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# Medicinal properties, phytochemistry, and pharmacology of Myristicaceae family: A review

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**ABSTRACT**

The Myristicaceae family has 500 species, divided into 3 genera: *Myristica*, *Knema*, and *Horsfieldia*. These species are distributed across tropical Asia, Africa, and America. This plant has active ingredients, including polyketides and lignans, which have a range of biological properties such as anti-inflammatory, anti-cancer, and anti-microbial. This review aims to examine the variety of biological activities and chemical structures of the bioactive chemicals present in the Myristicaceae family from across the globe.

## INTRODUCTION

The Myristicaceae family, also known as Magnoliophyta, is a group of pantropical plants that share traits such as having two homes, trees, axis flowers, meat or hard fruit, red seeds, fragrant leaves, and typically a substance called myristicin. Easily found in tropical Asia, the Pacific Islands, Africa, and tropical America, the Myristicaceae family has 21 genera and 520 species [1]. "Nutmeg" plants are members of the Myristicaceae family, divided into 3 primary genera and 11 species by Chinese taxonomists [2]. The Island of Java is home to roughly 210 species of Myristicaceae, including 100 *Myristica* species, 70 Horsfieldia species, and 40 *Knema* species [3,4].

The fruits, leaves, bark, and stems of the Myriticaceae family can all be employed in traditional medicine [5]. Conversely, the fruit is frequently added to dishes as a flavouring [6].

Below is the taxonomy of the Myristicaceae family

| | |
|---|---|
| Kingdom | : Plantae |
| Division | : Magnoliophyta |
| Class | : Maginoliospida |
| Order | : Magnoliales |
| Family | : Myristicaceae |
| Genus | : *Myristica*/*Knema*/*Horsfieldia* |

## METHODOLOGY

This review cites over 100 published works over the last 25 years. Medicinal Plants Research, Food Chemistry, Natural Product Community, Biodiversity Journal of Biological Diversity, Journal of Medicinal Plants Research, Food Chemistry Toxicology, Phytomedicine, Phytochemistry, Phytochemistry Letters, and so on, were among the online sources and electronic databases from which the articles were sourced. To locate pertinent publications, online databases such as Scopus, Pubmed, and so on, were searched using terms such as Myristicaceae, *Myristica*, *Horsfieldia, and Knema*. The writers made an effort to incorporate in Table 1. All publications

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**Table 1.** Previously published review articles focusing on *Myristica, Horsfieldia, Knema* genus, and their main theme of research.

| Main theme of the review | References |
|---|---|
| Analysis of the alkyl and alkenyl phenol compounds from *Knema austrosiamensis* and *Knema laurina* as identified by gas chromatography-methylthiomethylation mass spectrometry [7]. | Gonzalez *et al.* [7] |
| Three different species of *Horsfieldia*, namely *Horsfieldia fulva* Warb, *Horsfieldia sucosa* Warb, and *Horsfieldia superba* Warb, were identified, and their chemical makeup was determined in Malaysia. Their gas chromatography-mass spectrometry and gas chromatography-flame ionization detector characteristics were noted [8]. | Salleh *et al.* [8] |
| Based on grouping patterns on the dendrogram of pollen morphological features, phenetic kinship of the genera *Knema*, *Horsfieldia*, and *Myristica* in Java [3]. | Arrijani [3] |
| The biology and conservation of the *Myristica* genus in Indonesia humans can utilize any plant species as food components, traditional medicinal substances, or as producers of essential oils, which are used as raw materials in soap, cosmetics, and other industries. Fruit, seeds, bark, leaves, and arillus (mace) are the sources of the essential oil [5]. | Arrijani [5] |
| Widely utilized in cuisine, wild nutmeg (*Myristica fragrans* and *Myristica argentea*) offers a novel source of antioxidants [9]. | Calliste *et al.* [9] |
| *Myristica* fruit extracts (*Myristica beddomeii*, *M. fragrans*, *Myristica fatua*, and *Myristica malabarica*) were used to quantify the bioactive components and their *in vitro* antiproliferative activity using the liquid chromatography-mass spectroscopy technique [6]. | Pandey *et al.* [6] |
| Examining the body of research from 1978 to 2016 on the phytochemical composition and biological activity of the genus *Knema* (Myristicaceae), as well as the isolation, structural diversity, bioactivity, and structural explanation of secondary metabolites [10]. | Salleh and Ahmad [10] |

in which the material was pertinent. Only cytotoxic, antioxidant, antibacterial, anti-inflammatory, and antidiabetic properties are included in this review.

## MEDICINAL PROPERTIES

Native populations in tropical and subtropical nations have utilized plants in the Myristicaceae family as medicinal [5,6]. Table 2 lists the therapeutic applications of the Myristicaceae family in indigenous peoples' traditional medicine in tropical and subtropical regions. Myristicaceae plants are recognized to possess antibacterial, antioxidant, anti-inflammatory, and anti-cancer effects in their seeds and fruits, similar antioxidant and anti-cancer properties are also present in the leaves of various Myristicaceae plants. For instance, A-357, MCF-7, vero, and colon cancer cell lines are all subject to mild cytotoxic activity from *M. fragrans* [11–13]. This further demonstrates anti-inflammatory properties and a potent inhibitory effect on the RAW264.7 cell line's ability to produce nitric oxide [14–16]. Specific *Myristica fatua* plant components are considered to lower obesity and are used to treat diabetes [17–19]. Myristicaceae plants are also used for oral care [20], reducing skin allergies [21], cockroach control [22], and food preservatives [23,24] . According to these applications, these plants could have antibacterial-containing chemicals.

## PHYTOCHEMISTRY

Regarding investigations into the components of Myristicaceae's secondary metabolites, polyketides **1–72**, lignans **73–172**, terpenoids **173–206**, flavonoids **206–270**, chalcones, quinones, and alkaloids **271–292** were isolated.

### Polyketides

A polyketide, known as beta-polyketone, is a secondary metabolite molecule with alternating carbonyl and methylene groups. Table 3 and Figure 1 present the 72 compound isolated cyclic polyketides that were reported from the Myristicaceae family, within *Myristica* genus **1–16, 18, 19, 21, 22–24, 42–46, 51,** and **60–63** compounds contained in the seeds of *Myristica dactyloide* from Sri Lanka [25], the fruits of *Myristica maingayi* [26] and *Myristica gigantea* [27] from Malaysia, the stem bark and seeds of *Myristica malabarica* from India [28], the leaves and fruits of *Myristica crassa* from Malaysia [29], the bark of *maxima maxima* from Malaysia [30], the barks and seeds of *Myristica cinnamomea* from Malaysia [31], the seeds of *Myristica beddomei* from India [32], the leaves and barks of *M. fatua* from India and Indonesia [17,33], the leaves of *Myristica philippensis* from the Philippines [34], and all parts of *M. fragrans* from China, Korea, Africa, India, Indonesia, Malaysia, Korea, and Japan [16,35].

The *Horsfiedia* genus compounds **17, 20, 21, 25–27, 30-33, 40, 41, 47–50, 52, 53, 56–59,** and **64–70**, contained in all parts of *Horsfieldia macrobotrys* from Indonesia [36], the leaves *Horsfieldia spicata* from Indonesia [37], the leaves and twigs *Horsfieldia kingie* from Thailand and China [38,39], all parts of *Horsfieldia irya* from Thailand [40,41], the barks *Horsfieldia superba* from Malaysia [42], the barks *Horsfieldia pandurifolia* from China [43], and all parts of *Horsfieldia tetratepala* from China [44].

In the *Knema* genus **1**, **24–27, 32–37, 43, 52, 53, 62, 69,** and **70** compounds contained in leaves and stem bark *Knema glauca* from Malaysia [45], the twigs *Knema furfuracea* from China [46], the leaves and twigs *Knema elegans* from China [47], the roots *Knema globularia* from Thailand [48], the stem bark *Knema hookeriana* from Indonesia [49], and the leaves *Knema stellate from Philippines* [34].

### Lignans

Myristicaceae plants are rich in lignan and lignan-derived chemicals. Lignans are a comprehensive class of phenolic compounds defined by two C6–C3 units joined by a bond between the 8 and 8′ or β - β′ positions. The Myristcaceae family has 99 different types of lignan chemicals.(Table 4 and Fig. 2). The *Horsfieldia* genus contains the compounds **73–76, 108, 109, 126–129**, and **167–169** found in the seeds of *Horsfieldia iryaghedhi* from Sri Lanka [40,50], the leaves and twigs of *Horsfieldia glabra* from China [50,51], the leaves and twigs of *H.*

**Table 2.** Medicinal uses and some origins of the Myristicaceae family.

| Species | Part | Medicinal use | Country or region |
|---|---|---|---|
| *Myristica fragrans* | Whole | Cytotoxic [11–13], Anti-inflammatory [14–16], Antibacterial [20–22, 52] , Antioxidant [23,53] | China, Korea, Africa, India, Indonesia, Malaysia, Korea, and Japan |
| *Myristica maxima* | Stem bark | Cytotoxic, Antioxidant [30] | Malaysia |
| *Myristica argentea* | Seed, Stem bark | Antioxidant [9], Antibacterial [54] | Papua and India |
| *Myristica maingayi* | Fruits | Cytotoxic [26] | Malaysia |
| *Myristica gigantea* | Fruits | Cytotoxic [27] | Malaysia |
| *Myristica malabarica* | Stem bark<br>Seed | Cytotoxic [55], Antibacterial [28], Antioxidant [56] | India |
| *Myristica cinnamomea* | Seed | Cytotoxic, Antibacterial, Anti-inflammatory [57], Antidiabetic [58] | Malaysia and Colombia |
| *Myristica fatua* Houtt | Leaves<br>Stem bark | Cytotoxic [33,59–61], Antidiabetic [17,18], Antibacterial [23,52,62], Antioxidant [23,52,62] | India and Indonesia |
| *Myristica iners* | Stem bark | Antioxidant [63] | Indonesia |
| *Myristica monodora* | Seed | Antibacterial, Antioxidant [24] | Africa |
| *Myristica andamanica* | Leaves | Anti-inflammatory [64] | India |
| Knema *globularia* | Roots<br>Stem bark | Cytotoxic [48,65,66] | Thailand |
| *Knema pachycarpa* | Fruits | Cytotoxic [67,68] | Vietnam |
| *Knema furfuracea* | Twigs<br>Stem bark<br>Leaves | Cytotoxic [69], Anti-inflammatory [46], Antioxidant [70] | China, Indonesia and Thailand |
| *Knema laurina* | Stem bark | Antioxidant [70] | Indonesia and Europa |
| *Knema attenuate* | Stem bark<br>leaves | Antibacterial [71]<br>Antioxidant [72] | India |
| *Knema elegans* | Leaves twigs<br>Stem bark | Cytotoxic [73]<br>Antidiabetic, Antioxidant [74] | China<br>Myanmar Vienam |
| *Knema glauca* | Leaves<br>Stem bark | Antidiabetic [45,75]<br>Antibacterial [45] | Malaysia |
| *Knema kunstleri* | Stem bark | Anti-inflammatory [76] | Philipines |
| *Horsfieldia glabra* | Whole | Cytotoxic [51,77] | China |
| *Horsfieldia pandurifolia* | Stem bark | Cytotoxic [43] | China |
| *Horsfieldia tetratepala* | Whole | Cytotoxic [44,78,79] | China |
| *Horsfieldia superba* | Stem bark | Cytotoxic [8,42] | Malaysia |
| *Horsfieldia irya* | Whole | Cytotoxic [40], Antioxidant [70] | Thailand |
| *Horsfieldia kingii* | Leaves<br>Twigs | Anti-inflammatory [38] | Thailand |
| *Horsfieldia amygdalina* | Fruits | Anti-inflammatory [80] | Japan |
| *Horsfieldia macrobotrys* | Whole | Antidiabetic, Antioxidant [81] | Indonesia |
| *Horsfieldia moetleyi* | Fruits | Antidiabetic, Antioxidant [82] | Thailand |
| *Horsfieldia helwigii* | Whole | Antibacterial [83] | Indonesia |
| *Horsfieldia spicata* | Leaves | Antibacterial [84]<br>Antioxidant [70,84] | Indonesia |

*kingii* from Malaysia [38], and the twigs of *H. tetratepala* from China [85]. The compounds of *Myristica* genus **77–88, 90–107, 110, 111, 132-147,** and **151–166** contained in the *leaves and barks M. fatua from Indonesia* [59]*, all parts of M. fragrans from China*, Korea, Africa, India, Indonesia, Malaysia, Korea, and Japan [13,15,19,20,86–88], the barks *M. argentea from Indonesia* [9,54]*, the stem barks Myristica dactyloides from Srilanka* [89,90]*, the seeds Myristica otoba* from Malaysia [91], and the seeds *Myristica schefferi* from Indonesia [92]. The compounds of *Knema* genus **75, 76, 89, 92–94, 108, 112–125, 130–131, 148–150,** and **170–172** are contained in roots *K. globularia* from Thailand [48,65,66], the fruits *Knema pachycarpa* from Vietnam

**Table 3.** Polyketides isolated from Myristicaceae.

| Name of polyketides | Species |
|---|---|
| Malabaricones A **1** | *Myristica dactyloide* [25], *M. maingayi* [26], *M. gigantean* [27], *M. malabarica* [28], *M. crassa* [29], *K. glauca* [45], *M. maxima* [30], *M. cinnamomea* [31] *Myristica fatua* [17], *M. beddomei* [32] |
| Malabaricones B **2** | *Myristica dactyloide* [25], *M. maingayi* [26], *M. gigantea* [27], *M. malabarica* [28], *M. crassa* [29], *M. philippensis* [93], *M. maxima* [30], *M. cinnamomea* [31], *M. fatua* [17,33], *M. beddomei* [32] |
| Malabaricones C **3** | *Myristica fatua* [17,33], *M. philippensis* [93], *M. maxima* [30], *M. dactyloide* [25], *M. maingayi* [26,27], *M. gigantea* [31], *M. cinnamomea* [94], *M. malabarica* [28], *M. beddomei* [32], *M. fragrans* [16], *M. crassa* [29], |
| Malabaricones D **4** | *Myristica dactyloide* [25], *M. malabarica* [28], *M. beddomei* [32] |
| Malabaricones E **5** | *Myristica cinnamomea* [31] |
| Promalabaricones B **6** | *Myristica maingayi* [26], *M. crassa* [29], *M. beddomei* [32], |
| Prepromalabaricone B **7** | *Myristica gigantea* [27] |
| Promalabaricones C **8** | *Myristica maingayi* [26], *M. crassa* [29] |
| Giganteone A **9** | *Myristica gigantean* [26], *M. crassa* [29], *M. maxima* [30] |
| Giganteone B **10** | *Myristica gigantea* [27] |
| Giganteone C **11** | *Myristica crassa* [29], *M. maxima* [30] |
| Giganteone D **12** | *Myristica cinnamomea* [58] |
| Giganteone E **13** | *Myristica maxima* [30] |
| Maingayones A **14** | *Myristica maingayi* [26], *M. gigantea* [27], *M. maxima* [30], *M. cinnamomea* [31] |
| Maingayones B **15** | *Myristica crassa* [29], *M. maxima* [30], *M. cinnamomea* |
| Maingayones C **16** | *Myristica crassa* [29] |
| Maingayones D **17** | *Horsfieldia macrobotry* [81] |
| Maingayat Acid B **18** | *Myristica maingayi* [27], *M. maxima* [30], *M. cinnamomea* [31] |
| Maingayi Acid C **19** | *Myristica cinnamomea* [26] |
| Myristicyclins A **20** | *Horsfieldia spicata* [37], |
| Myristicyclins B **21** | *Horsfieldia spicata* [37], |
| Cinnamomeone A **22** | *Myristica cinnamomea* [58], |
| Trimyristin **23** | *Myristica beddomei* [32], |
| Partensein **24** | *Myristica beddomei* [32], |
| Virolanol B **25** | *Horsfieldia kingii* [38] |
| Virolanol C **26** | *Horsfieldia pandurifolia* [43], *Horsfieldia kingii* [38], *K. furfuracea* [46] |
| Virolane **27** | *Horsfieldia glabra* [51], *H. kingii* [38], *K. elegans* [47] |
| Kneglobularic A Acid **28** | *Knema globularia* [48] |
| Kneglobularic B Acid **29** | *Knema globularia* [48] |
| Horsfielenide C **30** | *Horsfieldia kingii* [38,39] |
| Horsfielenide D **31** | *Horsfieldia kingii* [38,39] |
| Horsfielenide E **32** | *Horsfieldia kingii* [38,39] |
| Horsfielenidine A **33** | *Horsfieldia kingii* [38] |
| Khookerianone A **34** | *Knema hookeriana* [49] |
| Khookerianone B **35** | *Knema hookeriana* [49] |
| Khookerianone C **36** | *Knema hookeriana* [49] |
| Khookerianic acid A **37** | *Knema hookeriana* [49] |
| Khookerianic acid B **38** | *Knema hookeriana* [49] |
| Khookerianic acid C **39** | *Knema hookeriana* [49] |
| Horsfieldones A **40** | *Horsfieldia macrobotrys* [81], *H. kingii* [95] |
| Horsfieldones B **41** | *Horsfieldia kingii* [95] |

