

Pharmacological, medicinal, nutritional and phytofungicidal properties of *Xylopi aethiopica* (Dunal) A. rich., *Piper guineense* Schumach. & Thonn. and *Monodora myristica*(Gaertn.) dunal spices

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Received on: 30/01/2025

Accepted on: 07/06/2025

Published on: 10/06/2025

ABSTRACT

Mankind has constantly sought empirical treatments for health problems and nutritional deficits since time immemorial. In this regard, several botanicals from renowned plant species have been employed. This recognition is largely due to the presence of a wide repertoire of biologically active phytoconstituents. Thus, this review explores the culinary and medicinal applications of the *Xylopi aethiopica*, *Piper guineense* and *Monodora mystica*; validating their continual usage in managing various health conditions and their importance in enhancing food flavor, food preservation, and nutritional value. This was achieved by collation of relevant articles published reputable journals indexed in Scopus, Web of Science, PubMed and other databases from 2015 till date. Finally, a summary of findings, concluding remark and recommendations on the medicinal and culinary applications of the said spices were presented.

Keywords: Phytochemicals; Spices; Antioxidants; Preservatives; Food Chemistry

How to cite this article: Etaware PM, Usama CJ, Egara OW and Ekun VS (2025). Pharmacological, medicinal, nutritional and phytofungicidal properties of *Xylopi aethiopica* (Dunal) A. Rich., *Piper guineense* Schumach. & Thonn. and *Monodora myristica*(Gaertn.) dunal spices. J. Agri. Res. Adv., 07(02): 23-32.

Introduction

There is widespread recognition of the therapeutic and nutritional efficacies of plants in the management of a variety of pathologies and malnourishment in populations. This recognition which has been present in every era of history and in many civilizations around the globe, is largely due to the presence of a wide repertoire of biologically active phytoconstituents (Nwokeke *et al.*, 2019). Thus, the connection between traditional medicine and culinary practices has long been a defining feature of ethnobotany. Moreover, the theory behind plant-derived medications is that they are naturally occurring compounds that are capable of improving health and treating diseases, and they are also substantially economical (Quadri *et al.*, 2021).

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Accordingly, several indigenous plants serve dual roles, offering both nutritional and therapeutic benefits. Among these, *Xylopi aethiopica*, *Piper guineense* and *Monodora myristica* spice plants are particularly significant due to their extensive use in West and Central African cuisines and traditional healing systems (Akinmoladun *et al.*, 2021). They are rich in aromatic compounds and have found wide applications in traditional medicine, industries, food preservation, and the improvement of sensory characteristics. Moreover, several ethnic cuisines are exceptionally certified owing to their spice constituents. A Few examples are Indian cuisine (turmeric), Thai cuisine (lemon grass, ginger, and, chili peppers), Italian cuisine (basil, sage, rosemary and oregano) and the African/Nigerian

“Pepper soup” (basted melegueta, clove, alligator pepper, ginger, black pepper, garlic, Ethiopian pepper, chilli peppers, and African nutmeg,

Ashanti pepper and other spices) (Evuen *et al.*, 2022).

Xylopia aethiopica, a deciduous tree that belongs to the plant family, *Annonaceae* is predominant in West Africa and is commonly referred to as *pepper tree*, *African guinea pepper*, *Ethiopian pepper*, or *Senegal pepper*. In Nigeria, *X. aethiopica* has many vernacular names: *eeru* (Yoruba), *Kimba* (Hausa), *uda* (Igbo) and *urherien* (Urhobo). The medicinal and culinary importance of *X. aethiopica* has been reported (Adepoju *et al.*, 2019). *Piper guineense* is a West African spice plant commonly called Ashanti pepper. In Nigeria, it is known as *uzizain* Igbo and *Iyerein* Yoruba. It has other common names such as *Guinea pepper*, *Benin pepper*, and *False cubeb*. *Piper guineense* is utilized in different forms for a variety of purposes; culinary, medicinal, cosmetic, and insecticidal uses (Okwu and Morah, 2020). *Monodora myristica*, a perennial plant of the *Annonaceae* family that grows well in the tropics of West Africa and the Caribbean, is also referred to as *African nutmeg* or *calabash nutmeg*. The seed contains a variety of components and is highly valuable because of its medicinal and nutritional properties. (Okechukwu *et al.*, 2022). *M. myristica* seeds are frequently utilized in medicine and cuisine. In traditional medicine, the fruits and seeds of spices are used as stimulants and effectively in the treatment of haemorrhoids, sores, feverish pains, stomach aches and eye disorders. *M. myristica* has a pleasant aroma that makes it useful when preparing conventional dishes (Ezeuko *et al.*, 2017).

