AgriSustain-An International Journal

Review

Nature's Hidden Delicacy: The Termite Mushroom

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Abstract

Termitomyces, a genus of edible fungi within the Lyophyllaceae family, is well-known for its symbiotic relationship with termites from the Macrotermitinae subfamily. These mushrooms are highly valued for their outstanding taste, substantial texture, nutritional and medicinal properties. Found extensively across Africa and Asia, Termitomyces mushrooms significantly contribute to local economies, ecosystems, and traditional healing practices. Recent molecular research has verified the genus as monophyletic and has identified new species through ITS, LSU, and mt SSU sequencing (Paloi et al., 2023; Seelan et al., 2022). In India, species like *Termitomyces microcarpus, T. heimii*, and *T. schimperi* are commonly found and consumed, particularly during the monsoon period. They are rich source of proteins, vitamins, minerals, and bioactive substances such as flavonoids, phenolics, and antioxidants (Manjula et al., 2024; Kumar et al., 2022a). Cultivating Termitomyces is challenging due to their reliance on termites, although methods like artificial inoculation and fungal comb simulation are being investigated (Nguyen et al., 2023). Ethnomedicinally, they are used in various cultures to treat fevers, infections, and digestive issues. They are also being researched for industrial uses, including enzyme production, nutraceutical development, and bioremediation.

Keywords: Termitomyces, mushrooms, edible fungi and Termite.

Introduction

The genus *Termitomyces*, first described by Heim in 1942, as an edible mushroom that form a symbiotic relationship with termites. These mushrooms belong to the Lyophyllaceae family within the Agaricales order. Predominantly found in tropical forests, especially in Africa and Asia. Termitomyces mushrooms are found growing on termite's combs. The fungi assist in breaking down organic substrates, providing nutrients back to the termites (Paloi et al., 2023; Rouland-Lefevre et al., 2002). These mushrooms hold significant importance in traditional diets and folk medicine, particularly in rural and tribal regions where forest resources are integral to daily life. *Termitomyces* spp. are harvested during the rainy season known for their distinctive flavor and medicinal benefits, including anti-inflammatory and antimicrobial properties (Manjula et al., 2024; Kumar et al., 2022b). In recent years, scientific interest in Termitomyces has surged due to their potential as functional foods and bio-resources. Advances in molecular tools have clarified their taxonomy and opened avenues for commercial use. Although more than 30 species are currently recognized, ongoing research and phylogenetic studies suggest greater diversity and ecological specialization than previously understood (Seelan et al., 2022; Oyetayo, 2012).

Habitat

OPEN ACCESS

CITATION

Kumar, Vijay and Ashok Chhetri. Nature's Hidden Delicacy: The Termite Mushroom. *AgriSustain-an International Journal,* 2025, 03(2), 01-06.

ARTICLE INFORMATION

Received: May 2025
Revised: June 2025
Accepted: July 2025

DOI: **10.5281/zenodo.18222942**

Termitomyces species predominantly thrive in tropical and subtropical forest ecosystems. They are obligatorily associated with termites from the subfamily Macrotermitinae, which includes genera such as *Odontotermes* sp., *Macrotermes* sp., and *Microtermes* sp. These termites construct fungal combs within their nests by chewing plant debris and inoculating it with fungal spores. Termitomyces mushrooms mycelia colonize termite combs and eventually produce fruiting bodies that emerge from the soil surface, often near termite mounds (Kumari et al., 2022; Paloi et al., 2023). The habitat of Termitomyces mushrooms is characterized by moist, humus-rich soil, partial shade and high organic matter content. These mushrooms are usually found during the monsoon or rainy season when environmental humidity favors the emergence of fruit bodies (Manjula et al., 2024; Mossebo et al., 2023). The termites and fungus maintain a top balanced ecological relationship. The termites get benefited from the Termitomyces fungus in term of enzymatic breakdown of plant material, while the mushrooms depend on the termites for a suitable growth medium and spore dispersal (Aanen et al., 2002; Smith et al., 2002).

Distribution

Termitomyces mushrooms are widely distributed across the paleotropical regions, particularly in Africa and Asia. In Africa the highest diversity of *Termitomyces* species, over 67% are recorded (Paloi et al., 2023). Countries such as Kenya, Cameroon, Nigeria, Zambia, and South Africa are rich in *Termitomyces* species. In Asia, India is a hotspot for Termitomyces mushroom having reported diversity more than 22 species from regions like Punjab, Kerala, Himachal Pradesh, Goa, Tripura, Odisha, Karnataka, Maharashtra, and the Western Ghats (Kumari et al., 2022). Apart from India a rich biodiversity of Termitomyces mushroom is recorded in Thailand, China, Nepal, and Sri Lanka. The *Termitomyces microcarpus* is commonly found throughout the Indian subcontinent (Manjula et al., 2024).

The *Termitomyces* species are typically found in undisturbed, forested regions and are strongly associated with active termite mounds. Due to the seasonal nature of their fruiting, they are most often harvested during the monsoon months (June–September in India). Regional markets in India sell these mushrooms fresh or dried, indicating their commercial value (Kumar et al., 2022a; Aryal et al., 2022).

