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Morphological Characteristics and Nutritional Potentiality of Wild Termitomyces Discovered in Pohara Forest and Sant Gadge Baba Amravati University Campus

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Abstract - The genus Termitomyces, renowned for its symbiotic mutualism with termites and nutritional significance, remains underexplored in diverse ecological settings. This study investigates the morphological characteristics and nutritional potential of wild Termitomyces species from two contrasting habitats: the biodiverse Pohara Forest and the urbanized Sant Gadge Baba Amravati University (SGBAU) campus in Maharashtra, India. Specimens were collected during monsoon and post-monsoon seasons (2023) from termite mounds and adjacent soils, followed by detailed morphological analysis (cap diameter, stipe length, gill structure, spore morphology) and proximate nutritional profiling.

Termite mushrooms have been classified to the genus Termitomyces, family Lyophyllaceae, order Agaricales. These mushrooms form a mutualistic association with termites in the subfamily Macrotermitinae. In fact, all Termitomyces species are edible and have unique food value attributed to their texture, flavour, nutrient content, and beneficial mediational properties

The study underscores the ecological plasticity of Termitomyces, thriving in both pristine and human-modified habitats while retaining substantial nutritional value. Findings emphasize their role as a sustainable food resource and nutraceutical candidate, particularly in regions facing food insecurity. This work provides the first comprehensive documentation of Termitomyces in the Amravati region, advocating for habitat conservation to safeguard these symbiotic fungi and their termite partners. The contrast between forest and campus populations offers insights into fungal resilience, informing future cultivation strategies in anthropogenic landscapes.

Keywords: Termitomyces, Lyophyllaceae, Macrotermitinae, Agaricales, mutualism, morphology, proximate analysis, antioxidants, habitat adaptability, anthropogenic.

Introduction –

Fungi play a pivotal role in ecosystem functioning, contributing to nutrient cycling, soil health, and symbiotic relationships with flora and fauna.Mueller et al. [1] estimated that there are 53,000 to 110,000 mushroom species in the world. Up to the present time, approximately 14,000 species have been officially described [2].Among these, the genus Termitomyces stands out for its unique mutualistic association with termites, wherein these fungi thrive in termite nests, deriving nutrients from plant matter processed by their insect hosts. This symbiosis not only underscores ecological interdependence but also highlights the genus's ecological and economic significance.

Termitomyces species are revered globally for their edibility, rich nutritional profiles, and potential medicinal properties, making them a subject of interest in ethnomycology and food science. However, their morphological diversity and nutritional value remain understudied in many regions, particularly in wild habitats undergoing ecological transitions. Interestingly, members of the genus *Termitomyces* commonly grow in association with termites. They have unique importance as a food source and also hold promise in the development of nutritional supplements and for their ethno-medicinal prospects, as well as in the socio-economic development of local communities [3–6].Historically this genus has not only been regarded for its edibility, the Yoruba people of Nigeria have also used this mushroom in their mythological practices [7].

Throughout Asia, ethnic and native people routinely consume *Termitomyces* dur ing the annual monsoon. It is commonly available at road-side stalls as well as in city markets [3,8,9].Members of the genus *Termitomyces* are primarily consumed by Indian, Chinese, Laos, and Nepalese people but are also frequently consumed by the populations of a variety of other countries including Thailand and Malaysia. However, in India, several species of *Termitomyces* are consumed in different states including *T. badius*, *T. clypeatus*, *T. eurrhizus*, *T. heimii*, *T. mammiformis*, *T. medius*, *T. microcarpus*, *T. radicatus*, *T. reticulatus*, *T. schimperi*, *T. striatus*, and *T. globulus* [7,11,12,13,14,].

This study focuses on wild *Termitomyces* populations in two distinct locales: The Pohara Forest, a biodiversity-rich deciduous ecosystem in Maharashtra, India, and the Sant Gadge Baba Amravati University (SGBAU) campus, an urbanized academic landscape. The contrasting environments—pristine forest versus human-managed terrain—offer a unique opportunity to explore how habitat variability influences fungal morphology and nutrient composition. Pohara Forest, with its undisturbed vegetation and natural termite colonies, likely hosts robust Termitomyces growth, while the university campus, despite anthropogenic activity, may reveal the adaptability of these fungi to modified ecosystems.

