTHOR'S CONTRIBUTIONS

Both the authors contributed equally in collecting the data, validating and in preparing the manuscript. The first author SR also participated in the review of the manuscript.

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