Nutrition Values

Termitomyces mushrooms are highly valued for their nutritional benefits and play a crucial role in human diets. Studies on their nutritional content have shown that *Termitomyces* species are rich in protein (up to 20% of their dry weight), dietary fiber, essential amino acids, and have a very low-fat content (Paloi et al., 2023). These mushrooms are also abundant in vitamins such as thiamine (B1), riboflavin (B2), ascorbic acid (C), tocopherol (E), and β-carotene. They contain important minerals such as calcium, magnesium, phosphorus, potassium, iron, and zinc (Manjula et al., 2024). Furthermore, their antioxidant properties, including phenolics, flavonoids, and lycopene, contribute to their role in preventing oxidative stress and chronic diseases (Pattanayak et al., 2015). Research has demonstrated that Termitomyces possess hypoglycemic, antimicrobial, and anti-inflammatory properties making these high functional foods (Valverde et al., 2015; Kumar et al., 2022b).

Taxonomy and Identification

The classification of Termitomyces has advanced with the use of molecular tools. Initially described by Heim in 1942 based on physical characteristics, recent developments have incorporated ITS, nrLSU, and mtSSU markers for precise species identification (Paloi et al., 2023; Seelan et al., 2022). Now DNA barcoding facilitates the identification of cryptic and morphologically similar species.

Termitomyces spp. is recognized as a monophyletic group within the Lyophyllaceae family. Molecular phylogenetic studies have identified distinct clades that correspond to geographical and ecological variations (Froslev et al., 2003; Rouland-Lefevre et al., 2002). Research conducted in Thailand, Pakistan, and Cameroon has led to the discovery of several new species, such as *T. gilvus* and *T. sheikhupurensis*, using multilocus approaches (Mossebo et al., 2023; Izhar et al., 2021). Morphologically, *Termitomyces* species are distinguished by centrally stipitate fruit bodies, large fleshy caps, hollow stipes, and a pseudorrhiza that connects the mushroom to termite nests. Key diagnostic features include pileus color, the presence of an umbo, veil structure, and spore print color. Microscopic analysis reveals basidiospores that are thin-walled, ellipsoid, and hyaline (Kumari et al., 2022). Ongoing efforts aim to resolve taxonomic ambiguities through global sequence databases and high-resolution imaging techniques. Integrating morphological and molecular data is essential for establishing a stable taxonomy for this ecologically significant group.

Economic Importance

Termitomyces mushrooms play a significant role in rural economies by providing seasonal income and nutritional security. In India, fresh basidiocarps are sold in local markets for INR 150–700 per kg, depending on size and species (Kumar et al., 2022a). The harvest supports tribal communities in Odisha, Goa, and the Western Ghats, where foraging is often combined with ecotourism (Dabolkar & Kamat, 2020). In West and Central Africa, roadside vendors sell *T. titanicus* and *T. clypeatus*, generating household income during the rainy season (Elkhateeb & Daba, 2022). Different value-added products such as dried slices and pickles are prepared. The extracted enzyme is being used in dairy and leather industries (Majumder et al., 2021). However, the high demand accelerates habitat disturbance, highlighting the need for sustainable harvesting guidelines (Mishra et al., 2021).

Cultivation Practices

Artificial cultivation of Termitomyces mushrooms remains a significant challenge due to their dependence on a living termite colony. Current laboratory efforts involve simulating fungal combs with sterilized lignocellulosic blocks inoculated with spore suspensions, maintained by termite workers (Nguyen et al., 2023). In China, small-scale success with *T. albuminosus* has been achieved by regulating CO_2 levels and maintaining 90% humidity (De Souza & Kamat, 2021). Indian experiments utilize a combination of sawdust, rice bran, and finely ground termite-nest soil to induce pseudorrhiza formation, although yields remain inconsistent (Kumari et al., 2022). Future research aims to identify volatile cues from termites that stimulate primordia and employ CRISPR-aided modification of lignocellulolytic genes to enhance saprotrophic independence (Paloi et al., 2023).

Ethno-Medicinal Knowledge

In Asia and Africa, Termitomyces play a crucial role in traditional health practices. Decoctions of *T. microcarpus* are used to treat fever, colds, and skin infections among the Kondh tribes in Odisha (Kumar et al., 2022b). In Nigeria, Yoruba healers grind *T. clypeatus* with palm oil for the treatment of gonorrhea (Elkhateeb & Daba, 2022). The Maasai in Tanzania use smoke from dried basidiocarps to alleviate postpartum pain, while Nepali hill communities consume boiled *T. heimii* as an immune tonic (Manjula et al., 2024). Bioactive screening has confirmed the presence of neuritogenic cerebrosides and potent antioxidants, supporting these traditional uses (Paloi et al., 2023; Majumder et al., 2021).

Uses in Food and Industrial Applications

Termitomyces mushrooms are widely used for different culinary applications range from simple stir-fries to fermented pickles. In Goa, *T. eurrhizus* is prepared with coconut and tamarind to create the dish "Roos Unn" (Dabolkar & Kamat, 2020). Thai cuisine incorporates *T. fuliginosus* in spicy soups. Industrially, lignocellulolytic enzymes from *T. heimii* are utilized in paper pulp bleaching, while proteases from *T. clypeatus* serve as a substitute for calf rennet in cheese production (Majumder et al., 2021). Mycelial extracts show potential as natural dyes and biocontrol agents against plant pathogens (Seelan et al., 2022).

Conclusion

Termitomyces mushrooms represent a confluence of ecology, culture, nutrition, and biotechnology. The molecular analysis of *Termitomyces* species has revealed greater species richness. The innovative cultivation strategies aim to reduce dependence on termites for mushroom production. Their rich nutrient profile and bioactive metabolites support both traditional medicine and modern functional food markets. Integrating sustainable harvesting, habitat conservation, and community-based enterprises will ensure that Termitomyces continue to provide ecological services and economic benefits. Future research should prioritize genome sequencing, termite–fungus signaling mechanisms, and scalable cultivation models to fully realize the potential of this remarkable genus.

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