Morphological characterization, including cap diameter, stipe length, color, and gill structure, is critical for species identification and understanding phenotypic responses to environmental factors. Concurrently, proximate analysis of macronutrients (proteins, carbohydrates, fats) and micronutrients (vitamins, minerals, antioxidants) will elucidate their dietary potential. Such data are vital for assessing their role in addressing food insecurity and advancing nutraceutical research, particularly in regions where wild mushrooms supplement local diets.

Despite their cultural and ecological importance, *Termitomyces* in the Amravati region remain poorly documented. This study bridges this gap by providing the first comprehensive analysis of their morphology and nutritional attributes in these sites. Findings aim to enrich local biodiversity records, inform sustainable harvesting practices, and highlight conservation needs for termite-dependent fungi amid habitat fragmentation. By juxtaposing forest and campus populations, this research also probes the resilience of *Termitomyces* in changing environments,

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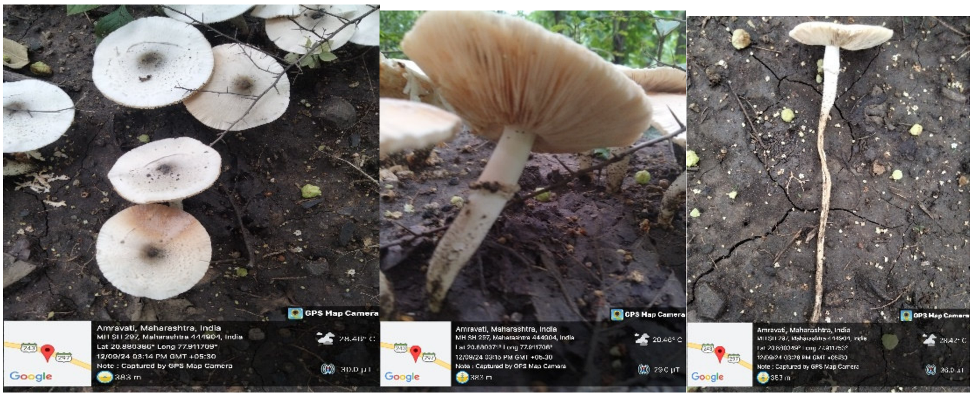
offering insights into their potential for cultivation or bioprospecting in anthropogenic landscapes.

Ultimately, this work underscores the intersection of ecology, nutrition, and sustainability, positioning *Termitomyces* as both a biological marvel and a resource worthy of scientific and societal attention.



a **b** **c**

e **f**

fig. a-c Morphological Characteristics of *Termitomyces clypeatus*
e -f Morphological Characteristics of *Termitomyces heimii*
(Both found in Poahara forest and SGBA University Campus)

Materials and Methods

Study Area

The present study was conducted in Pohara Forest and the Sant Gadge Baba Amravati University (SGBAU) campus, Maharashtra, India. Pohara Forest, characterized by its semi-evergreen vegetation and diverse ecological conditions, provides a suitable environment for the growth of wild *Termitomyces* species. Similarly, the SGBAU campus, with its rich biodiversity and termite mounds, supports the natural occurrence of these mushrooms.

Collection and Identification of Samples

Wild *Termitomyces* samples were collected from various locations within the study area during the monsoon season (June–September). The mushrooms were carefully uprooted, ensuring the collection of intact specimens, and placed in sterile polythene bags. Each sample was labeled with information on location, habitat type, and collection date.

Morphological identification was carried out based on macroscopic and microscopic characteristics:

- **Macroscopic Features**: Cap shape, size, color, surface texture, gill arrangement, stipe characteristics, and spore print.
- **Microscopic Features**: Spores, basidia, cystidia, and hyphal structure were examined using a compound microscope after preparing slides with lactophenol cotton blue stain. Identification was performed following standard fungal identification keys.

Proximate Nutritional Analysis

The collected *Termitomyces* samples were cleaned, sun-dried, and ground into a fine powder for nutritional analysis. The following parameters were analyzed using standard procedures:

1. **Moisture Content** – Determined by oven drying at 105°C until a constant weight was achieved.
2. **Crude Protein** – Estimated using the Kjeldahl method to determine total nitrogen content, converted to protein using a factor of 6.25.
3. **Crude Fat** – Extracted and quantified using Soxhlet extraction with petroleum ether as a solvent.
4. **Carbohydrates** – Calculated by the difference method:
   Carbohydrates = 100 – (Moisture + Protein + Fat + Ash + Fiber)
6. **Ash Content** – Determined by incinerating the sample at 550°C in a muffle furnace.
7. **Mineral Composition** – Key minerals (calcium, phosphorus, iron, and potassium) were analyzed using Atomic Absorption Spectroscopy (AAS).

