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Torch Ginger Essential Oil: A Multi-Faceted Ethnobotanical Treasure with Promising Antibacterial Potential

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Abstract

Etlingera elatior (Torch ginger) is an enchanting tropical plant belong to Zingiberaceae known for its striking appearance, captivating inflorescence, and diverse ethnobotanical uses across cultures. This comprehensive review explores the scientific basis underlying the promising antibacterial potential of torch ginger. The unique chemical composition of essential oil enriched with terpenes, terpenoids, and aromatic compounds, contributed to its distinct aroma and therapeutic properties. Hence the essential oil of this plant is a promising source of novel druggable molecules. Furthermore, its potential applications in food packaging, as exemplified by its incorporation into starch-based edible films, shows its potential as a sustainable and biodegradable alternative for food preservation. The pharmacological effects of torch ginger essential oil should be more studied for a better understanding of its mechanism of action.

Keywords: *Etlingera elatior,* Torch ginger, Essential oil, Antibacterial, Ethnobotany

Introduction

Plants played a fundamental and multifaceted role in human societies in ancient times. Human's deep connection with the plant world is evident throughout history, with plants holding immense cultural, economic, and ecological importance. Ancient cultures relied heavily on plants for medicinal purposes. Herbal remedies made from various plant parts, such as leaves, roots, bark, and seeds, were used to treat various ailments and illnesses. Knowledge of herbal medicine was passed down through generations, forming the foundation of traditional healing systems in some cultures today.

Among the diverse array of botanical treasures, the Torch Ginger plant (*Etlingera elatior*) has stood out for its enchanting appearance and wide range of ethnobotanical uses. *Etlingera elatior* belongs to the family Zingiberaceae which consists of 53 genera and 1300 species (Barbosa *et al*., 2017). The Zingiberaceae family encompasses diverse species that serve as abundant sources of various phytochemicals. Among these are alkaloids, carbohydrates, proteins, phenolic acids, flavonoids, and diarylheptanoids (Ivanović *et al*., 2021). Furthermore, ginger plants are widely acknowledged for their notable role in producing essential oils, which are abundant in monoterpenes and sesquiterpenes content (Ashokkumar *et al*., 2020; Zhang *et al*., 2020). The remarkable presence of these bioactive compounds highlights the potential significance of Zingiberaceae species as valuable resources in natural product research and drug discovery. Originating from tropical regions, *E. elatior* is revered for its ornamental value and cherished for its essential oil, which carries a rich history of traditional healing practices. In recent days essential oils have gained tremendous popularity in various industries, including the food, cosmetic, and pharmaceutical sectors. Synonyms of *E. elatior* include *Alpinia elatior, Elettaria speciosa, Nicolaia elatior, Nicolaia speciosa, and Phaeomeria speciosa*.

In this comprehensive review, we embark on an exploration of Torch Ginger's ethnobotanical importance. Furthermore, this review seeks to examine scientific research that explains the potential antimicrobial properties of Torch Ginger essential oil. While research on the antimicrobial potential of the extract has been extensively explored, the specific focus on the essential oil remains comparatively scarce. Understanding the unique chemical composition and potential synergistic effects of essential oil is essential for comprehending its distinct antimicrobial activities. As such, this review aims to bridge this knowledge gap by delving into the available literature and elucidating the antimicrobial properties of Torch Ginger essential oil.

Torch Ginger: An Ethnobotanical Treasure

Torch Ginger (*Etlingera elatior* (Jack) R. M. Smith), also known as the "Torch Lily" or "Red Ginger Lily," is a captivating tropical plant that belongs to the Zingiberaceae family (Lutfia *et al*., 2020). This tall perennial plant can reach a height of 5-6 meters and form a clump. The strongly aromatic stout rhizomes found below ground level measuring 3-4 cm in diameter. The mature leaves are entirely green, growing up to 80 × 18 cm, occasionally displaying a pink flush in young leaves. The inflorescence emerges from a cone-shaped bract and consists of bright red or pink flowers, each with an elegant, elongated form, whereas the young inflorescences have a spear-like appearance. The crushed leaves and flowers emanate a distinct and pleasant sour fragrance (Lim, 2000; Khaw, 2001; Chan *et al*., 2011). Beyond its ornamental allure, Torch Ginger has earned immense ethnobotanical importance across various cultures, where it has been traditionally used for culinary, medicinal, and ceremonial purposes.