***Continued***

| Name of polyketides | Species |
|---|---|
| 1-(2,6-dihydroxyphenyl)9-(4-hydroxy-3-methoxyphenyl)nonan-1-on **42** | *Myristica dactyloides* [25] |
| 1-(2-methoxy-6- hydroxyphenyl)tetradecan-1-on **43** | *Myristica dactyloides* [96] |
| 1-(2-methoxy-6-hydroxyphenyl)-9-(3′,4′-methylenedioxyphenyl)-nonan-1-on **44** | *Myristica dactyloides* [96] |
| 1- (2,6-dihydroxyphenyl) tetradecan-1-on **45** | *Myristica dactyloides* [96], *K. glauca* [45] |
| 1-(2-methoxy-6-hydroxyphenyl)-9-(4′-hydroxyphenyl)-nonan-1-on **46** | *Myristica dactyloides* [96] |
| 5,7-dihydroxy-2-n-nonylchromen-4-on **47** | *Horsfieldia iryaghedhi* [40,41] |
| 5,7-Dihydroxy-2-(6-phenylhexyl)-chromen-4-on **48** | *Horsfieldia iryaghedhi* [41] |
| 8-Hydroxy-2-n-nonyl-5,6,7,8-tetrahydrochromone **49** | *Horsfieldia iryaghedhi* [41] |
| 8-Hydroxy-2-(60-phenylhexyl)-5,6,7,8-tetrahydrochromone **50** | *Horsfieldia iryaghedhi* [41] |
| 2-dodecylcyclobutanon **51** | *Myristica fragrans* [35] |
| 5,6-dihydro-6-undecyl-2H-pyran-2-on **52** | *Horsfieldia superba* [42] |
| 5,6-dihydro-6-tridecyl-2H-pyran-2-on **53** | *Horsfieldia superba* [42] |
| 2-[(Z)-heptadec-8-enyl]-6-hydroxybenzoic acid **54** | *Knema stellate* [34] |
| 2-[(Z)-pentadec-8-enyl]-6-hydroxybenzoic acid **55** | *Knema stellate* [34] |
| 1-(2′ -hydroxy-4′ -methoxyphenyl)-3-(3″, 4″-methylenedioxyphenyl)-propan-2-ol **56** | *Horsfieldia pandurifolia* [43], *H. kingii* [38] |
| Methyl 3,4-dihydroxybenzoat **57** | *Myristica fatua* [18] |
| 1-(2′,4′-dihydroxy-3′,5′-dimethylphenyl)-3-(2″-methoxy4″,5″-methylenedioxyphenyl)-propan **58** | *Horsfieldia tetratepala* [44] |
| 1-(2′ ,4′ -dihdyroxyphenyl)-3-(3″,4″-methylenedioxyphenyl)-propan **59** | *Horsfieldia tetratepala* [44] |
| 1-3-tridecanoybenzoic acid **60** | *Myristica fatua* [17] |
| 1-(2-hydroxy-6-methoxyphenyl)tetradecan-1-one **61** | *Myristica fatua* [17] |
| 1-(2,6-dihydroxyphenyl) tetradecan-1- one **62** | *Myristica fatua* [17] |
| 1-(2-hydroxy-6-methoxyphenyl)-9-(4- hydroxyphenyl)nonan-1-one **63** | *Myristica fatua* [17] |
| 1-(2″-hydroxy-4′ -methoxyphenyl)- 3-(4″-hydroxy-3″-methoxyphenyl)-propan **64** | *Horsfieldia tetratepala* [78], *K. elegans* [47] |
| 4-(3-(4-hydroxy-3-methoxyphenyl)propyl)benzene-1,3-diol **65** | *Horsfieldia kingii* [39] |
| 1,3-di(4-hydroxyphenyl)-propan **66** | *Horsfieldia kingii* [39] |
| 1-(4-hydroxy-2- methoxyphenyl)-3-(4-hydroxy-3-methoxyphenyl)-propan **67** | *Horsfieldia kingii* [39] |
| 1,3-bis(4-methoxyphenyl)propane **68** | *Horsfieldia kingii* [39] |
| Phlorodecanophenon **69** | *Horsfieldia iryaghedhi* [40] |
| Phlorododecanophenon **70** | *Horsfieldia iryaghedhi* [40] |
| 1-(2′ -hydroxy-4′ -methoxyphenyl)-3-(3″ ,4″ -methylenedioxy phenyl)-propan-2-ol Virolanol **71** | *Knema furfuracea* [46] |
| 1-(2′ -hydroxy-4′ - methoxyphenyl)-3-(4″ -hydroxy-3′′ -methoxyphenyl) –propan **72** | *Knema furfuracea* [46] |

[67,68], the leaves and stem barks *K. glauca* from Malaysia [45], the twigs *K. furfuracea* from Chinese [45,46], and the leaves and twigs *K. elegans* from China [10,47,74].

**Terpenoid**

Interestingly, terpenoids have demonstrated encouraging anticancer action, which may lead to more options in cancer treatment [97]. Essential oils (monoterpenes) comprise most terpenoid group constituents in Myristicaceae plants. *Horsfieldia*, *Knema*, and *Myristica* are the genera from which most of the around 33 essential oils (monoterpenes) have been isolated.

The compounds include in the *Myristica* genus **173, 174, 177–194, 198, and 200** contained in *M. fragrans, Myristica monodora, M. schefferi, M. philippensis, M. maxima,* and *M. monodora*. The compound in the *Knema* genus **195, 198,** and **206** contained *K. globularia, K. furfuracea,* and stem bark *Knema patentinervia* from Malaysia. The compound in the *Horsfieldia* genus **173, 17–177, 181–185, 188, 191, 192, 194, 196, 197, 199–205** contained in *H. fulva, Horsfieldia hainensis, H. superba,* and *H. fulva* (Table 5 and Fig. 3).

**Flavans, isoflavonoids, and flavones**

Myristicaceae has about 63 different types of flavonoids. The first flavan compound in *Horsfieldia amygdaline* was identified as myristinin A **207** in 1992. It was successfully discovered that isomeric compounds of myristinin A were present in the seeds and barks of *Myristica cinnamomea* (*Myristinin B* **213***, C* **214***, D* **215***, E* **216***,* and *F* **217**) (34), the fruits *Horsfieldia motley* [82] (*Myristinin D*

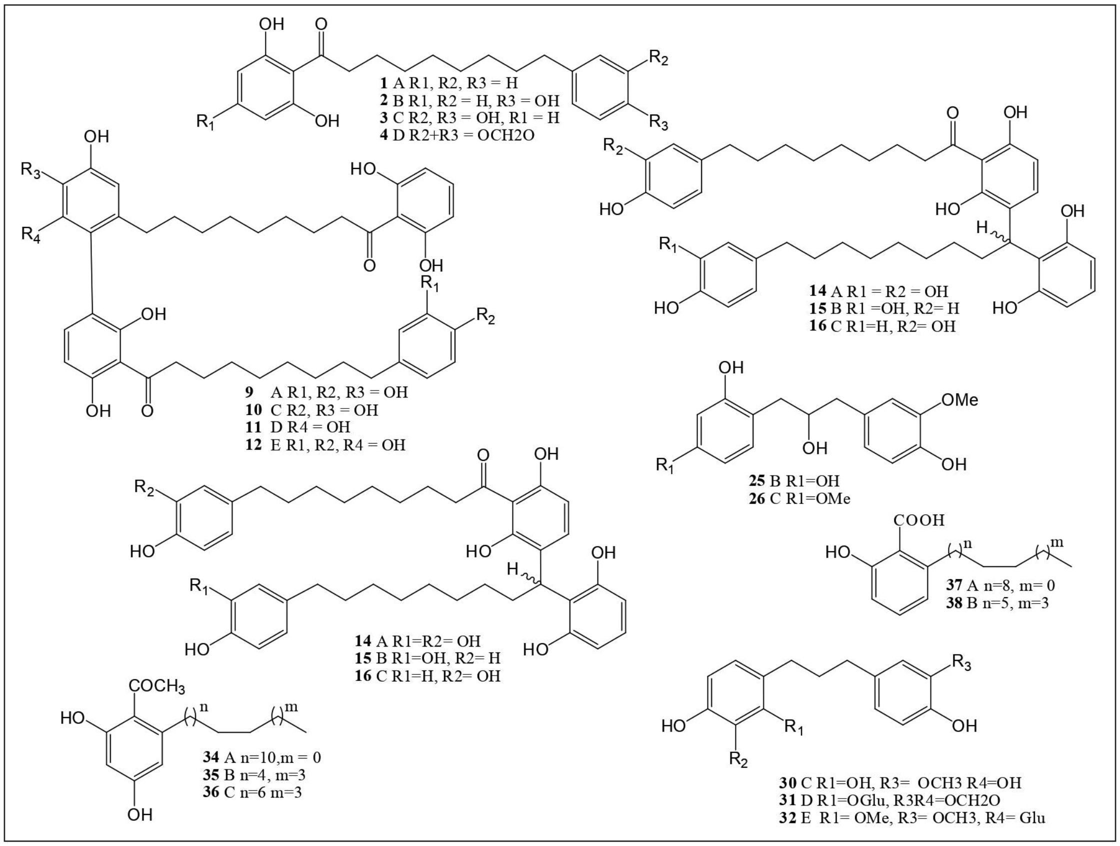



**Figure 1.** Polyketides isolated from Myristicaceae species.

**Table 4.** Lignans compounds isolated from Myristicaceae.

| Name of lignans | Species |
|---|---|
| Fargesin **73** | *Horsfieldia iryaghedhi* [50] |
| Horsfieldin **74** | *Horsfieldia iryaghedhi* [50,98] |
| Sesamin **75** | *Horsfieldia glabra* [50], *Horsfieldia iryaghedhi* [40], *K. glauca* [45] |
| Asarinin **76** | *Knema glauca* [45], *H. iryaghedhi* [40,50,98,99] |
| Macelignan **77** | *Myristica fragrans* [20,86,87] |
| Myristargenol A **78** | *Myristica argentea* [54], *M. fragrans* [87] |
| Myristargenol B **79** | *Myristica argentea* [54] |
| Fagransol-A **80** | *Myristica fragrans* [88] |
| Fragransol-B **81** | *Myristica fragrans* [88] |
| Fragransin $D_1$ **82** | *Myristica fragrans* [88] |
| Fragransin $D_2$ **83** | *Myristica fragrans* [88] |
| Fragransin $D_3$ **84** | *Myristica fragrans* [88] |
| Fragransin $E_1$ **85** | *Myristica fragrans* [88] |
| Machilin D **86** | *Myristica fragrans* [15,87] |
| Machilin F **87** | *Myristica fragrans* [87] |
| Licarin A **88** | *Myristica fragrans* [87] |
| Fragransin A2 **89** | *Knema furfuracea* [45] |
| Fragrasin $C_1$ **90** | *Myristica fragrans* [19] |
| Licarin B **91** | *Myristica fragrans* [17,87] |
| Nectandrin A **92** | *Myristica fragrans* [19], *K. elegans* [10] |
| Nectandrin B **93** | *Myristica fragrans* [19,87], *K. elegans* [10] |

***Continued***

| Name of lignans | Species |
|---|---|
| Tetrahydrofuroguaiacin B **94** | *Myristica fragrans* [19], *K. elegans* [10] |
| Saucernetindiol **95** | *Myristica fragrans* [19] |
| Verrucosin **96** | *Myristica fragrans* [19] |
| Galbacin **97** | *Myristica fragrans* [19],*M. schefferi* [92] |
| Argenteane **98** | *Myristica argentea* [9] |
| 3′-methoxy licarin B **99** | *Myristica fragrans* [14] |
| Myrisfrageal A **100** | *Myristica fragrans* [14] |
| Myrisfrageal B **101** | *Myristica fragrans* [14] |
| Myrifralignan A **102** | *Myristica fragrans* [14] |
| Myrifralignan B **103** | *Myristica fragrans* [14] |
| Myrifralignan C **104** | *Myristica fragrans* [14] |
| Myrifralignan D **105** | *Myristica fragrans* [14] |
| Myrifralignan E **106** | *Myristica fragrans* [14] |
| Myrislignan **107** | *Myristica fragrans* [14] |
| Virolane **108** | *Horsfieldia glabra* [51], *H. kingii* [38], *K. elegans* [47] |
| (-)-Kobusin **109** | *Horsfieldia glabra* [51], *Horsfieldia tetratepala* [44], *H. kingii* |
| Licarin C **110** | *Myristica fragrans* [13] |
| Odoratisol A **111** | *Myristica fragrans* [13] |
| Kneglobularone A **112** | *Knema globularia* [48] |
| Knepachycarpic acid A **113** | *Knema pachycarpa* [67] |
| Knepachycarpic acid B **114** | *Knema pachycarpa* [67] |
| Knepachycarpanol A **115** | *Knema pachycarpa* [67] |
| Knepachycarpanol B **116** | *Knema pachycarpa* [67] |
| Knepachycarpanol C **117** | *Knema pachycarpa* [68] |
| Knepachycarpasinol **118** | *Knema pachycarpa* [68] |
| Knepachycarpanone A **119** | *Knema pachycarpa* [68] |
| Knepachycarpanone B **120** | *Knema pachycarpa* [68] |
| Knemavones A **121** | *Knema elegans* [47] |
| Knemavones B **122** | *Knema elegans* [47] |
| Kneglobularone B **123** | *Knema globularia* [65] |
| Kneglobularolsa A **124** | *Knema globularia* [65] |
| Kneglobularolsa B **125** | *Knema globularia* [65] |
| (+)-Eudesmin **126** | *Horsfieldia kingii* [38] |
| (+)-Phillygenin **127** | *Horsfieldia kingii* [38] |
| (-)-Hinokinin **128** | *Horsfieldia kingii* [38] |
| Matairesinol **129** | *Horsfieldia kingii* [38] |
| Kenamavoid A **130** | *Knema elegans* [74] |
| Kenamavoid B **131** | *Knema elegans* [74] |
| 6,7 - Dimethoxy - 2,3 - dimethyl - 1 α- (3′,4′- dimethoxyphenyl)-tetralin **132** | *Myristica otoba* [91] |
| 6,7-Methylenedioxy-2α,3β-dimethyl- 10α- (3′,4′-dimethoxyphenyl)-tetralin **133** | *Myristica otoba* [91] |
| 6, 7-Dimethox y-2α,3β -dimethyl- l α-( 3′,4′-dimethoxyphenyl)-tetralin **134** | *Myristica otoba* [91] |
| 6, 7-Methylenedioxy- 2α,3β -dimeth yl- 1β( 3′,4′-dimethox phenyl)-tetralin **135** | *Myristica otoba* [91] |
| 6, 7-Dimethoxy- 2α,3β -dimethyl- 1β ( 3′,4′-methylenedioxyphenyl)-tetralin **136** | *Myristica otoba* [91] |
| 7,8- Methylenedioxy-2α,3β –dimethyl- 1α-( 3′,4′-dimethoxyphenyl)-tetralin **137** | *Myristica otoba* [91] |