Despite the widespread culinary and medicinal use of *Piper guineense*, *Xylopiiaethiopica*, and *Monodora myristica* in West African traditional practices, their potential health benefits and bioactive compounds remain underexplored in scientific literature. Moreover, the integration of these spices into modern medicine and functional food industries is constrained by a lack of standardized data on their efficacy, optimal dosage, and mechanisms of action. Additionally, their culinary applications, though well established in traditional diets, have not been sufficiently evaluated in terms of their potential role in improving nutrition and preventing diet-related diseases. The increasing global interest in natural remedies and functional foods has necessitated a scientific exploration of traditional spices with potential

health benefits. *Piper guineense*, *Xylopiiaethiopica*, and *Monodora myristica* are widely used in West African traditional medicine and cuisine, however their full therapeutic potential and nutritional contributions remain inadequately documented in scientific literature. This study is justified in their ethnopharmacological significance, nutritional and culinary importance, potential for drug and functional foods, and in bridging the knowledge gap on their potencies, ensuring their sustainable utilization in health and nutrition.

2.0 Botanical description of the selected spices

2.0.1 *Xylopia aethiopica*

Xylopia aethiopica, sometimes known as "African pepper" (Family: *Annonaceae*), is said to thrive in forest areas, frequently beside rivers and areas lacking sufficient rainfall. The genus, *Xylopia* comprises about 150 species. It matures as a slim, tall tree of approximately 60 - 70 cm in diameter and can grow up to 15 - 30 m high with a straight stem having a slightly stripped or smooth bark growing mainly in the tropical forest of Nigeria. It bears odoriferous fruits, which are slender pods slightly curved with about 15 carpels and are arranged in capitula to form bouquets of 12-20 bacciferous-like capsules (Aguoru *et al.*, 2016). The fruits of *Xylopia aethiopica* are tiny, swirled pods containing beans and are cylindrical, dark brown (Fig 1), about 2.5–5 cm long, and 4–6 mm thick (Ekop *et al.*, 2018). Five to eight kidney-like seeds, each measuring around 5 mm in length, are contained in each pod (Ekop *et al.*, 2018). After drying, the ripe fruit's colour (green) normally turns brownish-black (Imo *et al.*, 2018).



Fig 1. The fruits from *Xylopia aethiopica*

Taxonomy of *Xylopia aethiopica*

Kingdom: Plantae

Division: Magnoliophyta (Angiosperm)

Class: Magnoliopsida

Order: Magnoliales

Family: Annonaceae

Genus: *Xylopia*

Species: *X. aethiopica*

2.0.2 *Piper guineense*

Piper guineense, a member of the *Piperaceae* family commonly referred to as Ashanti pepper, West African Black pepper, Guinea pepper, Benin pepper, and false cubeb in the English language; is a perennial climber that uses its adventitious rootlets to scale trees up to 12m high. It is indigenous to Africa's tropical rain forests, mostly in the wild. The leaves are simple, alternate, and lanceolate, measuring up to 40 cm in length and 12 to 15 cm in width. They exhibit pinnate veining and have an acuminate apex. The inflorescence consists of pedicellate flower spikes ranging from 3 to 6 cm in length, with peduncles approximately 5 mm long. The flowers are greenish-yellow. The fruits are small, berry-like, and turn red upon ripening ((Ogbunugafor *et al.*, 2017; Fig 2). They are typically dried and used as a spice, imparting a pungent and peppery flavor to various dishes (Alagbe *et al.*, 2021; Ojimekwe, 2021).

Taxonomic Classification of *Piper guineense*

Kingdom – Plantae

Division– Magnoliophyta (Angiosperm)