Etlingera elatior holds significant ethnobotanical importance. It is a prevalent species among the Batak Karo subethnic group in North Sumatra, owing to its diverse array of benefits as a spice, vegetable, and medicinal resource. The pseudostem fluid of *E. elatior* finds extensive utilization in traditional medicine as a remedy for cough and fever. Moreover, the Batak Karo subethnic group incorporates Torch Ginger as a spice or *cekala* in their traditional culinary practices, featuring it prominently in dishes like *arsik* and *terites* (Silalahi *et al*., 2015; Silalahi and Nisyawati, 2018). Extensive research has been conducted on the biological properties of *E. elatior*. These studies have revealed its remarkable potential as an antimicrobial, antioxidant, antitumor, antihyperglycemic, anti-hyperuricemic, anti-inflammatory, anti-larvae, and anti-aging agent (Chan *et al*., 2011; Juwita *et al*., 2018). The fruit and leaf decoctions of *E. elatior* are employed as a traditional remedy for earache and wound cleaning purposes, respectively (Ibrahim and Setyowati, 1999). In addition, postpartum women used the leaves of *E. elatior* along with other aromatic herbs for bathing to eliminate body odor (Chan *et al*.,2011). Recently, its essential oil has garnered attention for potential therapeutic benefits.

Essential oil: Nature's Essence

Essential oils are lipophilic and extremely volatile secondary metabolites with a molecular weight of less than 300, derived from various plant parts by distillation (Turek and Stintzing, 2013). The International Organization for Standardization (ISO) defined the term 'essential oil' as a "product obtained from vegetable raw material, either by distillation with water or steam, or from the epicarp of citrus fruits by a mechanical process, or by dry distillation" (ISO 9235, 1997). They are often obtained using steam or hydro-distillation, which Arabs pioneered in the Middle Ages. Essential oils are characterized by their liquid state, volatility, and transparent appearance, rarely exhibiting coloration. These oils are soluble in organic solvents and have a preference for lipid-based substances, making them lipid-soluble. Essential oils are naturally synthesized by various plant organs, including buds, flowers, leaves, stems, twigs, seeds, fruits, roots, wood, or bark. These oils are then stored in specialized structures within the plant, such as secretory cells, cavities, canals, epidermal cells, or glandular trichomes (Bakkali *et al*., 2008).

Figure 1: Leaves and inflorescence of *E. elatior*

Approximately 3000 essential oils are currently identified, with 300 holding significant commercial importance, particularly in the pharmaceutical, agronomic, food, sanitary, cosmetic, and perfume industries (Bakkali *et al*., 2008). Their versatile applications in aromatherapy, topical use, and holistic wellness have made essential oils an increasingly popular choice for individuals seeking alternative approaches to enhance their health. From relieving stress and anxiety to soothing sore muscles, supporting respiratory health, and even aiding in sleep improvement, the potential of essential oils to promote better health seems boundless. Essential oils are renowned for their diverse health effects, notably their antibacterial, antibiotic, and antiviral properties (Ramsey *et al*., 2020; Ali *et al.,* 2015). Furthermore, they have garnered considerable attention for their potential medicinal properties and therapeutic applications in the context of organ dysfunctions and systemic disorders (Ali *et al*., 2015).

Chemical Composition of Torch Ginger Essential Oil

The chemical composition of essential oils is highly complex, as they are composed of a diverse array of volatile organic compounds. These compounds are responsible for essential oils' characteristic aroma and therapeutic properties. The chemical constituents of essential oils can vary significantly depending on the plant species, the plant part used for extraction, geographic location, climate, and extraction methods. Essential oils consist of a diverse array of over 300 different compounds. The primary group is composed of terpenes and terpenoids, while the aromatic (phenolic) components form the second group. Lastly, the third group comprises aliphatic compounds (alkanes and alkenes), typically present in trace amounts (Pichersky *et al*., 2006; Bakkali *et al*., 2008; Bayala *et al*., 2014).

The chemical composition of essential oils in *E. elatior* demonstrates variability depending on the specific plant parts being analyzed. According to a study conducted by Jaafar *et al*., the compounds such as (E)-β-farnesene, β-pinene, 1,1-dodecanediol diacetate, cyclododecane, and (E)-5-dodecane were found in high concentrations in the leaves, flowers, stems and rhizome of *E. elatior* collected from Malaysia (Jaafar *et al*., 2007). In contrast to this, *E. elatior* collected from another place in the same country exhibited variations in the essential oil components. For instance, myrcene, α-humulene, and β-caryophyllene were found in more concentrations in the leaf whereas rhizome and root oils were rich in camphene and β-pinene (Wong *et al*., 2010). The study conducted on *E. elatior* inflorescence essential oil revealed the presence of dodecanol, dodecanal, and alpha-pinene as major constituents. In contrast, leaf oil has been documented to contain beta-pinene and 1-dodecene as major constituents. Additionally, it consists of sesquiterpenes, particularly (E)- farnesene and (E)- caryophyllene (Wong *et al*., 1993; Zoghbi and Andrade, 2005; Chan *et al*., 2011).