***Continued***

| Name of lignans | Species |
|---|---|
| 2,3-Dimethyl-l,4-bis-(3,4-dimethoxyphenyl)-butane **138** | *Myristica otoba* [91] |
| Meso-dihydroguaiaretic acid **139** | *Myristica argentea* [9,54], *M. fragrans* [87] |
| Austrobailignan-7 **140** | *Myristica fragrans* [88] |
| Erythro-2-(4″-allyl-2″,6″-dimethoxyphenoxy)-l-(3′,4′,5′-trimethoxyphenyl) propan- 1,3-diol **141** | *Myristica fragrans* [88] |
| Threo-1-(4′-hydroxy-3′-methoxyphenyl)-1-methoxy-2-(2″-methoxy-4″-(1‴-(E)-propenyl)phenoxy)-propan **142** | *Myristica fragrans* [88] |
| Erythro1-(4-hydroxy-3-methoxyphenyl)-4-(3,4-methylenedioxyphenyl)2,3-dimethyl-butane **143** | *Myristica argentea* [54] |
| (8S,8′R)-dimethyl-(7S,7′R)-bis(3,4-methylenedioxyphenyl)tetrahydrofuran **144** | *Myristica dactyloides* [90] |
| (8S,8′S)dimethyl-(7S,7′S)-bis(4-hydroxy-3-methoxyphenyl) tetrahydrofuran **145** | *Myristica dactyloides* [90] |
| (8S,8′S)-bis(3,4-methylenedioxy)-8,8′-neolignan **146** | *Myristica dactyloides* [89] |
| (8S,8′R)dimethyl-(7S,7′R)-bis(4-hydroxy-3-methoxyphenyl) tetrahydrofuran **147** | *Myristica dactyloides* [89] |
| 7-Megastigmene-3, 6, 9-triol(5) **148** | *Knema globularia* [66] |
| Sulfuterin **149** | *Knema globularia* [66], *K. elegans* [74] |
| (+)-trans -1,2-dihydrodehydroguaiaretic acid **150** | *Knema furfuracea* [69] |
| 3,3′-dimethoxy-1,1′-biphenyl-4,4′ –diol **151** | *Myristica argentea* [9] |
| Erythro-austrobailignan-6 **152** | *Myristica argentea* [9], *M. schefferi* [92] |
| ((7S)-80 -(benzo[30 ,40 ]dioxol-10 -yl)-7-hydroxypropyl)benzene-2,4-diol **153** | *Myristica fragrans* [16] |
| ((8R,8′S)-7-(4-hydroxy-3- methoxyphenyl)-8′ -methylbutan-8-yl)-3′ -methoxybenzene-4′,5′ –diol **154** | *Myristica fragrans* [16] |
| Erythro-(7S,8R)-7-(4-hydroxy-3-methoxypheny1)-8-[2′-methoxy-4′-(E)-propenyl)phenoxy]propan-7-ol **155** | *Myristica fragrans* [16] |
| (+)-Erythro-(7S,8R)-$\Delta^{8'}$-7-acetoxy-3,4,3′,5′-tetramethoxy-8-O-4′-neolignan **156** | *Myristica fragrans* [16] |
| Isodihydrocainatidin **157** | *Myristica fragrans* [14] |
| (7S,8R)-2-(4-allyl2,6-dimethoxy-henoxy)-1-(3,4,5-trimethoxyphenyl) **158** | *Myristica fragrans* [15] |
| (7R,8S)-2-(4-propenyl-2-methoxyphenoxy)-1-(3,4,5-trimethoxyphenyl)-propan-1-ol **159** | *Myristica fragrans* [15] |
| (7S,8R)-2-(4-allyl-2,6-dimethoxy phenoxy)-1-(4- hydroxy-3,5-dimethoxy phenyl)-propan-1-ol **160** | *Myristica fragrans* [15] |
| Benzenemethanol **61** | *Myristica fragrans* [13] |
| 1,3-benzodioxate-5-methanol,α-[1-[2,6-dimethoxy-4-(2-propenyl)phenoxy] ethyl]-acetat **162** | *Myristica fragrans* [13] |
| (S)1-(3,4,5-trimethoxyphenyl)-2-(3- methoxy 5-(prop-1-yl)phenyl)-propan-1-ol **163** | *Myristica fragrans* [13] |
| α-[1-[2,6-dimethoxy-4-(2-propen-1-yl)phenoxy]ethyl]-3,4-dimethoxy-1-acetate **164** | *Myristica fragrans* [13] |
| (7S, 8R, 8′S, 7′S) 7,7′-bis(3-hydroxy-5-methoxyphenyl)-8,8′–dimethylbuthane 7,7′-diol **165** | *Myristica fatua* [59] |
| 3″-hydroxydemethyldactyloidin **166** | *Myristica fatua* [59] |
| 3′ ,4′ -de-O-methylenehinokinin **167** | *Horsfieldia kingii* [38] |
| Pluviatilol **168** | *Horsfieldia iryaghedhi* [40] |
| 3′ -desmethylarctigenin **169** | *Horsfieldia kingii* [38] |
| 1-(2- hydroxy 4 methoxyphenyl)-3-(4 – hydroxyl- 3- methoxyphenyl)propane **170** | *Knema globularia* [65] |
| (+)-Pinoresinol **171** | *Knema furfuracea* [46] |
| (+)-Epipinoresinol **172** | *Knema furfuracea* [46] |

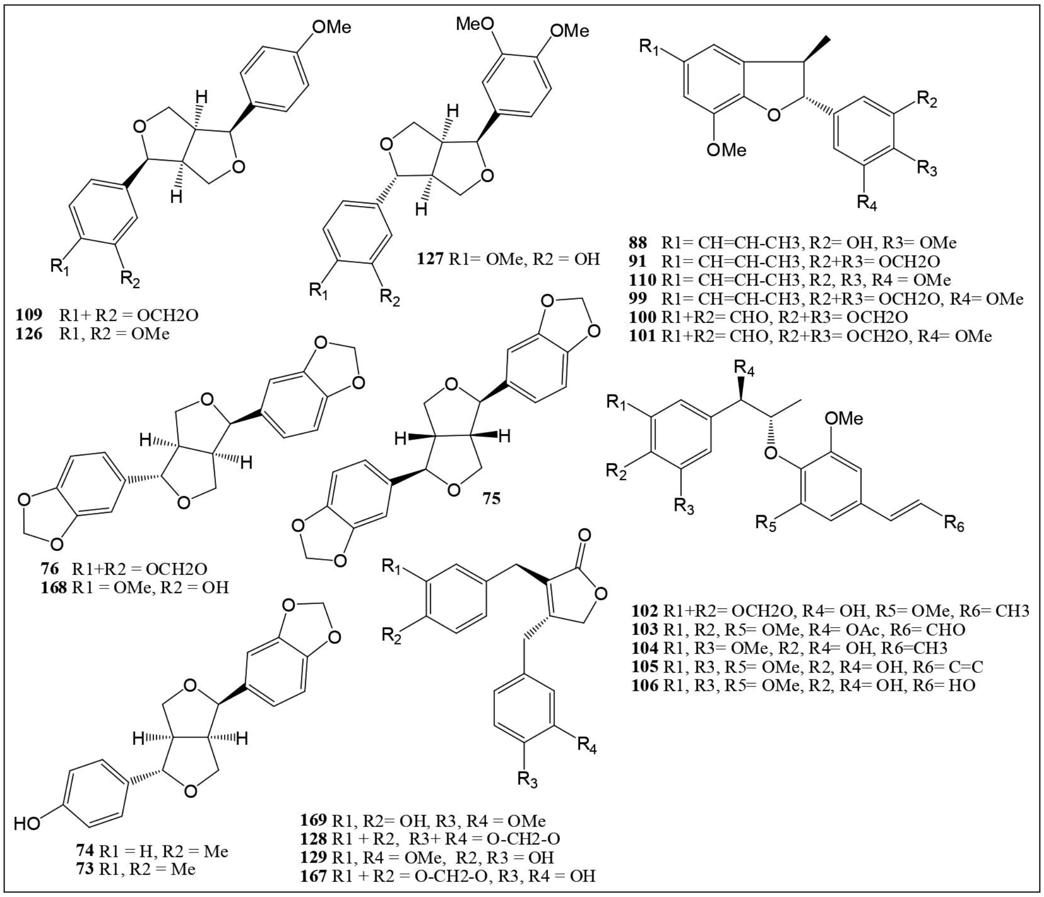



**Figure 2.** Lignans compounds isolated from Myristicaceae species.

**215**, *E* **216**, and *G* **228**), and *Myristinin I* **229** from all parts of *H. iryaghedhi* [40]. The stem bark methanol extract of *K. globularia* contained the derivative of Kaempferol **235** [66] (Table 6 and Fig. 4).

**Chalcone, quinone, and alkaloids**

The Myristicaceae family contains nine compounds in the chalcone group **271–280,** and **290**. These compounds are primarily found in the *Horfieldia* genus and include the trunk methanol extract of *H. pandurifolia* [43], the stem bark methanol extract of *H. superba* [42], and the fruits methanol extract of *H. glabra* [77]. The Quinone compounds are found in the genus *Horsfieldia*, Horsfiequinone A–F, isolated from the stem extract of *H. tetratepala* [79]. Compounds derived from napthale 2-methyl-1, 4, 4a, 8a-tetrahydro-endo-1, 4-methanonaphthalene-5,8-dione **281** have been isolated from *Myristica argantea* seed extract [100]. The Malaysian native tree species *H. superba* was not known to have alkaloids before. Isolation from leaves including a new alkaloid, Horsfiline1 **285**, 6-methoxy-2-methyl-1, 2, 3, 4-tetrahydro-β-carboline **286,** and 5-mehoxy-N,N-dimethyl-tryptamine **287** Table 7 and their structures are displayed in Figure 5.

## PHARMACOLOGY

Studying the effects of medications and other substances on living things is the study of pharmacology, an interesting area. All substances, natural or artificial, that affect a biological system can be considered drugs. Considering all the many ways medications may be utilized to alleviate ailments and enhance people's quality of life is impressive.

**Cytotoxicity**

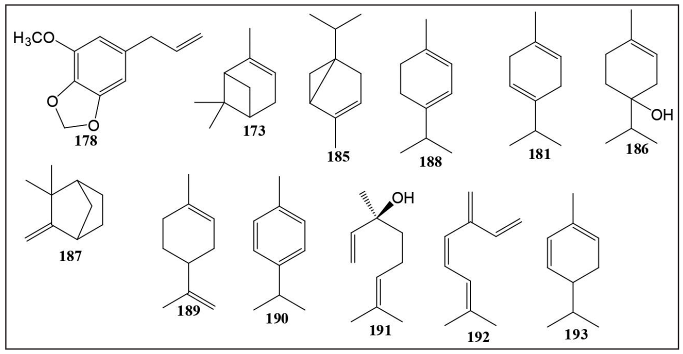
Regarding compounds have been shown to have the ability to inhibit MCF-7 cells. These include compounds from the polyketide groups **1, 2, 3**, and **6** that are found in various *Myristica* genus; more recently, the compound *Malabaricones A* **1** in the *K. glauca* species [45], the lignan group 116, 120 that is found in *K. pachycarpa* [68], and 165, 166 compounds that are found in *M. fatua* [59]. The terpenoids group **196, 197** are contained in *H. superba* [42], and the flavones group, Giffithane **240** is contained in *K. globularia* [65]. In addition to MCF-7 cells, tests were also carried out against HT-29 colon cells **110,** and **162** compounds, KB tumor cells test **1, 2, 3, 7, 9,** and **10** compounds, PC3 cells **1, 9, 196,** and **197** compounds, vero cells **112**, **196, 197,** and **199–204** compounds, NCI-H187 **89, 112, 208,** and **240** compounds, Hela cell **119, 120,** and **229** compounds, and P388 cells **207, 215** compounds (Table 9).