Class – Magnoliopsida

Order – Piperales

Family – Piperaceae

Genus – *Piper*

Species – *P. guineense*



Fig 2. Dry seeds of *Piper guineense*

2.0.3 *Monodora myristica*

Monodora myristica commonly known as African nutmeg or calabash nutmeg is a medium to large evergreen tree native to West and Central Africa. Despite facing habitat loss in certain areas, it has a wide distribution and is present in multiple protected regions. It belongs to the Annonaceae family. The tree typically reaches heights of 30 to 40 m, with a diameter at breast height ranging from 40 to 100 cm. The bark is grayish-brown and smooth, becoming scaly with age. The leaves are simple, alternate, and obovate, measuring 11 to 50 cm in length and 4 to 14 cm in width (Nwaozuzu and Ebi, 2016). They have a cuneate to cordate base and an acuminate apex. The leaf surface is glabrous, with a prominent midrib and 13 to 23 pairs of secondary veins. The tree produces large, solitary, pendulous flowers on stalks up to 20 cm long. Each flower has three pale green sepals with dark red frilly edges, and six petals arranged in two whorls. The outer petals are cream-yellow with dark red-brown spots and measure 4 to 10 cm, while the inner petals are cream-white with purple-brown markings. The fruit is a large, globose, woody berry; nearly 20 cm in diameter (Afolabiet *al.*, 2024; Fig 3). It contains numerous brown seeds embedded in an aromatic pulp (Agiriga and Siwela, 2017).



Fig 3. Fresh pods containing fruits of *Monodora myristica*

Taxonomy of *Monodora myristica*

Kingdom: Plantae

Division: Angiosperms

Class: Magnoliopsida

Order: Magnoliales

Family: Annonaceae

Genus: *Monodora*

Species: *Monodora myristica* (Dunal)

2.1 Phytochemical, Nutritional and Medicinal Properties of Some Selected Spices

2.1.10 Phytochemistry of the fruit extract of *Xylopia aethiopica*

The rich phytochemical profile of *Xylopiaaethiopica*, encompassing essential oils, alkaloids, diterpenes, flavonoids, phenolic compounds, saponins, and tannins, underpins its extensive use in traditional medicine. These bioactive constituents contribute to the plant's diverse pharmacological activities, including antimicrobial, anti-inflammatory, antioxidant, and analgesic effects.

Essential Oils

The fruits of *X. aethiopica* are particularly rich in essential oils, which are responsible for their characteristic aroma and a significant portion of their medicinal properties. Analyses of these essential oils have revealed the presence of monoterpenes and sesquiterpenes, with β -pinene, α -pinene, and myrcene being predominant components. These compounds are known for their antimicrobial and anti-inflammatory activities (Erhirhie *et al.*, 2015).

Alkaloids

Alkaloids are another significant class of phytochemicals found in *X. aethiopica*. These nitrogen-containing compounds have been associated with various pharmacological effects, including analgesic and antimalarial activities. The presence of alkaloids such as xylopine has been documented in the plant's extracts (Fetse *et al.*, 2016).

Diterpenes

Diterpenes, a class of compounds known for their diverse biological activities, have also been isolated from *X. aethiopica*. Notably, compounds such as ent-15 β -angeloyloxykaur-16-en-19-oic acid have been identified, which exhibit antimicrobial and cytotoxic properties (Fetse *et al.*, 2016).

Flavonoids and Phenolic Compounds: The plant contains flavonoids and other phenolic compounds, which are renowned for their antioxidant properties. These compounds contribute to the plant's ability to scavenge free radicals, thereby imparting protective effects against oxidative stress-related diseases (Erhirhie *et al.*, 2015).

Saponins and Tannins

Saponins and tannins have been detected in various parts of *X. aethiopica*. Saponins are known for their expectorant and immune-

boosting properties, while tannins possess astringent and antimicrobial effects, supporting the plant's traditional use in treating infections and inflammatory conditions (Evuen *et al.*, 2022).

2.1.11 Proximate composition of *Xylopiaaethiopica*

In a study by Eyoh (2023), the proximate analysis of *X. aethiopica* fruits revealed the following composition: crude protein: 7.83%- fat: 9.07%- crude fiber: 15.23%- ash: 5.02%- nitrogen-free extract (carbohydrates): 56.52%. In another study by Imo *et al.* (2018) the following proximate composition for the fruits were reported: moisture content: 6.02%- dry matter: 93.99%- crude protein: 18.47%- crude fiber: 38.72%-lipid (fat): 6.73%- ash: 4.00%- carbohydrates: 26.08%. Additionally, Obiloma *et al.* (2019) provided another set of data for the proximate composition: protein: 3.99%- moisture: 11.70%- at: 9.74%- ash: 4.65%- crude fiber: 7.74%- carbohydrates: 62.18%. These variations in proximate composition may be attributed to differences in geographical location, environmental conditions, and analytical methods used in the studies.