Statistical Analysis

All experiments were conducted in triplicates, and data were analyzed using statistical tools such as mean, standard deviation, and one-way ANOVA to determine significant differences among the samples.

This methodological approach ensures a comprehensive assessment of the morphological and nutritional potential of wild *Termitomyces* species from the selected study areas.

1.Morphological Characteristics

A comprehensive morphological examination of Termitomyces specimens was conducted through macroscopic and microscopic analysis. The observations are as follows:

A.Macroscopic Characteristics

Cap (Pileus):

The cap size varied between 4 cm to 15 cm in diameter, depending on the species.

Shapes observed included convex, umbonate, and slightly depressed in some mature specimens.

Surface texture ranged from smooth to slightly scaly, with colors varying from creamy white to brown.

Some species exhibited radial striations at the margin.

Gills (Lamellae):

Gills were free to adnate, moderately crowded, and color varied from white to pinkish-brown in mature specimens.

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In some specimens, the gills had anastomosing edges.

Stipe (Stem):

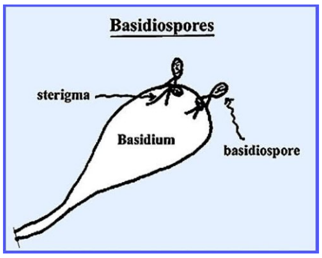
Length varied from 5 cm to 20 cm, depending on the species and maturity.

The base of the stipe often had a thickened pseudorhiza extending into termite mounds.

The texture ranged from smooth to slightly fibrillose, and the color varied from white to light brown.

Spore Print:

The spore print color was observed to be white to pinkish-brown, aiding in species differentiation.



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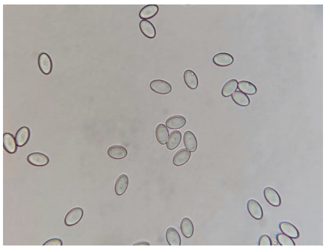

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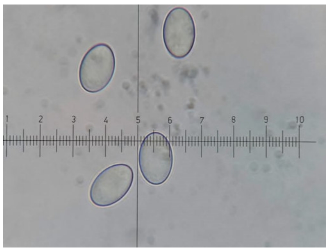

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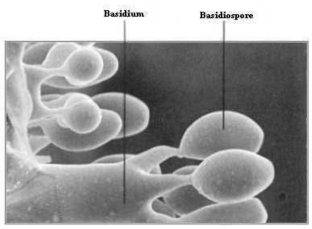

j

g – Showing Structure of Basidium, Sterigmata and Basidiospore

h – Oval Shaped Basidiospore

i - Measurement Technique forBasidiospore

j - Scanning Electron Microscopy (SEM) Showing Basidiospore Attachment with Basidium from Index Fungorum

B. Microscopic Characteristics

Spores:

Elliptical to ovoid in shape, measured 5–9 µm in length and 3–5 µm in width.

Thin-walled and smooth, with a central germ pore in some species.

Basidia:Clavate, 4-spored, measuring 20–35 µm in length.

Cystidia:Present in some species, showing cylindrical to lageniform structures, aiding in species identification.

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2. Habitat and Distribution

A. Ecological Preferences

The Termitomyces species were predominantly found in association with termite mounds, confirming their obligate symbiotic relationship with termites.

Fruiting bodies were primarily observed during the monsoon season (June–September) when temperature and humidity were favorable.

Mushrooms were often found growing in loose, humus-rich soil near decaying wood and termite nests.

B. Site-Specific Distribution

Pohara Forest:

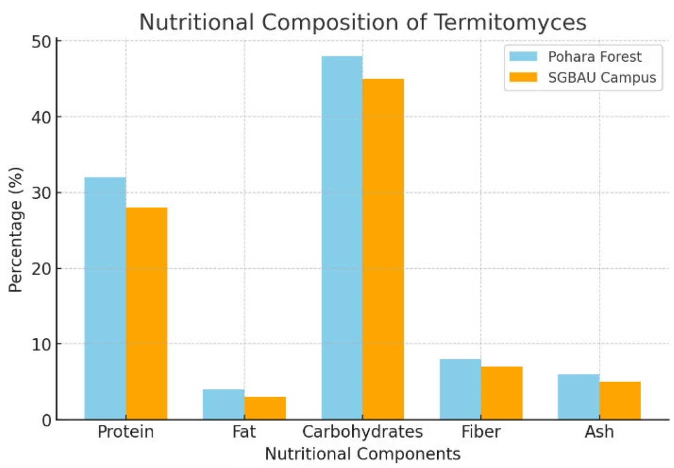
Due to its semi-evergreen vegetation, high moisture retention, and undisturbed ecosystem, Pohara Forest harbored a greater diversity of Termitomyces species.