**Anti-inflammatory**

Anti-inflammatory effects have been discovered in a wide range of natural substances. In a bioassay, for instance, the methanol extract of *Myristica andamanica* leaves which contains

**Table 5.** Terpenoids compounds isolated from Myristicaceae.

| Name of terpenoid | Species |
|---|---|
| α-Pinen **173** | *Myristica fragrans* [11,22], *H. fulva* [8], *M. monodora* [24] |
| Safrol **174** | *Myristica fragrans* [11,22,87] |
| Copaene **175** | *Horsfieldia hainensis* [101] |
| Hexanedioic acid, bis(2-ethylhexyl) ester **176** | *Horsfieldia hainensis* [101] |
| Octadecenoic acid **177** | *Horsfieldia hainensis* [101], *M. schefferi* [98] |
| Myristisin **178** | *Myristica fragrans* [11], *M. schefferi* [98] |
| Elemisin **179** | *Myristica fragrans* [11] |
| β-Ocimene **180** | *Myristica fragrans* [11] |
| γ-Terpinen **181** | *Myristica fragrans* [11], *H. superba* [8] |
| α-Terpinolen **182** | *Myristica fragrans* [11], *H. superba* [8] |
| p-Ment 2 en-1-ol **183** | *Myristica fragrans* [11], *H. fulva* [8] |
| β-Pinen **184** | *Myristica fragrans* [11], *H. fulva* [8] |
| α-Tujen **185** | *Myristica fragrans* [11], *H. fulva* [8] |
| p-Menth 1-en-4-ol **186** | *Myristica fragrans* [11] |
| Campen **187** | *Myristica fragrans* [11] |
| α-Terpinen **188** | *Myristica fragrans* [11], *H. superba* [8] |
| Limonen **189** | *Myristica fragrans* [11] |
| p-Cimen **190** | *Myristica fragrans* [11] |
| Linalool **191** | *Myristica fragrans* [11],*H. fulva* [8] |
| β- Mircen **192** | *Myristica fragrans* [11], *H. superba* [8] |
| α-Fellandren **193** | *Myristica fragrans* [11] |
| 3-Caren **194** | *Myristica fragrans* [11], *H. fulva* [8] |
| Sesquiterpene **195** | *Knema patentinervia* [102] |
| (-)-5,6-dihydro-6-undecyl-2H-pyran-2-one **196** | *Horsfieldia superba* [42] |
| (-)-5,6-dihydro-6-tridecyl-2H-pyran-2-one **197** | *Horsfieldia superba* [42] |
| β-Sitosterol **198** | *Myristica philippensis* [93], *M. maxima* [30], *K. globularia* [48] |
| α-Cadinol **199** | *Horsfieldia superba, H. fulva* [8] |
| δ-Cadinene **200** | *Horsfieldia superba, H. fulva* [8], *M. monodora* [24] |
| Germacrene B **201** | *Horsfieldia fulva* [8] |
| Germacrene D **202** | *Horsfieldia superba* , *H. fulva* [8] |
| Epi-α-muuroll **203** | *Horsfieldia fulva* [8] |
| α-Humulene **204** | *Horsfieldia superba* [8] |
| Aromadendrene **205** | *Horsfieldia fulva* [8] |
| (+)-Syringaresinol | *Knema furfuracea* [46] |
| (E)-2-hydroxy-6-(pentadec-8-en-1-yl) benzoic acid **206** | |




**178** **173** **185** **188** **181** **186** **187** **189** **190** **191** **192** **193**

**Figure 3.** Terpenoids compound isolated from Myristicaceae species.

**Table 6.** Flavan, isoflavonoids, and flavone compounds isolated from Myristicaceae family.

| Name | Species |
|---|---|
| Myristinin A **207** | *Horsfieldia amygdaline* [80], *M. cinnamomea* [57], *K. elegans* [73], *Knema glauca* [45] |
| Biochanin A **208** | *Myristica malabarica* [103], *K. furfuracea* [69], *K. globularia* [65], *M. beddomei* [32] |
| Prunetin **209** | *Myristica malabarica* [103] |
| Luteolin **210** | *Knema globularia* [66], *Horsfieldia pandurifolia* [43], *K. elegans* [47] |
| Taxifolin **211** | *Knema globularia* [66] |
| Cathechin **212** | *Knema globularia* [66], *Horsfieldia superba* [42], *Horsfieldia kingii* [38] |
| Myristinin B **213** | *Myristica cinnamomea* [57] |
| Myristinin C **214** | *Myristica cinnamomea* [57] |
| Myristinin D **215** | *Myristica cinnamomea* [57], *K. elegans* [73], *K. glauca* [45], *H. motley* [82] |
| Myristinin E **216** | *Myristica cinnamomea* (34), *H. motley* [82] |
| Myristinin F **217** | *Myristica cinnamomea* [57] |
| Epicathechin **218** | *Horsfieldia superba* [42] |
| Iristectorigenin A **219** | *Horsfieldia pandurifolia* [43] |
| 2′–hydroxyformononetin **220** | *Horsfieldia pandurifolia* [43] |
| Formononetin **221** | *Horsfieldia pandurifolia* [43] |
| Tectorigenin **222** | *Horsfieldia pandurifolia* [43], *K. elegans* [47] |
| Genistein **223** | *Horsfieldia pandurifolia* [43], *K. elegans* [47] |
| Liquiritigenin **224** | *Horsfieldia pandurifolia* [43] |

*Continued*

| Name | Species |
|---|---|
| Butin **225** | *Horsfieldia pandurifolia* [43], *K. elegans* [74] |
| Fustin **226** | *Horsfieldia pandurifolia* [43] |
| (-)-Festidinol **227** | *Horsfieldia pandurifolia* [43] |
| Myristinin G **228** | *Horsfieldia motley* [82] |
| Myristinin I **229** | *Horsfieldia iryaghedhi* [40] |
| 2′hydroxybiochanin A **230** | *Knema globularia* [65] |
| 2′methoxyformononetin **231** | *Knema globularia* [65] |
| Horsiryanone A **232** | *Horsfieldia iryaghedhi* [40] |
| Horsiryanone B **233** | *Horsfieldia iryaghedhi* [40] |
| Spiralisone D **234** | *Horsfieldia iryaghedhi* [40] |
| Kaempferol **235** | *Knema globularia* [66] |
| Kaempferol-3-O-β-D-rutinosde **236** | *Knema globularia* [66] |
| Kaempferol-3-O-β-D-galactopyranoside **237** | *Knema globularia* [66] |
| Kaempferol-3- O-β-D-glucopyranoside **238** | *Knema globularia* [66] |
| Quercetin-3-O-β-D-glucopyranoside **239** | *Knema globularia* [66] |
| Giffithane **240** | *Knema globularia* [65] |
| Sakuranetin **241** | *Knema elegans* [74] |
| Naringenin **242** | *Knema elegans* [74] |
| Eriodictyol **243** | *Knema elegans* [74] |
| 7-methylliquiritigenin **244** | *Knema elegans* [74] |
| Fisetinidol **245** | *Knema furfuracea* [46] |
| 7-hydroxy-3′,4′-methylenedioxyflavan **246** | *Knema laurina* [7], *H. superba* [42] |
| 7,4′- dimethoxy-5-hydroxyisoflavon **247** | *Myristica malabarica* [103] |
| (2R) 1-(2-hydroxy-4-methoxyphenyl)-3-(3,4-methyl-enedioxyphenyl)-propan-2-ol **248** | *Myristica malabarica* [103] |
| (2R) 1-(2-hydroxy-4-methoxyphenyl)-3-(3,4-methyl-enedioxyphenyl)-propan-2-ol **249** | *Myristica malabarica* [103] |
| 4′,7-dihydroxy-3′-methoxyflavan **250** | *Knema glauca* [45], *H. superba* [42] |
| 3,4′,7-trihydroxy-3′-methoxyflavan **251** | *Horsfieldia superba* [42] |
| 4′-hydroxy-7-methoxyflavan **252** | *Horsfieldia superba* [42] |
| 4′,7-dihydroxyflavan **253** | *Horsfieldia superba* [42] |
| 2,2′-epoxy-4′-methoxy-3,7-dihydroxy isoflavan **254** | *Horsfieldia pandurifolia* [43] |
| 7-hydroxyflavonone **255** | *Horsfieldia pandurifolia* [43] |
| 3,7,4′- trihydroxyflavone **256** | *Horsfieldia pandurifolia* [43], *K. elegans* [47] |
| (2R,4R)′-4hydroxy-3′,5′-methyl-6,7-methylenedioxy-4-O-2′-cycloflavan **257** | *Horsfieldia glabra* [51] |
| (2R, 4R)-4′-hydroxy-3′-methyl-6,7-methylenedioxy-4-O-2′-cycloflavan **258** | *Horsfieldia glabra* [51], *K. elegans* [47] |
| 3,6-dihydroxy-2-(1-oxododecyl)-2-cyclohexen-1-one **259** | *Horsfieldia iryaghedhi* [40] |
| 3,5-dihydroxy-2-(1-oxododecyl)-2-cyclohexen-1-one **260** | *Horsfieldia iryaghedhi* [40] |
| 3-hydroxy-2-(1- oxodecyl)-2-cyclohexen-1-on **261** | *Horsfieldia iryaghedhi* [40] |
| 3-hydroxy-2-(1-oxododecyl)-2- cyclohexen-1-on **262** | *Horsfieldia iryaghedhi* [40] |
| 1-(2,6-dihydroxyphenyl)- 1-decanon **263** | *Horsfieldia iryaghedhi* [40] |
| (2S)-3′, 4′, 7-trihydroxyflavan **264** | *Knema furfuracea* [46] |
| (+)-7,4′ - dihdroxy-4′ -methoxyflavanol **265** | *Knema furfuracea* [46] |
| (2S)-7,3′ -dimethoxy-4′ hydroxyflavan **266** | *Knema furfuracea* [46] |
| 7,2′ -dihydroxy-6,8-dimethyl-4′ ,5′ -methylenedioxyflavan **267** | *Knema elegans* [74] |
| 2′ -hydroxy-7-methoxy-4′ ,5′ -methylenedioxyflavan **268** | *Knema elegans* [74] |
| 7-hydroxy-3′ ,4′ -methylenedioxyflavan **269** | *Knema elegans* [74] |
| 5,7-dihydroxy-3-(5′-hydroxybenzo[d](7′,9′)-dioxol-1′-yl)-4H-chromen-4-on **270** | *Myristica beddomei* [32] |

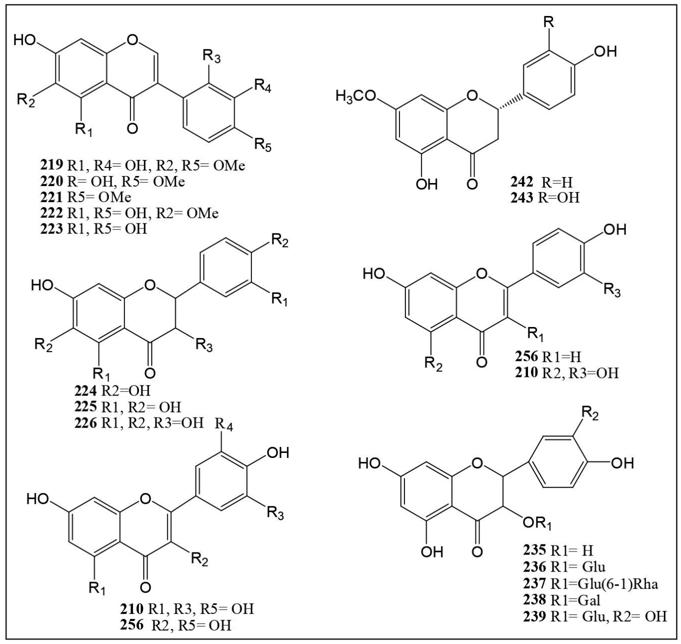



**Figure 4.** Flavans, isoflavonoids, and flavone compounds isolated from Myristicaceae family.

steroids, carbohydrate alkaloids, and amino acids was used to test the anti-inflammatory properties of the plant's extracts. Rat wounds treated with this extract have been demonstrated to heal effectively [64] (Table 8). Similarly, the anti-inflammatory activity of *M. fragrans* performed using the chloroform extract and isolated compounds **154, 155,** and **156** from the seeds have been tested on murine monocyte-macrophages [16]. Myristinin **207, 213–217** compounds obtained from the chloroform extract of *M. cinnamomea* fruit have been found to selectively inhibit the enzyme cyclooxygenase-2 [80]. Other compounds isolated from various plant extracts, such as horsfielenide D **31** and cathechin **212**, have also shown anti-inflammatory activity [47]. Acetone extracts of *K. furfuracea* twigs and leaves **26, 245, and 265** compounds have also been found to be anti-inflammatory active in various compounds. These organic substances provide encouraging possibilities for the creation of novel anti-inflammatory drugs [46] (Table 9).

**Antidiabetic activity**

Recent research has revealed that *K. glauca* dichloromethane extracts have antidiabetic qualities [75] (Table 8). In more detail, **2, 3, 12**, and **57** compounds from the n-hexane and acetone fractions of *M. cinnamomea* stem bark, as well as **17** and **40** compounds from the methanol extract of *H. macrobotrys* fruit, and compounds **130** and **131** from *K. elegans* twig and leaves extracts, and **215, 216**, and **228** compounds *from H. motleyi* stem bark have all shown an antidiabetic activity against *α-amylase* and *α-glucosidase*

**Table 7.** Chalcone, quinone, and alkaloid compounds isolated from Myristicaceae family.

| Name | Species |
|---|---|
| Horsfiequinone A **271** | *Horsfieldia tetratepala* [33], *K. globularia* [65] |
| Horsfiequinone B **272** | *Horsfieldia tetratepala* [79] |
| Horsfiequinone C **273** | *Horsfieldia tetratepala* [79] |
| Horsfiequinone D **274** | *Horsfieldia tetratepala* [79] |
| Horsfiequinone E **275** | *Horsfieldia tetratepala* [79] |
| Horsfiequinone F **276** | *Horsfieldia tetratepala* [79] |
| Combrequinone B **277** | *Horsfieldia tetratepala* [79] |
| Rhusopolypheno l E **278** | *Horsfieldia pandurifolia* [79] |
| Isoliquiritigenin **279** | *Horsfieldia pandurifolia* [79] |
| Butein **280** | *Horsfieldia pandurifolia* [79] |
| Naphthalene, 1,2,3,5,6,8a-hexahydro-4,7-dimethyl-1-(1-methylethyl) **281** | *Horsfieldia hainensis* [101] |
| 2-methyl-1,4,4a,8a-tetrahydro-endo-1,4-methanonaphthalene-5,8-dione **282** | *Myristica argentea* [100] |
| I-(2,6-dihydroxypheny)-1I-Phenylundecan-l-on **283** | *Horsfieldia glabra* [77] |
| 1-(2,4,6-trihydroxypheny)-9-Phenylnonan-l-on**284** | *Horsfieldia glabra* [77] |
| Horsfiline1**285** | *Horsfieldia superba* [104] |
| 6-methoxy-2-methyl-1,2,3,4-tetrahydro-β-carboline **286** | *Horsfieldia superba* [104] |
| 5-mehoxy-N,N-dimethyl-tryptamine **287** | *Horsfieldia superba* [104] |
| α-2′-hydroxy-4,4′-dimethoxyhydrochalcone **288** | *Myristica malabarica* [103] |
| 2′,3,4-trihydroxy-4′-methoxydihydrochalcone **289** | *Horsfieldia superba* [42] |
| α-2′-dihydroxy-4,4′–dimethoxydihydrochalcon **290** | *Horsfieldia pandurifolia* [43] |
| 4,2′,4′-tetrahydroxydihydrochalcone **291** | *Horsfieldia pandurifolia* [43] |
| β-hydroxydihydrochalcone **292** | *Myristica beddomei* [32] |