2.1.12 Ethnomedicinal values of *Xylopia aethiopica*

Xylopiaaethiopica is widely used in traditional medicine across Africa for treating various ailments. The different parts of the plant, including the fruits, bark, seeds, and leaves, possess bioactive compounds that contribute to their therapeutic properties:

Treatment of Respiratory Disorders

The fruits and bark of *X. aethiopica* are commonly used in managing respiratory ailments such as cough, bronchitis, asthma, and chest infections. Decoctions or infusions prepared from these plant parts are believed to help clear airways and relieve breathing difficulties (Erhirhie *et al.*, 2015).

Gastrointestinal Disorders: Traditional medicine practitioners use *X. aethiopica* to treat stomach pain, indigestion, diarrhea, and dysentery. The plant's antimicrobial and carminative properties contribute to its effectiveness in alleviating gastrointestinal issues (Ogunwande *et al.*, 2017).

Antimalarial and Antipyretic Uses: Extracts from *X. aethiopica* are employed in the treatment of malaria and fever-related conditions. Studies suggest that the plant contains bioactive compounds with antimalarial effects, supporting its traditional use in managing fevers and malaria symptoms (Fetse *et al.*, 2016).

Management of Rheumatism and Inflammatory Conditions

Due to its anti-inflammatory properties, *X. aethiopica* is used in treating rheumatism, arthritis, and general body pain. Topical applications or oral preparations are believed to reduce swelling and pain associated with inflammatory conditions (Akinwunmi and Oyedapo, 2015).

Gynecological and Postpartum Applications

In some African cultures, women use *X. aethiopica* for postpartum recovery and menstrual regulation. The plant is believed to aid uterine contraction and cleanse the reproductive system after childbirth (Ekop *et al.*, 2018).

Antimicrobial Activity

Extracts from *X. aethiopica* have demonstrated significant antimicrobial effects against various pathogens. A study by Oloyede and Aduramigba-Modupe (2016) reported that crude ethanolic extracts exhibited inhibitory effects on bacteria such as *Escherichia coli*, *Proteus vulgaris*, *Pseudomonas aeruginosa*, *Shigella boydii* and *Klebsiella oxytoca*.

Antioxidant Properties

The plant is rich in phytochemicals, including flavonoids and tannins, which contribute to its antioxidant capacity. These compounds help neutralize free radicals, reducing oxidative stress and potentially lowering the risk of chronic diseases (Evuen *et al.*, 2022).

Antifungal Effects

Xylopia aethiopica has shown antifungal activity against clinical organisms. Research indicates that chloroform and ethanol extracts are active against *Candida albicans* and *Aspergillus niger*, suggesting potential applications in treating fungal infections (Osei-Asare and Brookman-Amissah, 2016).

Anti-inflammatory Activity: The oil extracted from *X. aethiopica* fruits contains compounds that exhibit anti-inflammatory properties. These compounds can stabilize cell membranes and inhibit prostaglandin synthesis, which are key processes in the inflammatory response (Osafo *et al.*, 2018).

Anthelmintic Properties

Studies have evaluated the anthelmintic activity of *X. aethiopica*, indicating its potential in treating parasitic worm infections. The ethanol extracts of the plant have been found to exhibit

significant anthelmintic effects (Osei-Asare and Brookman-Amissah, 2016).

2.1.13 Culinary applications of *Xylopia aethiopica*

The dried fruits of *X. aethiopica* are utilized in various culinary applications, imparting a distinctive flavor to numerous dishes (Ogueke *et al.*, 2016; Onoh *et al.*, 2020):

- **Flavoring Agent:** The dried fruits of *X. aethiopica* are used as a spice in cooking, adding a unique flavor to various dishes.
- **Seasoning for Soups and Stews:** In West African cuisine, the seeds are ground and added to soups, stews, and sauces to enhance flavor.
- **Beverage Flavoring:** In Senegal, the fruit is used to flavor café Touba, a traditional coffee drink.
- **Preservative:** The spice can be used as a preservative in food preparation.