Essential Oil from *E. elatior*: A Potential Source of Antibacterial Agent

Previous studies suggested that *E. elatior* holds promising potential as novel sources of natural antioxidants and antibacterial agents in the food and pharmaceutical industries. The antibacterial properties of *E. elatior* essential oil were first reported by Abdelwahab *et al.,* in 2010. The essential oil extracted from the whole plant was found to inhibit the growth of Methicillin-Resistant *Staphylococcus aureus* (MRSA). However, the oil was not effective against *Pseudomonas aeruginosa*, and Gram-negative bacteria like *Salmonella choleraesuis* and *Bacillus subtilis*. The selective permeability of the outer membrane of Gram-negative bacteria contributes to the high resistance towards volatile compounds (Abdelwahab *et al*., 2010). The essential oil extracted from the fresh rhizome of *E. elatior* was found to be effective against four pathogens like *S. aureus, Streptococcus pyogenes, Salmonella enteritidis, and Staphylococcus* spp. (Vairappan *et al*., 2012). The flower oil of *E. elatior* inhibited the growth of *S. aureus, Bacillus cereus, B. subtilis, Listeria monocytogenes,* and *Klebsiella pneumoniae* (Susanti *et al*., 2013; Wijekoon *et al*., 2013). In a recent study, Anzian *et al* investigated the inhibitory effect of flower oil against *S. typhimurium* and *E. coli* in addition to *S. aureus* (Anzian *et al*., 2020). Furthermore, flower oil also exhibits fungicidal activities against the human pathogens, *Candida albicans* and *C. neoformans* (Susanti *et al*., 2013). Antibacterial effects of the *E. elatior* fruit oil have also been investigated. The fruit oil suppressed the growth of B. *cereus, S. aureus, E. coli*, and *Pseudomonas aeruginosa* (Sukandar *et al*., 2017).

Table 1
Antibacterial Properties of *E. elatior* Essential Oil

Plant Part Used to Extract Oil	Microorganisms Inhibited by Essential Oil	References
Whole plant	*S. aureus*	Abdelwahab *et al.*, 2010
Rhizome	*S. aureus, S. pyogenes, S. enteritidis, Staphylococcus spp.*	Vairappan *et al.*, 2012
Flower	*S. aureus, B. cereus, B. subtilis, L. monocytogenes, K. pneumoniae, E. coli, S, typhimurium, C. albicans, C. neoformans*	Susanti *et al.*, 2013; Wijekoon *et al.*, 2013; Anzian *et al.*, 2020
Fruit	*S. aureus, B. cereus, E. coli, P. aeruginosa*	Sukandar *et al.*, 2017

In a recent study conducted by Marzlan *et al.* (2022), the essential oil derived from *E. elatior* flowers was effectively incorporated into a starch-based edible film for food packaging applications. The film demonstrated remarkable inhibitory effects against various pathogens, including *B. subtilis, S. aureus, L. monocytogenes, S. typhii,* and *E. coli.* This innovative edible film offers a sustainable and biodegradable alternative to conventional non-biodegradable packaging materials. Moreover, its antimicrobial properties contribute to an extended shelf life for poultry meat, presenting significant advancements in food preservation technology. The successful integration of *E. elatior* flower oil into the edible film highlights its potential value as a natural and eco-friendly solution for food packaging, with promising implications for the food industry's efforts toward sustainability and safety (Marzlan *et al.*, 2022).

Antimicrobial Mechanisms of Essential Oil

The antimicrobial mechanism of essential oils is a subject of great interest and research in the scientific community. These volatile plant extracts have shown impressive efficacy against various microorganisms, including bacteria and fungi. Unraveling the intricate molecular interactions and pathways by which essential oils exert their antimicrobial properties is pivotal for harnessing their full potential in developing novel therapeutic agents and natural alternatives to combat infections. The antimicrobial mechanisms of essential oils are attributed to the presence of a myriad of volatile bioactive compounds. The antimicrobial mechanisms of essential oils can be rather intricate due to the complex mixtures of bioactive compounds they contain. These compounds can interact with multiple molecular pathways, exerting their effects through various mechanisms. As a result, understanding the precise antimicrobial mechanism of essential oils can be challenging due to their multifaceted nature and the potential for diverse interactions with microbial targets (Sefu *et al.*, 2015). The hydrophobic nature of the non-polar components in essential oils is a pivotal characteristic that allows them to effectively partition into both bacterial cell membranes and mitochondria. This partitioning leads to the disruption of membrane structures, resulting in increased membrane permeability. Consequently, the essential oils cause ions and other cellular contents to leak, leading to the bactericidal effect (Susanti *et al.*, 2013).