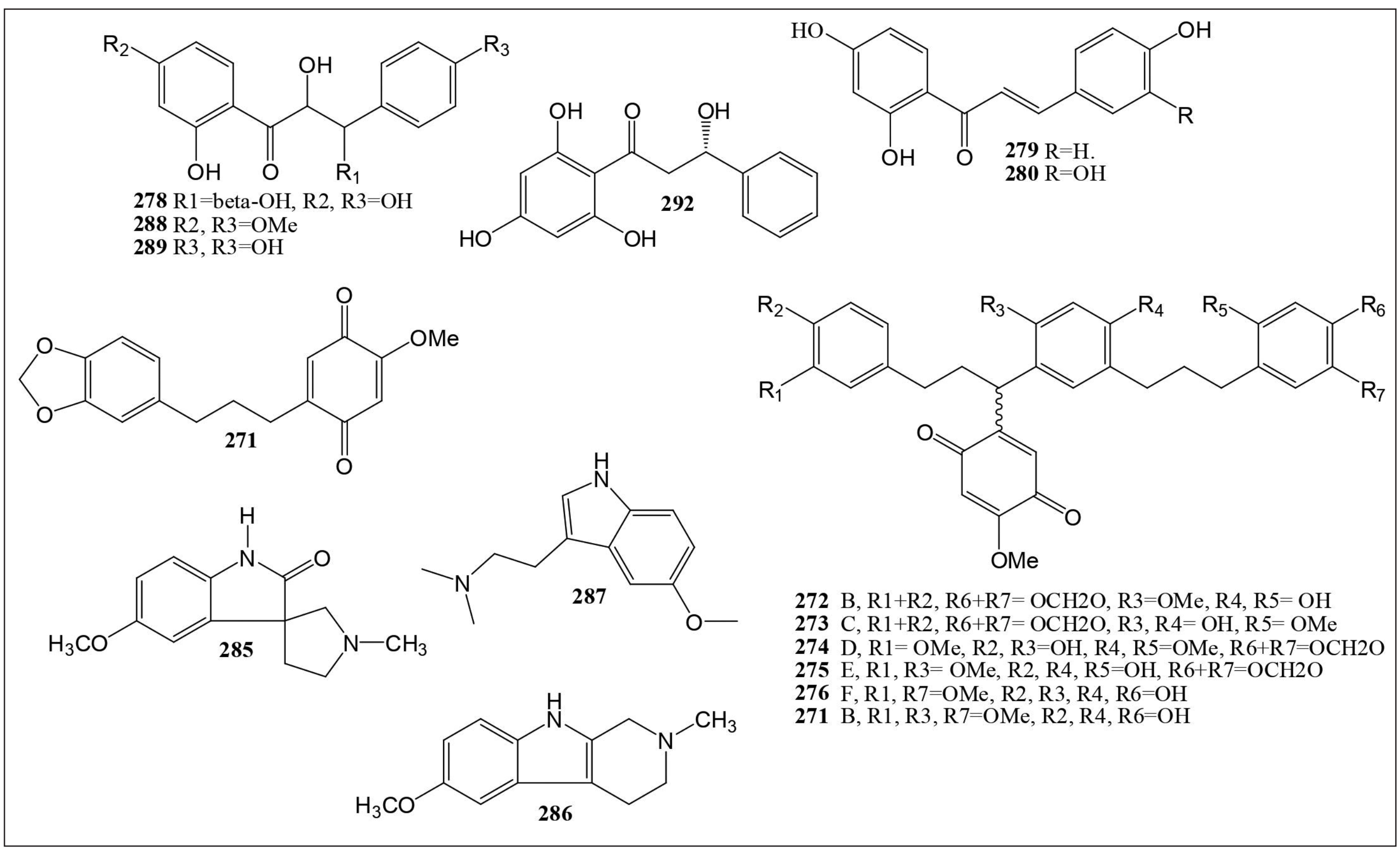



**Figure 5.** Chalcone, quinone, and alkaloid compounds isolated from Myristicaceae family.

**Table 8.** Biological activities extracts of Myristicaceae family.

| Species | Biological activity | Desription |
|---|---|---|
| *Myristica fatua* | Toxicity | Hexane leaves extraction has anti-cancer effects on MCF-7 cells, with an $IC_{50}$ of 2.19 ug/ml [60]. |
| | | In cytotoxic tests, methanol extract and ethyl acetate fraction of leaves were used with brine shrimp larvae (*Artemia salina*) with $LC_{50}$ values of 64.57 and 83.75 µg/ml [61]. |
| | Antioxidant | Methanol extracts from the kernel, aryl, and bark with $IC_{50}$ values of 0.0355, 0.038, and 0.049 mg/ml [62] |
| | Antibacterial | A substance with antibacterial qualities found in seed extracts, chloroform, inhibits the development of *S. aureus* bacteria at concentrations of 5 mg/ml [62]. |
| | | The acetone extract from the seeds demonstrated antibacterial and antifungal action against *A. niger* (14.4 ± 0.37 mm) and *S. aureus* (13.8 ± 0.42 mm) [23]. |
| *Myristica malabarica* | Toxicity | When tested for anti-tumor activity (*in vivo*) at 50 and 100 mg/kg bw, fruit extracts assessed for methanol showed no effects on hematological and renal function [55]. |
| | Antioxidant | *Myristica malabarica* seed inhibition in the benzene fraction extract (35.21 ± 0.09 µg/ml) and ethanol extract (46.88 ± 0.20 µg/ml) [56]. |
| *Myristica fragrans* | Toxicity | Significant cytotoxic action was demonstrated by the essential oil of leaf extract at 50–75 µl concentration against MCF7 cells (42%–52%) and A375 cells (30%–37%) [11]. |
| | | A cytotoxic activity of 24.83 µg/ml was demonstrated by nutmeg essential oil against Vero cells [12]. |
| | Antibacterial | *Bacillus cereus* (ATCC10876) and *S. aureus* (ATCC12600) can be inhibited by extracting methanol leaves and fully mature fruits at the lowest MIC of 50 mg/ml [52]. |
| | Antioxidant | The methanol leaf extract (EC50, µg/ml) for the FRAP technique is 25.3 ± 0.2, aryl (28.8 ± 0.4), seed-kernel (33.1 ± 0.2), and shell (9.7 ± 0.1), but the 2,2-diphenyl-1-picrylhydrazil (DPPH) approach has an EC50 over 150 µg/ml [52]. |
| | | Acetone antioxidant extract from seeds using the DPPH method: 63.04% ± 1.56% [23]. |
| | | The antioxidant activity of nutmeg oil is 88.68% ± 0.1% [53]. |
| *Myristica andamanica* | Anti-inflammatory | Along with a 1% methanol inflammatory test in rats, methanol extract of leaves containing steroids, carbohydrate alkaloids, and amino acids was also tested and shown to be able to cure wounds in rats [64]. |
| *Knema kunstleri* | Antioxidant | Fruit essential oil extract 50.7 µg/ml [76]. |
| *Knema glauca* | Antidiabetic | A substantial α-glucosidase inhibition (IC50 value of 4.09 µg/ml) was observed in the dichloromethane extract of leaves [75]. |
| *Myristica monodora* | Antibacterial | The essential oil has antibacterial activity against *S. aureus* (13 mm zone) and *E. coli* (16 mm zone) at a 75 µg/ml concentration [24]. |
| | Antioxidant | The seeds' essential oil exhibited a 93.46% inhibition [24] |
| *Myristica iners* | Antioxidant | The resistivity of the methanol extract of stem components' ethyl acetate fraction was IC50 94.94 µg/ml [63]. |
| *Knema attenuate* | Antibacterial | The ethanolic stem bark extract contains *C. albicans* (10 mm) microbiological activity [71] |
| | | The antibacterial activities of chloroform and hexane aryl and seed extracts were demonstrated against *S. aureus* (MIC 12563 ± 55.08; 12541 ± 55.1 (µg/ml) [72]. |
| *Horsfieldia helwigii* | Antibacterial | Methanolic extracts of bark, roots, and leaves exhibited bactericidal activity in the 8–22 mm range [83] |
| *Horsfieldia spicata* | Antibacterial | Stembark methanol extract included *B. subtilis* (13.33 ± 2.36 mm) and *P. aeruginosa* (15.33 ± 4.50 mm), with a MIC hexane fraction of less than 500 µg/ml [84]. |
| | Antioxidant | Fruit ethanol extract exhibits radical inhibition at 50% immersion at 300–400 ppm concentrations [105]. |
| | | Methanol extract has antioxidant capacity, as evidenced by the IC50 values of fruit (88.21% ± 0.56%), bark (89.78% ± 0.84%), and leaves (85.34% ± 0.38%) [70]. |
| | | Ethyl acetate extract of stem bark of IC50 25.53 µg/ml [84]. |
| *Horsfieldia irya* | Antioxidant | Inhibition of methanol extract on fruit (71.41% ± 1.58%), leaves (86.93% ± 0.70%), and stem bark (88.94% ± 0.10%) [70]. |
| *Horsfieldia irya* | Antioxidant | Fruit chloroform extract exhibits 15.03 ± 0.24 µmoles/100g extract of antioxidant activity [72]. |
| *Knema furfuracea* | Antioxidant | Antioxidant resistance measured at 91.91% ± 0.69% in the stem bark methanol extract [70]. |
| *Knema laurina* | Antioxidant | An antioxidant resistance of 85.98% ± 1.40% was found in the stem bark methanol extract [70]. |

***Continued***

**Table 9.** Biological activity of compounds isolated from Myristicacea family.

| Structure number | Compound | Biological activity | Description |
|---|---|---|---|
| 1 | Malabaricones A | Toxicity | The stem bark methanol extract demonstrated an antioxidant resistance of 85.98% ± 1.40% [30]. |
| | | | The *M. maingayi* fruit extract ethyl acetate, KB cells test 153 µM [26]. |
| | | | *Myristica beddomei* fruit extract in MCF-7 cells (ethanol extract) 15.4 µM [32]. |
| | | Antibacterial | The anti-promastigote/parasitic activity of *M. malabarica* fruit extract (IC50 16.0 µg/ml) has been shown in methanol extract [28]. |
| 2 | Malabaricone B | Toxicity | The ethyl acetate extract of stem bark the leaves of *M. fatua* Houtt showed inhibition 0.71 µg/ml MCF7 cells test [33]. |
| | | | The fruit ethyl acetate *M. maingayi* extract, KB cells test at value $IC_{50}$ 9 µM [26]. |
| | | | The ethanol extract of fruit *M. beddomei.* MCF-7 cells 22.92 µM [32]. |
| | | Antidiabetic | Extraction stem bark isolate of *M. fatua* had activity α-glucosidase 63.70 ± 0.546 µg/ml [17]. |
| | | Antibacterial | Methanol extract of *M. malabarica* fruit has anti-promastigote/parasitic activity 22.0 µg/ml [28]. |
| 3 | Malabaricone C | Toxicity | The ethylacetate extract of the stembark of *M. fatua* Houtt showed inhibition 2.38 µg/ml MCF7 cells test [33]. |
| | | | Ethanol extract of fruit *M. beddomei.* MCF-7 cells 36.25 µM [32]. |
| | | | Ethyl acetate of fruit of *M. maingayi* extract, KB cells test at value 11 µM [26]. |
| | | Antidiabetic | Extraction stem bark isolate of *M. fatua* had activity α-glucosidase 43.61 ± 0.620 µM [17]. |
| | | Antioxidant | Extraction stembark *M. maxima* of dichloromethane fraction potential antioxidant 5.28 ± 0.05 µM [30]. |
| | | Anti-inflamantory | Methanol extract of *M. fragrans* seeds had RAW 264.7 macrophage cells test, (2.3 ±0.4 µM) [16]. |
| 4 | Malabaricone D | Toxicity | The ethanol extract of *M. beddomei* fruits had MCF-7 cells 20.58 µM [32]. |
| 6 | Promalabaricone B | Toxicity | The ethanol extract of *M. beddomei* fruits MCF-7 cells 74,41 µM [32]. |
| 7 | Prepromalabaricone B | Toxicity | Extraction ethyl acetate extract *M. giganteones* fruit significant cytotoxic *invitro* against human nasopharynx KB cells $IC_{50}$ 18.9 µg/ml [27]. |
| 9 | Giganteones A | Toxicity | Extaction ethyl acetate of *M. giganteones* fruits had significant cytotoxic *invitro* against human nasopharynx KB cells $IC_{50}$ 11.4 µg/ml [27]. |
| | | | Extraction *M. maxima* stembark of dichloromethane had PC3 cell, $IC_{50}$ 17.5 ± 1.7 µM [30]. |
| | | Antioxidant | Extraction stembark *M. maxima* dichloromethane, potential antioxidant 3.17 ± 0.07 µM [30]. |
| 10 | Giganteones B | Toxicity | Extaction ethyl acetate extract of *M. giganteones* fruits had significant cytotoxic *invitro* against human nasopharynx KB cells $IC_{50}$ 1.8 µg/ml [27]. |
| 12 | Giganteone D | Antidiabetic | The crude acetone and hexane extracts *M. giganteones* of the stem barks inhibited the glucosidase has 5.05 µM [58]. |
| 13 | Giganteone E | Antioxidant | Inhibition DPPH from extraction dichloromethane *M. maxima* barks with $IC_{50}$ 2.92 ± 0.10 µM [30]. |
| 14 | Maingayone A | Antioxidant | Inhibition DPPH from extraction dichloromethane *M. maxima* barks with $IC_{50}$ 2.90 ± 0.01 µM [30]. |
| 15 | Maingayones B | Antioxidant | Inhibition DPPH from extraction dichloromethane *M. maxima* barks with $IC_{50}$ 6.08 ± 0.20 µM [30]. |
| 17 | Maingayone D | Antidiabetic | The methanol extract *H. macrobotrys* fruits effective antidiabetic by inhibiting a-glucosidase 5.65 µM [81]. |
| | | Antioxidant | The methanol extract of *H. macrobotrys* fruits effect by scavenging free radicals (DPPH) $IC_{50}$0.43 µM [81]. |
| 26 | Virolanol C | Anti-inflammatory | The acetone extract of twigs and leaves of *K. furfuracea* are active inhibition 15.14 µM [46]. |
| 31 | Horsfielenide D | Anti-inflammatory | Extraction twigs and leaves *H. kingii* of acetone show could inhibit iNOS expression in LPS-induced RAW264.7 cells 4.76 ± 0.31 µM [38]. |