Phytochemistry of *Piper guineense*

The different parts of *Piper guineense* have been characterized and their chemical compositions determined. The phytochemical screening and quantitative determination of the percentage yields of phytochemical constituents of *Piper guineense* showed that the seeds of the plant contained alkaloids (1.67%) flavonoids (1.92%), phenols (37.10%), and cardiac glycosides (39.33%) (Ogbunugafor *et al.* 2017). Several other authors have also confirmed the presence of Alkaloids, Flavonoids, Saponins, Tannins, Terpenes, Resins, Steroids, essential oils such as dillapiol, elemicin, myristicine, and safrole Cardiac glycosides in the seed extracts of *P. guineense* (Besong *et al.*, 2016; Ezekiel *et al.*, 2017; Chinedu *et al.*, 2018). In their quantitative analysis, Chiwendu *et al.*, (2016) indicated that seeds of *P. guineense* had alkaloids—0.86%, saponins—1.87%, tannins—1.19%, flavonoids—0.72%, and polyphenols—0.66%. They also reported a substantial amount of HCN (an anti-nutrient) 8.87%.

Proximate Composition of *Piper guineense*

The proximate composition of *Piper guineense* varies between its seeds and leaves. A study by Imo *et al.* (2018) provides the following analysis:

- **Seeds:** Moisture content: 5.98%, Crude protein: 12.99%, Crude fiber: 6.95%, Crude lipid (fat): 4.06%, Ash content: 4.55%, Carbohydrates: 65.46%
- **Leaves:** Moisture content: 6.11%, Crude protein: 15.17%, Crude fiber: 20.99%, Crude lipid (fat): 1.91%, Ash content: 11.98%, Carbohydrates: 43.86%.

These findings indicate that the seeds are particularly rich in carbohydrates, while the leaves have higher protein and fiber content. Such nutritional profiles suggest that both parts of the plant can be valuable in different dietary applications. In another study, Uzoekwe and Ezenwajiugo (2021) revealed the following for the leaves of *P. guineense*: Moisture Content: 12.00, Crude Protein: 17.55%, Crude Fiber: 9.55%, Crude Fat: 2.00%, Ash Content: 14.00% and Carbohydrates: 40.60%. Furthermore, investigation on the phytochemical content of the plant's seeds by Besonget *et al.* (2016) indicated the following: Moisture Content (12.35%), Dry Matter (87.65%), Ash Content (6.33%), Crude Fiber (8.79%), Crude Fat (9.89%), Crude Protein (5.86%) and Carbohydrates (57.32%).

Ethnomedicinal applications of Piper guineense

The various parts of *P. guineense*—including leaves, seeds, roots, and fruits—are utilized in traditional medicine for the treatment of numerous ailments (Chiwendu *et al.*, 2016; Alagbe *et al.*, 2021):

- Infectious Diseases
- The plant is employed in managing infections, leveraging its antimicrobial properties to combat pathogens.
- Reproductive Health
 - *Female Fertility*: Traditionally, *P. guineense* is used to address female infertility issues.
 - *Male Fertility*: The plant is also utilized to enhance male fertility by improving sperm count and motility.
- Gastrointestinal Disorders
- It is used to alleviate stomach discomfort and related digestive issues.
- Weight Management
- The plant is employed in traditional practices aimed at weight control.
- Abortifacient Uses
- Certain communities utilize *P. guineense* for its abortifacient properties.

Antioxidant Activity

The presence of phenolic compounds, such as flavonoids and tannins, in *P. guineense* contributes to its significant antioxidant properties. These compounds help neutralize free radicals, thereby reducing oxidative stress and potentially lowering the risk of chronic diseases (Ogbunugafor *et al.*, 2017).

Antimicrobial Properties

Studies have demonstrated that extracts from *P. guineense* exhibit antimicrobial activity against a range of pathogens, including bacteria and fungi. This suggests its potential use in treating infections and as a natural preservative in food (Alagbe *et al.*, 2021).

Anti-inflammatory Effects: The plant's bioactive compounds have been shown to possess anti-inflammatory properties, which can help in managing inflammatory conditions. This is particularly relevant in the treatment of ailments such as arthritis and other inflammatory disorders (Ohemuet *et al.*, 2023).

Aphrodisiac and Fertility Enhancements: Traditional medicine practices have utilized *P. guineense* for its aphrodisiac properties. Scientific investigations support these claims, indicating that the plant may enhance fertility and sexual function.

Anticonvulsant Activity: Research has indicated that *P. guineense* possesses anticonvulsant properties, making it a potential candidate for managing seizure-related disorders (Ojmelukwe *et al.*, 2021).

Larvicidal Effects: The plant has demonstrated larvicidal activity against certain insect species, suggesting its potential application in controlling vector-borne diseases (Ogbunugafor *et al.*, 2017).