Conclusion

In conclusion, *E. elatior* captures attention with its captivating aesthetics and diverse cultural applications. The essential oil composition of *E. elatior* is rich in terpenes, terpenoids, and aromatic compounds. This composition imparts a distinctive aroma and opens avenues for novel drug development. Moreover, the plant's role in sustainable food preservation through starch-based edible films showcases its versatility beyond traditional uses. The multidimensional virtues of Torch ginger underscore its significance as a potential source of therapeutics and sustainable solutions in various sectors.

References

Abdelwahab, S.I., Zaman, F. Q., Mariod, A. A., Yaacob, M., Ahmed Abdelmageed, A. H., & Khamis, S. (2010) Chemical composition, antioxidant and antibacterial properties of the essential oils of *Etlingera elatior* and *Cinnamomum pubescens* Kochummen. *Journal of the Science of Food and Agriculture*, *90*(15):2682-2688.

Ali, B., Al-Wabel, N. A., Shams, S., Ahamad, A., Khan, S. A., & Anwar, F. (2015) Essential oils used in aromatherapy: A systemic review. *Asian Pacific Journal of Tropical Biomedicine*, *5*(8): 601-611.

Anzian, A., Muhialdin, B. J., Mohammed, N. K., Kadum, H., Marzlan, A. A., Sukor, R., & Meor Hussin, A. S. (2020) Antibacterial activity and metabolomics profiling of torch ginger (*Etlingera elatior* Jack) flower oil extracted using subcritical carbon dioxide (CO2). *Evidence-Based Complementary and Alternative Medicine*, *2020*: 1-8.

Ashokkumar, K., Murugan, M., Dhanya, M. K., & Warkentin, T. D. (2020) Botany, traditional uses, phytochemistry and biological activities of cardamom [*Elettaria cardamomum* (L.) Maton]–A critical review. *Journal of ethnopharmacology*, *246*:112244.

Bakkali, F., Averbeck, S., Averbeck, D., & Idaomar, M. (2008) Biological effects of essential oils–a review. *Food and chemical toxicology*, *46*(2):446-475.

Barbosa, G. B., Jayasinghe, N. S., Natera, S. H., Inutan, E. D., Peteros, N. P., & Roessner, U. (2017) From common to rare Zingiberaceae plants-A metabolomics study using GC-MS. *Phytochemistry*, *140*:141-150.

Bayala, B., Bassole, I. H., Scifo, R., Gnoula, C., Morel, L., Lobaccaro, J. M. A., & Simpore, J. (2014) Anticancer activity of essential oils and their chemical components-a review. *American journal of cancer research*, *4*(6): 591.

Chan, E. W., Lim, Y. Y., & Wong, S. K. (2011) Phytochemistry and pharmacological properties of *Etlingera elatior*: a review. *Pharmacognosy Journal*, *3*(22):6-10.

Ibrahim H, Setyowati F.M. (1999) Etlingera. In: De Guzman CC, Siemonsma JS, Editors. Plant Resources of South-east Asia, Vol. 13, Backhuys Publisher, Leiden, Netherlands, 123-6

Ivanović, M., Makoter, K., & Islamčević Razboršek, M. (2021) Comparative study of chemical composition and antioxidant activity of essential oils and crude extracts of four characteristic zingiberaceae herbs. *Plants*, *10*(3): 501.

Jaafar, F. M., Osman, C. P., Ismail, N. H., & Awang, K. (2007) Analysis of essential oils of leaves, stems, flowers and rhizomes of *Etlingera elatior* (Jack) RM Smith. *The Malaysian Journal of Analytical Sciences*, *11*(1): 269-273.

Juwita, T., Puspitasari, I. M., & Levita, J. (2018) Torch ginger (*Etlingera elatior*): A review on its botanical aspects, phytoconstituents, and pharmacological activities. *Pakistan Journal of Biological Sciences*, *21*(4): 151-165.