***Continued***

| Structure number | Compound | Biological activity | Description |
|---|---|---|---|
| 40 | Horsfieldones A | Antidiabetic | The methanol extract of *H. macrobotrys* fruits effective antidiabetic by inhibiting a-glucosidase 22.61 µM [81]. |
| | | Antioxidant | The methanol extract of fruit *H. macrobotrys* effect by scavenging free radicals (DPPH) $IC_{50}$ 1.60 µM [81]. |
| 57 | Methyl 3,4-dihydroxybenzoate | Antioxidant | The methanolic extract of the *M. fatua* stembark assayed *in vitro* by DPPH $IC_{50}$ 7.96 µg/ml [18]. |
| | | Antidiabetic | Extraction stem bark isolate of *M. fatua* had activity α-glucosidase 7.68 µg/ml [18]. |
| 77 | Macelignan | Antibacterial | Methanol extract of *M. fragrans* seeds hads inhibitory activity against *S. mutans* with MIC 3.9 µg/ml and MBC 7.8 µg/ml [20]. |
| | | Antioxidant | Isolation from petroleum extract of *M. argantea* nutmeg had IC50 which was lower around 46 µM [9]. |
| 86 | Machilin D | Anti-inflamantory | Extraction *M. fragrans* using the super-critical $CO_2$ had inhibition 18.5 ± 0.5 µM [15]. |
| | | Toxicity | The methanol extract of leaves *K. furfuracea* showed no activity against MCF7, KB, Cl-H187 cells [69]. |
| 89 | Fragransin A2 | Toxicity | The methanol extract of leaves *K. furfuracea* showed no activity against MCF7, KB, Cl-H187 cells, while IC50 16.26 on KB cells, inactive on MCF-7 and NCL-H187 cells [69]. |
| 91 | Licarin B | Anti-inflamantory | The chloroform extract of *M. fragrans* seeds had an inhibition value of 53.6 µM in the RAW 264.7 murine monocyte-macrophage cell assay [14]. |
| 92 | Nectandrin A | Anti- diabetic | Ethanol extract of seeds *M. fragrans* can activate the AMPK enzyme as a treatment therapy for obesity and type-2 diabetes for concentration of 5 µM [19]. |
| 93 | Nectandrin B | Anti- diabetic | Ethanol extract of seeds *M. fragrans* can activate the AMPK enzyme as a treatment therapy for obesity and type-2 diabetes, for concentration of 5 µM [19]. |
| 94 | Tetrahydrofuroguaiacin B | Anti- diabetic | Ethanol extract of seeds *M. fragrans* can activate the AMPK enzyme as a treatment therapy for obesity and type-2 diabetes. for concentration of 5 µM [19]. |
| 98 | Argentanee | Antioxidant | Isolation from petroleum extract of *M. argantea* nutmeg $IC_{50}$ 70 µM [9]. |
| 99 | 3′-methoxy licarin B | Anti-inflamantory | The chloroform extract of *M. fragrans* seeds had an inhibition value of 48.7 µM in the RAW 264.7 murine monocyte-macrophage cell assay [14]. |
| 100 | Myrisfrageal A | Anti-inflamantory | The chloroform extract of *M. fragrans* seeds had an inhibition value of 76.0 µM, in the RAW 264.7 murine monocyte-macrophage cell assay [14]. |
| 101 | Myrisfrageal B | Anti-inflamantory | The chloroform extract of *M. fragrans* seeds had an inhibition value of 45.0 µM, in the RAW 264.7 murine monocyte-macrophage cell assay [14]. |
| 104 | Myrifralignan C | Anti-inflamantory | Extraction *M. fragrans* using the super-critical $CO_2$ had inhibition 47.2 ± 1.1 µM [15]. |
| 105 | Myrifralignan D | Anti-inflamantory | Extraction *M. fragrans* using the super-critical $CO_2$ had inhibition 49.0 ± 1.0 µM) [15]. |
| 106 | Myrifralignan E | Anti-inflamantory | Extraction *M. fragrans* using the super-critical $CO_2$ had inhibition 32.8 ± 2.7 µM [15]. |
| 107 | Myrislignan | Anti-inflamantory | Extraction *M. fragrans* using the super-critical $CO_2$ had inhibition 21.2 ± 0.8 µM [15]. |
| 110 | Licarin C | Toxicity | The methanol exctract of *M. fragrans* mace had inhibition HT-29 colon cells(EC 0.003 µM) [13]. |
| 112 | Kneglobularone A | Toxicity | The compound isolated from methanol extract of root *K. globularia*, had inhibition NCI-H187, KB and Vero cells 8.23 and 13.07 µg/ml [48]. |
| 116 | Knepachycarpanol B | Toxicity | The n-hexane extract of fruit *K. pachycarpa* had Hela and MCF-7 inhibition 31.36 mM [68]. |
| 118 | Knepachycarpasinol | Toxicity | The n-hexane extract of fruit *K. pachycarpa* had Hela and MCF-7 inhibition 41.30 mM [68]. |
| 119 | Knepachycarpanone A | Toxicity | the methanol extract of *K. pachycarpa* had Hela cell inhibition $IC_{50}$ 26.92 ± 1.46 µM [67]. |
| 120 | Knepachycarpanone B | Toxicity | The methanol extract of *K. pachycarpa* fruits had Hela cell inhibition $IC_{50}$ 30.20 ± 1.97 µM [67]. |
| 130 | Kenamavoid A | Antidiabetic | The twigs and leaves of *K. elegans* extracts have Antidiabetic 13 ± 0.87µM) [74]. |
| 131 | Kenamavoid B | Antioxidant | The acetone extract of twigs and leaves *K. elegans* has an antioxidant activity of 18.15 ± 0.74 µg/ml [74]. |
| | | Antidiabetic | The twig and leaves extracts *K. elegans* have antidiabetic (14.54 ± 0.91µM) [74]. |

*Continued*

| Structure number | Compound | Biological activity | Description |
|---|---|---|---|
| 139 | Meso-dihydroguaiaretic acid | Antibacterial | Ethanol extraction of stem bark and seeds *M. argantea* had strong inhibitory activity against *S. mutans* MIC 25 ppm [54]. |
| 152 | Erythro-austrobailignan-6 | Antioxidant | Isolation from petroleum extract of *M. argantea* nutmeg had inhibition $IC_{50}$ 103 μM [9]. |
| 154 | (8R,8′S)-7-(4-hydroxy-3-methoxyphenyl)-8′ -methylbutan-8-yl)-3′ - methoxybenzene-4′,5′ –diol | Anti-inflamantory | The methanol extract of seeds *M. fragrans* had inhibtion RAW 264.7 macrophage cells test, 32.5 ± 2.2 μM [16]. |
| 155 | erythro-(7S,8R)-7-(4-hydroxy-3-methoxypheny1)-8-[2′-methoxy-4′-(E) -propenyl)phenoxy] propan-7-ol | Anti-inflamantory | The methanol extract of seeds *M. fragrans* had ihibition RAW 264.7 macrophage cells test 25.0 ± 3.1 μM [16]. |
| 156 | (+)-erythro-(7S,8R)-Δ8′-7-acetoxy-3, 4,3′,5′-tetramethoxy-8-O-4′-neolignan | Anti-inflamantory | Methanol extract of seeds *M. fragrans* had inhibition RAW 264.7 macrophage cells test, (24,5 μM) [16]. |
| 158 | (7S,8R)-2-(4-allyl2, 6-dimethoxy-henoxy)-1-(3,4,5-trimethoxyphenyl) | Anti-inflamantory | Extraction *M. fragrans* using the super-critical CO2 had inhibition 48.3 ± 1.4 μM [15]. |
| 159 | (7R,8S)-2-(4-propenyl-2-methoxyphenoxy)-1-(3,4,5-trimethoxyphenyl)-propan-1-ol | Anti-inflamantory | Extraction *M. fragrans* using the super-critical $CO_2$ had inhibition 48.0 ± 1.2 μM [15]. |
| 160 | (7S,8R)-2-(4-allyl-2,6-dimethoxyphenoxy)-1-(4-hydroxy-3,5-dimethoxyphenyl)-propan-1-ol | Anti-inflamantory | Extraction *M. fragrans* using the super-critical $CO_2$ had inhibition 49.8 ± 1.9 μM [15]. |
| 161 | Benzenemethanol | Toxicity | The methanol extract of *M. fragrans* mace had inhibition HT-29 colon cells EC 3.07 μM [13]. |
| 162 | 1,3-benzodioxole-5-methanol, α -[1-[2,6-dimethoxy-4-(2-propenyl)phenoxy]ethyl]-acetat | Toxicity | The methanol extract of *M. fragrans* mace had inhibition HT-29 colon cells EC 0.0024 μM [13]. |
| 165 | (7S, 8R, 8′S, 7′S) 7,7′-bis(3-hydroxy-5-methoxyphenyl)-8,8′-dimethylbuthane7,7′-diol | Toxicity | The semipolar (ethylacetate) extract of *M. fatua* Houtt leaves showed inhibition 26.19 μM MCF7 cells test [59]. |
| 166 | 3″-hydroxydemethyldactyloidin | Toxicity | The ethylacetate extract of *M. fatua Houtt* leaves showed inhibition 8.33 μM MCF7 cells test [59]. |
| 173 | α-Pinene | Antibacterial | Methanol extract of seeds *M. fragrans* against female *B. germanica* colonies has potential as an insecticide or as lead for pest control. Strong insecticidal activity was also observed with inhibition 0.60 $mg/cm^2$ [22]. |
| 174 | Safrole | Antibacterial | Methanol extract of seeds *M. fragrans* against female B. germanica colonies has potential as an insecticide or as lead for pest control. Strong insecticidal activity was also observed with inhibition 0.55 $mg/cm^2$ [22]. |
| 178 | Myristisin | Antibacterial | The ethanol of nutmeg *M. fragrans* had an anthelmintic effect in Anisakis L3 simplex 0.5–0.7 mg/ml [21]. |
| 196 | (-)-5,6-dihydro-6-undecyl-2H-pyran-2-one | Toxicity | *In vitro* assay of compound demonstrated moderate cytotoxic activities, isolated from methanol extract of stem bark *H. superba* has $IC_{50}$ PC-3 cells (12.2 ± 0,9), HCT-116 cells (18.8 ± 2.8) and MCF-7 cells (15.0 ± 0.5) μM [42]. |
| 197 | (-)-5,6-dihydro-6-tridecyl-2H-pyran-2-one | Toxicity | *In vitro* assay of compound demonstrated moderate cytotoxic activities, isolated from methanol extract of stem bark *H. superba* has $IC_{50}$ PC-3 cells (15.3 ± 1.6), HCT-116 cells (13.4 ±0.1) and MCF-7 cells (20.5 ± 2.1) μM [42]. |
| 207 | Myristinin A | Anti-inflamantory | Isolated from the fruit of *H. amygdalin* had inhibition for PLA2 $IC_{50}$ 6.7 μM [80]. |
| | | Anti-inflammatory | Extraction fruits *M. cinnamomea* of chloroform Immortalized COX-1 and COX-2 mouse lung fibroblast cells less than $IC_{50}$ 10 and 16.9 μg/ml [57]. |
| | | Toxicity | Extraction fruits *M. cinnamomea* of chloroform had cytotoxicity to Vero cells $IC_{50}$ 17.7 μg/ml [57]. |
| | | Toxicity | The methanol extract of leaves *K. elegans* had P388 9 μM [73]. |
| | | Antifungal activity | Extraction fruits *M. cinnamomea* of chloroform, tested for their antifungal activity against a clinical isolate of Candida albicans $IC_{50}$ 8.8 μg/ml [57]. |

***Continued***

| Structure number | Compound | Biological activity | Description |
|---|---|---|---|
| 212 | Cathechin | Anti-inflammatory | Extraction acetone twigs and leaves of *H. kingii* had could inhibit iNOS expression in LPS-induced RAW264.7 cells 8.86 ± 0.35 µM [38]. |
| 213 | Myristinin B | Toxicity | Extraction fruits *M. cinnamomea* of chloroform, cytotoxicity to Vero cells 16.4 µg/ml [57]. |
| | | Antifungal activity | Extraction fruits *M. cinnamomea* of chloroform, tested for their antifungal activity against a clinical isolate of Candida albicans $IC_{50}$ 6.0 µg/ml [57]. |
| | | Anti-inflammatory | Extraction fruits *M. cinnamomea* of chloroform Immortalized COX-1 and COX-2 mouse lung fibroblast cells less than $IC_{50}$ 10 and 2.1 µg/ml [57]. |
| 214 | Myristinin C | Toxicity | Extraction fruits *M. cinnamomea* of chloroform had cytotoxicity to Vero cells 16.4 µg/ml [57]. |
| | | Antifungal activity | Extraction fruits *M. cinnamomea* of chloroform tested for their antifungal activity against a clinical isolate of Candida albicans $IC_{50}$ 6.0 µg/ml [34]. |
| | | Anti-inflammatory | Extraction fruits *M. cinnamomea* of chloroform Immortalized COX-1 and COX-2 mouse lung fibroblast cells less than $IC_{50}$ 10 and 2.1 µg/ml [57]. |
| 215 | Myristinin D | Toxicity | the methanol extract of leaves *K. elegans* have $P_{388}$ activity (9 µM). |
| | | | Extraction fruits *M. cinnamomea* of chloroform had cytotoxicity to Vero cells 13.6 µg/ml [57]. |
| | | Antioxidant | The methanol stem bark extract of *H. motleyi* stem bark had antioxidant activity (DPPH and ABTS) 47.1 µM and 23.7 µM [82] |
| | | Antidiabetic | The methanol extract of *H. motleyi* stem bark had Rat intestinal α-glucosidase inhibitory activity 53.8 µM [82]. |
| | | Anti-inflammatory | Extraction fruits *M. cinnamomea* of chloroform had Immortalized COX-1 and COX-2 mouse lung fibroblast cells less than $IC_{50}$ 10 and 4.5 µg/ml [57]. |
| 216 | Myristinin E | Antidiabetic | The methanol extract of *H. motleyi* stem bark had Rat intestinal α-glucosidase inhibitory activity 67.0 µM [82]. |
| | | Antioxidant | The methanol stem bark extract of *H. motleyi* had antioxidant activity was on DPPH and ABTS radical 40.3 µM and 20.3 µM [82]. |
| | | Toxicity | Extraction fruits *M. cinnamomea* of chloroform had cytotoxicity to Vero cells 8.9 µg/ml [57]. |
| | | Antifungal activity | Extraction fruits *M. cinnamomea* of chloroform had antifungal activity against a clinical isolate of Candida albicans $IC_{50}$ 5.9 µg/ml [57]. |
| | | Anti-inflammatory | Extraction fruits *M. cinnamomea* of chloroform had Immortalized COX-1 and COX-2 mouse lung fibroblast cells less than $IC_{50}$ 10 and 1.4 µg/ml [57]. |
| 217 | Myristinin F | Toxicity | Extraction fruits *M. cinnamomea* of chloroform had cytotoxicity to Vero cells 8.9 µg/ml [57]. |
| | | Antifungal activity | Extraction fruits *M. cinnamomea* of chloroform had antifungal activity against a clinical isolate of Candida albicans $IC_{50}$ 5.9 µg/ml [57]. |
| | | Anti-inflammatory activity | Extraction fruits *M. cinnamomea* of chloroform had Immortalized COX-1 and COX-2 mouse lung fibroblast cells less than $IC_{50}$ 10 and 1.4 µg/ml [57]. |
| 228 | Myristinin G | Antidiabetic | The methanol extract of *H. motleyi* stem bark had Rat intestinal α-glucosidase inhibitory activity 107.0 µM [82]. |
| | | Antioxidant | The methanol stem bark of *H. motleyi* had antioxidant activity on DPPH and ABTS radical 279.9 µM and 54.3 µM [82]. |
| 229 | Myristinin I | Toxicity | The ethyl acetate extract of fruit *H. irya* had cytotoxic effect on HeLa cells and HCT116 $IC_{50}$ cells 4.53 ± 0.05 and 4.53 ± 0.16 µg/ml [40]. |
| 230 | Biochanin A | Toxicity | The methanol extract of leaves *K. furfuracea* had NCL-H187 cells $IC_{50}$ 19.09 inactive on KB and MCF-7 cells [69]. |
| 240 | Giffithane | Toxicity | The compound from ethyl acetate extract of *K. globularia* had cytotoxic activity with NCI-H187 and MCF-7 cells 3.08 and 6.68 mg/ml [65]. |
| 245 | Fisetinidol | Anti-inflammatory | The acetone extract of twigs and leaves *K. furfuracea* is active inhibition (15.14 µM) [46]. |
| 265 | (+)-7,4′-dihdroxy-4′-methoxyflavanol | Anti-inflammatory | The acetone extract of twigs and leaves *K. furfuracea* is active inhibition 13.79 µM [46]. |

enzymes [17,18,58,81,82]. Furthermore, it has been discovered that the dichloromethane extract of *K. glauca* leaves has potent antidiabetic action against α-glucosidase inhibition, $IC_{50}$ of 4.09 µg/ml [75] (Table 9).