Culinary Applications

The leaves and seeds of *P. guineense* are utilized to impart a distinctive flavor and aroma to various dishes such as traditional West African soups and stews. The leaves can also be added fresh or dried, while the seeds are typically ground into a powder before incorporation. The dried leaves are a key spice in the popular Nigerian pepper soup, contributing to its characteristic flavor (Okiki *et al.*, 2023). Additionally, the seeds serve as a seasoning for meats and fish, infusing them with a warm, peppery taste. In some regions, the seeds are used to flavor beverages, adding a spicy kick to traditional drinks (Afolabi *et al.*, 2024).

Phytochemical Composition of Monodora myristica

According to a phytochemical investigation, alkaloids, saponins, tannins, flavonoids, cardiac glycosides, and phenols were among the bioactive substances found in *Monodora myristica* seeds. The phytochemical examination showed low concentrations of tannins, phenols, and alkaloids, moderate levels of terpenoids and saponins, and high levels of

steroids (Chinelo *et al.*, 2018). A variety of phytochemical substances, such as saponins, tannins, general glycosides, steroids, alkaloids, flavonoids, and triterpenoids, were present in the ethanolic extracts of *M. myristica*. Compared to other plant parts, *M. myristica*'s bark and seed extracts had a greater variety of phytochemical components (Jimoh *et al.*, 2020).

Proximate Composition of *Monodora myristica*

Nkwocha and Eluwa (2018) found that the seeds of *M. mystica* had 8.4% moisture, 2.2% ash, 27.67% crude fat, 9.4% crude protein, 21.9% crude fiber, and 30.7% nitrogen-free extract (soluble carbohydrates). In another study by Ogungbenle and Adu (2017) the dehulled African nutmeg seeds contained approximately 7.2% moisture, 2.51% ash, 7.46% crude fat, 13.00% crude protein, 2.0% crude fiber, and 28.02% carbohydrates. The specific values can vary depending on factors such as geographical location, environmental conditions, and processing methods. These studies collectively suggest that *Monodora myristica* seeds are a significant source of energy due to their high carbohydrate and fat content, and they also provide essential nutrients such as proteins and fibers.

Ethnomedicinal Applications

The plant's bark and seed are used to treat various ailments, including hemorrhoids, eye conditions, stomachaches, fever, and febrile lumbago. The seed aids postpartum women, manages uterine hemorrhage, and treats stomach discomfort, diabetes, ocular infections, parasite infections, arthritis, anemia, sexual weakness, and malaria (Agiriga and Siwela, 2017; Salisu, 2023). The herb has been used for treatment of dysentery, toothaches and skin conditions. Also, the oil from *M. myristica*'s roots, seeds, and stem bark is used to treat dysentery, helminthiasis, scabies, and malaria (Onoh *et al.*, 2020). Research has shown that the numerous phytochemical compounds in *M. myristica* The phytochemical compounds have a variety of positive health effects, such as antioxidant, anti-diabetic, hepatoprotective, antibacterial, antifungal, diuretic, antispasmodic, antimicrobial, and antihypertensive properties (Agiriga and Siwela, 2017; Okaiyeto *et al.*, 2021). Research has also shown that *M. myristica* seed extracts have antibacterial and antioxidant qualities (Okechukwu *et al.*, 2022; Osukoya *et al.*, 2021).

Culinary Applications

Monodora myristica is a spice integral to West African cuisine. Its seeds are prized for their aromatic properties and are utilized in various culinary applications:

Flavor Enhancement

The seeds are ground into a fine powder and added to soups, stews, and sauces to impart a warm, nutty flavour. This practice is prevalent among the Yoruba and Igbo communities in Nigeria (Afolabi *et al.*, 2024).

Beverages

Monodora myristica is sometimes used to flavour beverages, adding a distinct spicy note that complements various drink recipes. These culinary uses highlight the versatility of *Monodora myristica* in enhancing the flavour profiles of diverse dishes and its significance in traditional West African gastronomy (Agiriga and Siwela, 2017).

Conclusions

The medicinal and culinary applications of *Xylopiiaethiopica*, *Piper guineense*, and *Monodora myristica* demonstrate their significant contributions to health and nutrition. These plants offer a wide array of pharmacological benefits, including antimicrobial, anti-inflammatory, and antioxidant properties. Their role in traditional medicine aligns with modern scientific findings, validating their continued use in managing various health conditions. Additionally, their application in culinary practices highlights their importance in enhancing food flavor, preservation and nutritional value.

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