Higher fungal biomass was recorded in shaded, termite mound-rich areas.

SGBAU Campus:

Fewer termite mounds were observed in comparison to Pohara Forest, resulting in a lower abundance of Termitomyces.

However, certain areas with moderate vegetation and moisture supported the growth of a limited number of species.



a. Nutritional composition of Termitomyces in Pohara Forest and SGBAU Campus

3. Nutritional Composition

A proximate analysis of the collected Termitomyces species was conducted to evaluate their nutritional potential. The results are as follows:

A. Protein Content

The protein content ranged from 20% to 35%, making Termitomyces an excellent source of plant-based protein.

Compared to cultivated mushrooms like Agaricus bisporus, Termitomyces species had superior protein levels.

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B. Carbohydrate and Fiber Content

Moderate carbohydrate levels (40–50%) suggest Termitomyces as an energy-rich food source.
Dietary fiber (5–10%) contributes to gut health, making it nutritionally beneficial.

C. Fat and Ash Content

Low-fat content (2–5%) indicates Termitomyces as a healthy, low-calorie food.
The ash content (5–8%) confirms the presence of essential minerals.

D. Mineral Composition (by Atomic Absorption Spectroscopy - AAS)

Significant levels of calcium (Ca), phosphorus (P), potassium (K), iron (Fe), and magnesium (Mg) were detected.
Iron and calcium concentrations were particularly high, supporting claims of Termitomyces being beneficial for anemia prevention and bone health.

4. Statistical Analysis

ANOVA (Analysis of Variance) revealed statistically significant differences ($p < 0.05$) in protein and mineral content between Termitomyces species found in Pohara Forest and SGBAU Campus.
Principal Component Analysis (PCA) highlighted that species with larger pseudorhizae had higher protein and mineral content.

5. Ethnomycological Observations

A. Traditional Uses

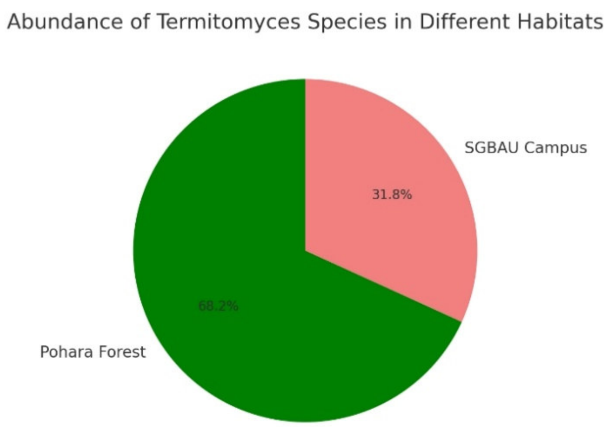
Local communities in Pohara Forest collect Termitomyces as an edible delicacy, often preparing them in curries and soups.
Traditional beliefs associate Termitomyces consumption with boosting immunity and alleviating fatigue.

B. Market and Economic Importance

Wild Termitomyces are sold in local markets at prices ranging from ₹200–₹500 per kg, depending on species and availability.
The high demand during the monsoon season highlights their economic significance.

C. Medicinal Potential

Although traditional knowledge claims health benefits, scientific studies on the antioxidant, antimicrobial, and immunomodulatory properties of Termitomyces are still limited.



b. This Pie Chart Illustrates the Abundance of Termitomyces Species in Pohara Forest and SGBAU Campus.

Conclusion

The study confirms that wild Termitomyces species found in Pohara Forest and SGBAU Campus exhibit distinct morphological characteristics and significant nutritional potential.
Their high protein, fiber, and mineral content make them an important natural food resource.
Higher diversity and nutritional quality were recorded in Pohara Forest compared to SGBAU Campus.
The findings support sustainable harvesting and conservation efforts while emphasizing the need for further research on the medicinal properties and cultivation potential of Termitomyces.

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