Khaw, S. H. (2001) The genus Etlingera (Zingiberaceae) in Peninsular Malaysia including a new species. *Gard Bull Singapore*, *53*(1-2): 191-239.

Lim, C. K. (2000) Taxonomic notes on *Etlingera Giseke* (Zingiberaceae) in Peninsular Malaysia: The "Nicolaia" taxa. *Folia Malaysiana*, *1*(1): 1-12.

Lutfia, A., Munir, E., & Yurnaliza, Y. (2020) Molecular identification of endophytic fungi from torch ginger (*Etlingera elatior*) antagonist to phytopathogenic fungi. *Biodiversitas Journal of Biological Diversity*, *21*:(6).

Marzlan, A. A., Muhialdin, B. J., Abedin, N. H. Z., Manshoor, N., Ranjith, F. H., Anzian, A., & Hussin, A. S. M. (2022) Incorporating torch ginger (*Etlingera elatior* Jack) inflorescence essential oil onto starch-based edible film towards sustainable active packaging for chicken meat. *Industrial Crops and Products*, *184*:115058.

Pichersky, E., Noel, J. P., & Dudareva, N. (2006) Biosynthesis of plant volatiles: nature's diversity and ingenuity. *Science*, *311*(5762):808-811.

Ramsey, J. T., Shropshire, B. C., Nagy, T. R., Chambers, K. D., Li, Y., & Korach, K. S. (2020) Focus: Plant-based medicine and pharmacology: Essential oils and health. *The Yale journal of biology and medicine*, *93*(2):291.

Sefu, G., Satheesh, N., & Berecha, G. (2015) Antifungal activity of ginger and cinnamon leaf essential oils on mango anthracnose disease-causing fungi (*C. gloeosporioides*). *Carpathian Journal of Food Science & Technology*, *7*(2).

Silalahi, M., & Nisyawati, N. (2018) The ethnobotanical study of edible and medicinal plants in the home garden of Batak Karo sub-ethnic in North Sumatra, Indonesia. *Biodiversitas*, *19*(1): 229-238.

Silalahi, M., Supriatna, J., & Walujo, E. B. (2015) Local knowledge of medicinal plants in sub-ethnic Batak Simalungun of North Sumatra, Indonesia. *Biodiversitas*, *16*(1):44-54.

Sukandar, D., Fitriyanti, M., Amelia, E. R., Riyadhi, A., & Azizah, R. N. (2017) Characterization of chemical constituent and antibacterial activity of honje fruit skin (*Etlingera elatior*). In *International Conference on Science and Technology (ICOSAT 2017)-Promoting Sustainable Agriculture, Food Security, Energy, and Environment Through Science and Technology for Development* Atlantis Press.

Susanti, D., Awang, N. A., Qaralleh, H., Sheikh Mohamed, H. I., & Attoumani, N. (2013) Antimicrobial activity and chemical composition of essential oil of Malaysian *Etlingera elatior* (Jack) RM smith flowers. *Journal of Essential Oil Bearing Plants*, *16*(2): 294-299.

Turek, C., & Stintzing, F. C. (2013) Stability of essential oils: a review. *Comprehensive reviews in food science and food safety*, *12*(1): 40-53.

25. Vairappan, C. S., Nagappan, T., & Palaniveloo, K. (2012) Essential oil composition, cytotoxic and antibacterial activities of five *Etlingera* species from Borneo. *Natural Product Communications*, *7*(2), 1934578X1200700233.
26. Wong, K. C., Sivasothy, Y., Boey, P. L., Osman, H., & Sulaiman, B. (2010) Essential oils of *Etlingera elatior* (Jack) RM Smith and *Etlingera littoralis* (Koenig) Giseke. *Journal of Essential Oil Research*, *22*(5): 461-466.
27. Wong, K. C., Yap, Y. F., & Ham, L. K. (1993) The Essential Oil of Young Flower Shoots of P*haeomeria speciosa* Koord. *Journal of Essential Oil Research*, *5*(2):135-138.
28. Zhang, L., Pan, C., Ou, Z., Liang, X., Shi, Y., Chi, L., ... & Xiang, H. (2020) Chemical profiling and bioactivity of essential oils from *Alpinia officinarum* Hance from ten localities in China. *Industrial crops and products*, *153*:112583.
29. Zoghbi, M. D. G., & Andrade, E. H. (2005) Volatiles of the *Etlingera elatior* (Jack) RM Sm. and *Zingiber spectabile* Griff.: two Zingiberaceae cultivated in the Amazon. *Journal of Essential Oil Research*, *17*(2): 209-211.

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