**Antibacterial activity**

The antibacterial, antifungal, and antiviral properties of several Myristcacae families have been studied. Gram-positive and Gram-negative bacteria were inhibited in the extracts of *M. fragrans, Myristica mondora, M. fatua, Knema attenuate, K. glauca, Horsfieldia helwigii,* and *H. spicata*. The chloroform extracts [62] and acetone extracts [23] of *M. fatua* seeds inhibited *Staphylococcus aureus* bacteria and *Aspergillus niger*. MeOH extract leaves and full-ripe fruits *M. fragrans* inhibit bacteria with the lowest MIC 50 mg/ml against *S. aureus* and *Bacillus cereus* [52]. The essential oil of *M. mondora* has antibacterial *Escherichia coli* and *S. aureus* [24]. The ethanolic stem bark extract [71] and chloroform and hexane aryl and seed extracts [72] of *K. attenuate* microbial activity. Methanol extract of stems *H. spicata* had microbial activity *Bacillus subtilis* and *Pseudomonas aeruginosa* [84] in Table 8.

The antibacterial and antifungal qualities of several substances identified from different sections of the *M. fragrans, M. argantea,* and *M. cinnamomea* plants are encouraging. Compounds **77** [20] and **257** [21] from *M. fragrans* were found to be effective against *Streptococcus mutans*, while compound **139** from *M. argantea* displayed strong antibacterial activity against the same target [54]. Myristinin compounds from *M. cinnamomea* were shown to have antifungal activity. In addition, malabaricone **1** and **2** from *M. malabarica* demonstrated anti-promastigote/parasitic activity [28]. The results indicate that these substances hold significance in creating novel drugs that combat infections and fight fungal growth (Table 9).

**Antioxidant activity**

Several species within the Myristicaceae family have been shown to be a source of antioxidants, such as *M. fatua, Myristica iners, M. malabarica, M. fragrans, M. monodora, H. spicata, H. irya, K. furfuracea,* and *Knema laurina*. These species were tested using the radical scavenger inhibition DPPH method [81,82] as shown in Table 8. In addition, investigations of compounds **17**, **40**, **215**, **216**, and **228** were obtained from methanol extracts of *H. macrobotrys* and *H. motleyi*, **131** (*K. elegans*) [74], **3**, **9**, **13**, **14**, and **15** (*M. maxima*) [30], **139**, and **152** (*M. argentea*) [9], and **57** (*M. fatua*) [18] demonstrated antioxidant activity as shown in Table 9.

## CONCLUSION

This article aims to review the existing knowledge regarding the species of the *Myristica*, *Knema*, and *Horsfieldia* genus (Myristicaceae), which is an important effort to document various reports on the phytochemistry and pharmacology of medicinal plants from this family. Although the multiple benefits and traditional uses of Myristicaceae plants are known, only a few plant species have been investigated for their restorative and food preservative uses based on phytochemical and pharmacological reports, despite more than 520 known species of Myristicaceae. The data provided in this review will likely form the basis of further scientific research regarding this plant family. In addition, understanding the pharmacological studies in this family may be useful for validating their claimed traditional uses. The literature reviewed shows that different *Myristica*, *Knema*, and *Horsfieldia* species are good natural sources for various natural compounds with diverse and interesting chemical structures. The main classes of compounds reported in the literature include lignans and polyketides. A review of the pharmacology of the genus shows that many lignans and polyketides were isolated and exhibited strong, moderate to weak anticancer properties. These two groups of compounds also show a significant effect on antibacterial and anti-inflammatory activity. Pharmacological and phytochemical investigations have established that phytochemicals and crude extracts from various parts of the Myristicaceae family have versatile biological activities. However, modern drugs can be developed only after an intensive investigation of their bioactivity, mechanism of action, toxicity, and proper standardization and clinical trials.

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## AUTHOR CONTRIBUTIONS

MM: methodology, investigation, formal analysis, writing original draft, review, and editing.

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## CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest related to the publication of this article.

## ETHICAL APPROVALS

This study does not involve experiments on animals or human subjects.

## DATA AVAILABILITY

All data generated and analyzed are included in this research article.

## USE OF ARTIFICIAL INTELLIGENCE (AI)-ASSISTED TECHNOLOGY

The authors declares that they have not used artificial intelligence (AI)-tools for writing and editing of the manuscript, and no images were manipulated using AI.

## PUBLISHER'S NOTE

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## REFERENCES


1. Christenhusz MJM, Byng JW. The number of known plants species in the world and its annual increase. Phytotaxa [Internet]. 2016;261(3):201–17. Available from: https://www.biotaxa.org/Phytotaxa/article/view/phytotaxa.261.3.1/20598
2. Bingtao L, Wilson TK. Myristicaceae. Flora China. 2008;7:99–101.
3. Arrijani A. Phenetic relationship of genus *Knema*, *Horsfieldia*, and *Myristica* in Java based on pollen morphological evidence. Biodivers J Biol Divers. 2003;4(2):83–8.
4. Valderrama J. Distribution of flavonoids in the Myristicaceae. Phytochemistry. 2000;55(6):505–11.
5. Arrijani A. Biology and conservation of genus *Myristica* in Indonesia. Biodivers J Biol Divers. 2005;6(2):147–51.
6. Pandey R, Mahar R, Hasanain M, Shukla SK, Sarkar J, Rameshkumar KB, *et al*. Rapid screening and quantitative determination of bioactive compounds from fruit extracts of *Myristica* species and their *in vitro* antiproliferative activity. Food Chem [Internet]. 2016;211:483–93. doi: http://dx.doi.org/10.1016/j.foodchem.2016.05.065
7. Gonzalez MJTG, Deoliveira CJC, Fernandes JO, Kjjoa A. Further alkyl and alkenylphenols of *Knema laurina* and *Knema austrosiamensis*. Phytochemistry. 1996;43(6):1333–7.
8. Salleh WMNH, Shakri NM, Khamis S, Setzer W, Nadri MH. Chemical composition of three Malaysian *Horsfieldia* essential oils. Nat Prod Res [Internet]. 2022 Apr 3;36(7):1909–13. doi: https://doi.org/10.1080/14786419.2020.1819274
9. Calliste C, Kozlowski D, Duroux J, Champavier Y, Chulia A, Trouillas P. A new antioxidant from wild nutmeg. Food Chem [Internet]. 2010;118(3):489–96. doi: http://dx.doi.org/10.1016/j.foodchem.2009.05.010
10. Salleh WMNHW, Ahmad F. Phytochemistry and biological activities of the genus *Knema* (Myristicaceae). Pharm Sci [Internet]. 2017;23:249–55. doi: http://dx.doi.org/10.15171/PS.2017.37
11. Helen M, Vargheese TA, Jeeja K, Abiramy, Sajina, Seree J. Phytochemical analysis and anticancer activity of essential oil from. Int J Curr Pharm Rev Res. 2012;2:188–98.
12. Pillai S, Mahmud R, Lee WC, Perumal S. Anti-parasitic sctivity of *Myristica fragrans* Houtt. Essential oil against *Toxoplasma gondii* parasite. SciVerse ScienseDirct [Internet]. 2012;2:92–6. doi: http://dx.doi.org/10.1016/j.apcbee.2012.06.017
13. Acuna U, Carcache P, Matthew S, Blanco E. New acyclic bis phenylpropanoid and neolignans, from *Myristica fragrans* Houtt., exhibiting PARP-1 and NF-κB inhibitory effects. Food Chem. 2016;202:269–75.
14. Cao GY, Yang XW, Xu W, Li F. New inhibitors of nitric oxide production from the seeds of *Myristica fragrans*. Food Chem Toxicol [Internet]. 2013;62:167–71. doi: http://dx.doi.org/10.1016/j.fct.2013.08.046
15. Cao GY, Xu W, Yang XW, Gonzalez F, Li F. New neolignans from the seeds of *Myristica fragrans* that inhibit nitric oxide production. Food Chem [Internet]. 2015;173:231–7. doi: http://dx.doi.org/10.1016/j.foodchem.2014.09.170
16. Cuong TD, Hung TM, Na M, Ha DT, Kim JC, Lee D, *et al*. Inhibitory effect on NO production of phenolic compounds from *Myristica fragrans*. Bioorg Med Chem Lett. 2011;21(22):6884–7.
17. Prabha B, Neethu S, Krishnan S, Sherin D, Madhukrishnan M, Ananthakrishnan R, *et al*. Antidiabetic potential of phytochemicals isolated from the stem bark of *Myristica fatua* Houtt. var. magnifica (Bedd.) Sinclair. Bioorg Med Chem. 2018;26(12):3461–7.
18. Megawati, Darmawan A, Fajriah S, Primahana G, Dewi RT, Minarti, *et al*. Antioxidant and α-glucosidase activities of benzoic acid derivate from the bark of *Myristica fatua* Houtt. AIP Conference Proceedings. Indonesia: American Institute of Physics; 2017. p 020027. Available from: https://pubs.aip.org/aip/acp/article/830275
19. Nguyen PH, Le TVT, Kang HW, Chae J, Kim SK, Kwon KI, *et al*. AMP-activated protein kinase (AMPK) activators from *Myristica fragrans* (nutmeg) and their anti-obesity effect. Bioorgan Med Chem Lett [Internet]. 2010;20:4128–31. doi: http://dx.doi.org/10.1016/j.bmcl.2010.05.067
20. Chung J, Choo J, Lee M, Hwang J. Anticariogenic activity of macelignan isolated from *Myristica fragrans* (nutmeg) against *Streptococcus mutans*. Phytomedicine. 2006;13(4):261–6.
21. López V, Gerique J, Langa E, Berzosa C, Valero MS, Gómez-Rincón C. Antihelmintic effects of nutmeg (*Myristica fragans*) on Anisakis simplex L3 larvae obtained from *Micromesistius* potassou. Res Vet Sci [Internet]. 2015;100:148–52. doi: http://dx.doi.org/10.1016/j.rvsc.2015.03.033
22. Jung WC, Jang YS, Hieu TT, Lee CK, Ahn YJ. Toxicity of *Myristica fragrans* seed compounds against *Blattella germanica* (Dictyoptera: Blattellidae). J Med Entomol. 2007;44(3):524–9.
23. Gupta AD, Bansal VK, Babu V, Maithil N. Chemistry, antioxidant and antimicrobial potential of nutmeg (*Myristica fragrans* Houtt). J Genet Eng Biotechnol [Internet]. 2013;11(1):25–31. doi: http://dx.doi.org/10.1016/j.jgeb.2012.12.001
24. Okechukwu QN, Ugwuona FU, Ofoedu CE, Juchniewicz S, Okpala COR. Chemical composition, antibacterial efficacy, and antioxidant capacity of essential oil and oleoresin from *Monodora myristica* and *Tetrapleura tetraptera* in Southeast Nigeria. Sci Rep [Internet]. 2022;12(1):1–13. doi: https://doi.org/10.1038/s41598-022-23161-5
25. Cooray N, Jansz E, Wimalasena S, Wijesekera T, Nair B. Acylresorcinols from seed kernels of *Myristica dactyloides*. Phytochemistry. 1987;26:3369–71.
26. Pham VC, Jossang A, Sévenet T, Bodo B. Cytotoxic acylphenols from *Myristica maingayi*. Tetrahedron. 2000;56(12):1707–13.
27. Pham VC, Jossang A, Sévenet T, Bodo B. Novel cytotoxic acylphenol dimers of *Myristica gigantea*; enzymatic synthesis of giganteones A and B. Tetrahedron. 2002;58(28):5709–14.
28. Sen R, Bauri AK, Chattopadhyay SC. Antipromastigote activity of the malabaricones of *Myristica malabarica* (Rampatri). Phyther Res. 2008;21:592–5.
29. Maia A, Schmitz-Afonso I, Martin M, Awang K, Laprévote O, Guéritte F, *et al*. Acylphenols from *Myristica crassa* as new acetylcholinesterase inhibitors. Planta Med. 2008;74(12):1457–62.
30. Othman MA, Sivasothy Y, Looi CY, Ablat A, Mohamad J, Litaudon M, *et al.* Acylphenols and dimeric acylphenols from *Myristica maxima* Warb. Fitoterapia. 2016;111:12–7.
31. Wahab SMA, Sivasothy Y, Liew SY, Litaudon M, Mohamad J, Awang K. Natural cholinesterase inhibitors from *Myristica cinnamomea* King. Bioorg Med Chem Lett [Internet]. 2016;26(15):3785–92. doi: http://dx.doi.org/10.1016/j.bmcl.2016.05.046
32. Neethu S, Govind MG, Vimalkumar PS, Biji M, Sherin DR, Dan M, *et al.* Novel flavonoids from the aerial parts of unexplored and endangered wild nutmeg species *Myristica beddomei* subsp. spherocarpa W. J. de Wilde. Phytochem Lett [Internet]. 2021;45:72–6. doi: https://doi.org/10.1016/j.phytol.2021.07.007
33. Megawati, Darmawan A. Resorcinol compounds isolated form the bark of *Myristica fatua* Houtt. Indones J Pharm. 2017;28(2):82–90.
34. Ragasa CY, Torres OB, Mandia EH, Bernardo L, Shen CC. Phenolics from *Knema stellata* subsp. cryptocaryoides. Chem Nat Compd. 2015;51(6):1169–70.
35. Chen S, Tsutsumi T, Takatsuki S, Matsuda R, Kameya H, Nakajima M, *et al.* Identification of 2-alkylcyclobutanones in nutmeg (*Myristica fragrans*). Food Chem. 2012;134(1):359–65.
36. Ramadhan R, Phuwapraisirisan P. Arylalkanones from *Horsfieldia macrobotrys* are effective antidiabetic agents achieved by α-glucosidase inhibition and radical scavenging. Nat Prod Commun. 2015;10(2):325–8.

37. Lu Z, Van Wagoner RM, Pond CD, Pole AR, Jensen JB, Blankenship D, *et al.* Myristicyclins A and B: antimalarial procyanidins from *Horsfieldia spicata* from Papua new guinea. Org Lett. 2014;16(2):346–9.
38. Zhan R, Li D, Liu YL, Xie XY, Chen L, Shao LD, *et al.* Structural elucidation, bio-inspired synthesis, and biological activities of cyclic diarylpropanes from *Horsfieldia kingii*. Tetrahedron. 2020;76(40):1–8.
39. Liu B, Chen YG, Tian XJ, Zhan R. Diarylpropanes from *Horsfieldia kingii*. Nat Prod Res. 2021 Apr 3;35(7):1127–33.
40. Suthiwong J, Sribuhom T, Wongphakham P, Senawong T, Yenjai C. Cytotoxicity of acylphloroglucinol derivatives from the fruits of *Horsfieldia irya*. Nat Prod Res. 2021 Dec 2;35(23):4930–8.
41. Gonzalez MJ, Pinto MMM, Kijjoa A, Kengthong S, Mondanondra I, Silva AMS, *et al.* 5,7-Dihydroxychromones and 8-hydroxytetrahydrochromones from *Horsfieldia irya*. Phytochemistry. 2002;61:995–8.
42. Al-Mekhlafi NA, Shaari K, Abas F, Jeyaraj EJ, Stanslas J, Khalivulla SI, *et al.* New flavan and alkyl α,β-lactones from the stem bark of *Horsfieldia* superb. Nat Prod Commun. 2013;8(4):447–51.
43. Ma Q, Liu Y, Zhan R, Chen Y. A new isoflavanone from the trunk of *Horsfieldia pandurifolia*. Nat Prod Res. 2015;(2):1–9.
44. Du SZ, Wang ZC, Liu Y, Zhan R, Chen YG. Diarylpropanes and lignans from *Horsfieldia tetratepala*. Phytochem Lett. 2017;19:98–100.
45. Rangkaew N, Suttisri R, Moriyasu M, Kawanishi K. A new acyclic diterpene acid and bioactive compounds from *Knema glauca*. Arch Pharm Res. 2009;32(5):685–92.
46. Wang CF, Kuang F, Wang WJ, Luo L, Li QX, Liu Y, *et al.* Phenolic compounds with anti-inflammatory effects from *Knema furfuracea*. Results Chem [Internet]. 2021;3:100175. doi: https://doi.org/10.1016/j.rechem.2021.100175
47. Lu Z, Wu WC, Wang M, Zhang JQ, Chen YG, Zhan R, *et al.* Flavonoids from the leaves and twigs of *Knema elegans*. Biochem Syst Ecol [Internet]. 2020;88:103991. doi: https://doi.org/10.1016/j.bse.2019.103991
48. Sriphana U, Yenjai C, Koatthada M. Cytotoxicity of chemical constituents from the roots of *Knema globularia*. Phytochem Lett. 2016;(11):129–33.
49. Gény C, Rivière G, Bignon J, Birlirakis N, Guittet E, Awang K, *et al.* Anacardic acids from *Knema hookeriana* as modulators of Bcl-xL/Bak and Mcl-1/Bid interactions. J Nat Prod. 2016;79(4):838–44.
50. Gunatilaka AL, de Silva AJ, Sotheeswaran S, Tillekeratne L. Horsfieldin, a lignan and other constituents from *Horsfieldia iryaghedhi*. Phytochemistry. 1982;21(11):2719–23.
51. Peng W, Caiqiong Y, Zahn R, Chen Y. Two new flavans from the trunk and leaves of *Horsfieldia glabra*. Nat Prod Res. 2016;30(20):1–6.
52. Sulaiman SF, Ooi KL. Antioxidant and anti food-borne bacterial activities of extracts from leaf and different fruit parts of *Myristica fragrans* Houtt. Food Control [Internet]. 2012;25(2):533–6. doi: http://dx.doi.org/10.1016/j.foodcont.2011.11.005
53. Piaru SP, Mahmud R, Majid AMS, Nassar ZD. Antioxidant and antiangiogenic activities of the essential oils of *Myristica fragrans* and *Morinda citrifolia*. Asian Pac J Trop Med [Internet]. 2012;5(4):294–8. doi: http://dx.doi.org/10.1016/S1995-7645(12)60042-X
54. Nakatani N, Ikeda K, Kikuzaki H, Kido M, Yamaguchi Y. Diaryldimethylbutane lignans from *Myristica argentea* and their antimicrobial action against *Streptococcus mutans*. Phytochemistry. 1988;27(10):3127–9.
55. Bandyopadhyay C, Manna A, De S, Yasmin N, Bauri AK, Chattopadhyay S, *et al.* Anti-tumor effect of fruit rind of *Myristica malabarica* in an Ehrlich ascites carcinoma model. Int J Basic Clin Pharmacol. 2019;8(3):383.
56. Manjunatha BK, Mankani KL, Mukunda SK, Divakara R, Sridar BK, Paul K. Antioxidant and hepato protective effect of *Myristica malabarica* seed aril extracts on carbon tetrachloride induced hepatic damage. Glob J Biotechnol Biochem. 2011;6(1):25–30.
57. Sawadjoon S, Kittakoop P, Kirtikara K, Vichai V, Tanticharoen M, Thebtaranonth Y. Atropisomeric myristinins: selective COX-2 inhibitors and antifungal agents from *Myristica cinnamomea*. J Org Chem. 2002;67(16):5470–5.
58. Sivasothy Y, Loo KY, Leong KH, Litaudon M, Awang K. A potent alpha-glucosidase inhibitor from *Myristica cinnamomea* King. Phytochemistry [Internet]. 2016;122:265–9. doi: http://dx.doi.org/10.1016/j.phytochem.2015.12.007
59. Fajriah S, Darmawan A, Megawati, Hudiyono S, Kosela S, Hanafi M. New cytotoxic compounds from *Myristica fatua* Houtt leaves against MCF-7 cell lines. Phytochem Lett. 2017a;20:36–9.
60. Fajriah S, Megawati, Hudiyono S, Kosela S, Hanafi M. Chemical constituents and potential cytotoxic activity of n- hexane fraction from *Myristica fatua* Houtt leaves. AIP Conf Proc. 2017b;1862:030087
61. Fajriah S, Megawati. Phytochemical screening and toxicity assay from *Myristica fatua* Houtt leaves. Chim Nat Acta. 2015;3(3):116–9.
62. Viveka MR, Chandrashekar KR. Antioxidant and antibacterial activities of *Myristica fatua* var. Magnifica (Beddome) Sinclair. Asian J Pharm Clin Res. 2016;9(4):235–9.
63. Lestari F, Rija'i HRH. DPPH free radical scavenging activity test of ethyl acetate extract of stem penara (*Myristica iners* Blume.). Proceeding of Mulawarman Pharmaceuticals Conferences [Internet]. Indonesia: Fakultas Farmasi, Universitas Mulawarman; 2021. pp 65–71. Available from: http://prosiding.farmasi.unmul.ac.id/index.php/mpc/article/view/416/399
64. Arunachalam KD, Subhashini S. Preliminary phytochemical investigation and wound healing activity of *Myristica andamanica* leaves in Swiss albino mice. J Med Plants Res. 2011;5(7):1095–106.
65. Sriphana U, Yenjai C, Suthiwong J, Poopasit K. A new diarylhexane and two new diarylpropanols from the roots of *Knema globularia*. Nat Prod Res [Internet]. 2020;36(7):1741–8. doi: https://doi.org/10.1080/14786419.2020.1815736
66. Wenli M, Wei N, Yan H, Changxiang C. Flavonoids from *Knema globularia*. Nat Prod Res Dev. 2002;14(5):26–8.
67. Giap TH, Duc PM, Van The N, Popova M, Bankova V, Hue CT, *et al.* Chemical constituents and biological activities of the fruits of *Knema pachycarpa* de Wilde. Nat Prod Res [Internet]. 2021 Feb 1;35(3):455–64. doi: https://doi.org/10.1080/14786419.2019.1637868
68. Giap TH, Thoa HT, Oanh VTK, Hang NTM, Dang NH, Thuc DN, *et al.* New acetophenone and cardanol derivatives from *Knema pachycarpa*. Nat Prod Commun. 2019 Jun 16;14(6):1934578X1985004.
69. Rangkaew N, Suttisri R, Moriyasu M, Kawanishi K. A new arylnaphthalene lignan from *Knema furfuracea*. Fitoterapia [Internet]. 2009;80(6):377–9. doi: http://dx.doi.org/10.1016/j.fitote.2009.05.005
70. Wulansari D, Chairul. Antioxidant screening activity of several Indonesian medicinal plants using 2,2-difenil 1-1 picrylhidrazil(DPPH). Maj Obat Tradis. 2011;16(1):22–5.
71. Raja S, Suku J. *In vitro* evaluation of antimicrobial activity of *Knema attenuata* stem bark extract. Indo Am J Pharm Res. 2017;7(07):242–7.
72. Vinayachandra, Chandrashekar K. Phenolic contents of *Knema attenuata* fruits and their bioactive potentials. J Herbs Spices Med Plants. 2014;20(2):183–95.
73. Deng J, Starck SR, Li S, Hecht SM. (+) Myristinins A and D from *Knema elegans*, which inhibit DNA polymerase β and cleave DNA. J Nat Prod. 2005;68:1625–8.
74. Zhang YX, Lu Z, Wu WC, Chen YG, Zhan R. Bioactive flavonoids from *Knema elegans*. Phytochem Lett [Internet]. 2021;42:121–4. doi: https://doi.org/10.1016/j.phytol.2020.12.005
75. Jaafar FM, Ridhwan MJM, Mustapha NM, Alias A, Ismail N. Antidiabetic effects of *Knema glauca* leaf extract toward inhibitios of A- amylase and A-glucosiase assays. Sci Eng. 2016;3(78):103–8.

76. Salleh WMNHW, Anuar MZA, Khamis S, Nafiah MA, Sul'ain MD. Chemical investigation and biological activities of the essential oil of *Knema kunstleri* Warb. from Malaysia. Nat Prod Res [Internet]. 2019;35(3):1–7. doi: https://doi.org/10.1080/14786419.2019.1669027
77. Pinto M, Kijjoa A, Tantisewie B, Yoshida M, Gottlieb OR. Arylalkanones from *Horsfieldia glabra*. Phytochemistry. 1988;27:3988–9.
78. Du SZ, Kuang F, Liu Y, Chen YG, Zhan R. A new dimeric diarylpropane from *Horsfieldia tetratepala*. Nat Prod Res [Internet]. 2018;32(2):162–6. doi: https://doi.org/10.1080/14786419.2017.1342087
79. Ma Q, Min K, Li HL, Jiang JH, Liu Y, Zhan R, *et al.* Horsfiequinones A-F, dimeric diarylpropanoids from *Horsfieldia tetratepala*. Planta Med. 2014;80(8–9):688–94.
80. Miyake A, Yamamoto H, Takebayashi Y, Imai H, Honda K. The novel natural product YM-26567-1 [(+)-trans-4-(3-dodecanoyl-2,4,6-trihydroxyphenyl)-7-hydroxy-2-(4-hydroxyphenyl)chroman]a competitive inhibitor of group II phospholipase A2.pdf. J Pharmacol Exp Ther. 1992;263:1302–7.
81. Ramadhan R, Phuwapraisirisan P. New arylalkanones from *Horsfieldia macrobotrys*, effective antidiabetic agents concomitantly inhibiting α-glucosidase and free radicals. Bioorg Med Chem Lett. 2015 Oct 15;25(20):4529–33.
82. Ramadhan R, Kusuma IW, Amirta R, Worawalai W, Phuwapraisirisan P. A new 4-arylflavan from the pericarps of *Horsfieldia motleyi* displaying dual inhibition against α-glucosidase and free radicals. Nat Prod Res. 2018;32(22):2676–82.
83. Khan MR, Kihara M, Omoloso AD. Antimicrobial activity of *Horsfieldia helwigii* and *Melia azedarach*. Fitoterapia. 2001;72(4):423–7.
84. Minarti M, Ariani N, Prastya M, Darmawan A, Megawati M. Antioxidant and antibacterial properties derived from *Horsfieldia spicata* (Roxb.) J. Sinclair stem bark extract and its active fraction. Proceedings of the 1st International Conference for Health Research—BRIN (ICHR 2022). Dordrecht, Netherlands: Atlantis Press International BV; 2023. pp 327–7.
85. Du S, Wang Z, Liu Y, Zhan R, Chen Y. Diarylpropanes and lignans from *Horsfieldia tetratepala*. Phytochem Lett. 2017;19:98–100.
86. Woo WS, Shin KH, Wagner H, Lotter H. The structure of macelignan from *Myristica fragrans*. Phytochemistry. 1987;26(5):1542–3.
87. Lee SU, Ki SS, Shi YR, Yong KM, Seong HK. Machilin A isolated from *Myristica fragrans* stimulates osteoblast differentiation. Planta Med. 2009;75(2):152–7.
88. Hada S, Hattori M, Tezuka Y, Kikuchi T, Namba T. New neolignans and lignans from the aril of *Myristica fragrans*. Phytochemistry. 1988;27(2):563–8.
89. Herath HMTB, Priyadarshini AMA. Lignans from *Myristica dactyloides*. Phytochemistry. 1997;44(4):699–703.
90. Herath HMTB, Priyadarshani AMA. Two lignans and an aryl alkanone from *Myristica dactyloides*. Phytochemistry. 1996;42(5):1439–42.
91. Nemethy EK, Lago R, Hawkins D, Calvin M. Lignans of *Myristica otoba*. Phytochemistry. 1986;25(4):959–60.
92. Wahyuni S, Susilowati M, Bakri A, Bermawie N. Fruit and seed variation of wild nutmeg (*Myristica schefferi* Warb.) in South Aceh, Indonesia. Indonesia: IOP Publishing Ltd; 2022. p 012067. Available from: https://iopscience.iop.org/article/10.1088/1755-1315/974/1/012067
93. Ragasa CY, Torres OB, Vincent J, Tongco V, Razal RA, Shen CC. Resorcinols from *Myristica philippensis* Lam. J Chem Pharm Res [Internet]. 2013;(5):614–6. Available from: www.jocpr.com
94. Chong YM, Yin WF, Ho CY, Mustafa MR, Hadi AHA, Awang K, *et al.* Malabaricone C from *Myristica cinnamomea* exhibits anti-quorum sensing activity. J Nat Prod. 2011;74(10):2261–4.
95. Zhan R, Hu YT, Shao LD, Qin XJ, Kuang F, Du SZ, *et al.* Horisfieldones A and B, two aromatic ring-contracted dimeric diarylpropanes with human DOPA decarboxylase inhibitory activity from *Horsfieldia kingii*. Org Lett. 2019;21(10):3678–81.
96. Kumar NS, Herath HM, Karunaratne V. Arylalkanones from *Myristica dactyloides*. Phytochemistry. 1988;27(2):465–8.
97. Chopra B, Dhingra A, Dhar KL, Nepali K, Prasad D. Role of terpenoids as anticancer compounds: an insight into prevention and treatment. Key Heterocycl. 2022;1:57–104.
98. Wimalasena S, Karunawansha E. Characterization of a new aryl alkanone and other compound presents in *Horsfieldia irya* seeds. J Natl Sci Found Sri Lanka. 1994;22(3):301–4.
99. Tillekeratne L, Jayamanne K, Weerasuria K, Gunatilaka AL. Lignans of *Horsfieldia iryaghedhi*. Phytochemistry. 1982;21(12):476–8.
100. Chatterjee S, AnanthaKumar A, Variyar PS, Sharma A. Identification and estimation of a novel fluorescent compound in nutmeg. J Food Compos Anal. 2008;21(7):577–81.
101. Dang JL, Yang XB, Huang YF, Ye F, Luo T, Chen SL, *et al.* GC-MS analysis on the chemical constituents of essential oil from bark of *Horsfieldia hainanensis*. Zhong Yao Cai. 2009;32(5):714–6.
102. Taher M, Susanti D, Rezali MF. A new sesquiterpene from *Knema patentinervia*. Chem Nat Compd. 2013;48(6):985–7.
103. Talukdar AC, Jain N, De S, Krishnamurty HG. An isoflavone from *Myristica malabarica*. Phytochemistry. 2000;53(1):155–7.
104. Jossang A, Jossang P, Hadi H, Sevenet T, Bodo B. Horsfiline, an alkaloid from *Horsfieldia superba*. J Org Chem [Internet]. 1991 Nov 1;56(23):6527–30. Available from: https://pubs.acs.org/doi/abs/10.1021/jo00023a016
105. Susanty, Suryarachma H, Sari AM, Purnawan I, Sari F. Pengaruh Ekstrak Daun Tanaman Pala (*Horsfieldia spicata*) Terhadap Persentase Nilai Peredaman Radikal Bebas. JurnalUmjAcId/IndexPhp/Semnastek. 2022;(November):1–9.



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