INDIAN JOURNAL OF SCIENCE AND TECHNOLOGY

RESEARCH ARTICLE

# *Pleurotus giganteus* as a Valuable Source of Nutrients

**V L Thachunglura[1], P K Rai[1]*, Zohmangaiha[1], Benjamin Lalbiakmawia[1], Lalmuansangi[1], John Zothanzama[2]**

**1** Department of Environmental Science, Mizoram University, Tanhril, Aizawl, Mizoram, India
**2** Department of Biotechnology, Mizoram University, Tanhril, Aizawl, Mizoram, India

OPEN ACCESS

**Received:** 23-01-2023
**Accepted:** 09-06-2023
**Published:** 06-09-2023

**Citation:** Thachunglura VL, Rai PK, Zohmangaiha , Lalbiakmawia B, Lalmuansangi , Zothanzama J (2023) *Pleurotus giganteus* as a Valuable Source of Nutrients. Indian Journal of Science and Technology 16(PS1): 89-94. https://doi.org/10.17485/IJST/v16sp1.msc12

* **Corresponding author**.

pkraimzu@gmail.com

**Funding:** DBT-NER/AAB/64/2017 dated 14.10.2019 for providing necessary laboratory facilities. University Grants Commission, New Delhi for financial support under National Fellowship for ST

**Competing Interests:** None



Published By Indian Society for Education and Environment (iSee)

**ISSN**
Print: 0974-6846
Electronic: 0974-5645

## Abstract

**Objectives:** The present study aims to identify and evaluate the chemical composition of young and matured sporocarps of *Pleurotus giganteus*. **Methods:** Wild edible mushroom, *Pleurotus giganteus* was collected during the monsoon season in 2021 from Reiek Tlang, Mizoram. The collected sample was cleaned, oven dried at 45°C and finely powdered and stored in a tightly stoppered bottle for further analysis. **Findings:** The nutrient profiles revealed that the sample is generally rich in protein and carbohydrates with low-fat content and contained considerable amounts of minerals but lower toxic metal contents and can be used as a natural food source without any health risk which is vital in supplementing nutrition to mankind. **Novelty:** This study provides information regarding the nutritive quality of *P. giganteus* and can be used as a reference for food compositional data.

**Keywords:** Mushrooms; Mizoram; Nutritional value; Fruit body; Nutrients; Molecular identification

## 1 Introduction

Fungi have become one of the main decomposers of recalcitrant organic matter and occur in diverse climates under different conditions [(1)]. Mushroom is a general term used to describe the fruit bodies of fungi which belong either to Basidiomycetes or Ascomycetes.They usually grow on the trunks, soil, roots of trees as well as decaying woody materials and dead wood trees, and emerged more than a million years ago [(2)].

*Pleurotus giganteus* is formerly known as *Lentinus giganteus* and it bears many structures that are atypical of Lentinus and its taxonomic position has long been unresolved. With the support of morphological and molecular evidence, *Lentinus giganteus* was placed in *Pleurotus*, rather than in *Lentinus*. It is one of the largest edible mushrooms and is typically found either in groups or solitary on buried rotten wood above the ground soil. It has a thick, radicant stipe and subdistant broad lamellae [(3)]. Wild edible mushrooms have been widely used as food since time immemorial and the consumption of edible wild mushrooms is increasing due to their high nutritional and culinary value [(4)]. Mushrooms or macrofungi obtained their nutrients through external digestion and absorption by the mycelium.

Nutritional values of genera pleurotoid were considered as a good source of nutrients [(5)] and compatible with meat products [(6)] due to the presence of high amount

of proteins, vitamins, minerals and they are capable of colonizing and degrading many lignocellulosic residues. However, the nutritional benefits of wild edible mushroom *P. giganteus* are still meagre and have not been completely harnessed possibly due to insufficient information on the viability of this mushroom.

Mizoram is gifted with diverse landforms and a variety of climatic conditions that are suitable for a varied range of fungal species[7,8]. However, no significant study has yet been undertaken on the nutritional value of the mycoflora in Mizoram. Wild growing edible mushroom species are frequently consumed and knowledge of their nutritional composition is essential. Therefore, the present study aimed to determine the proximate chemical composition of *Pleurotus giganteus* to assess its valuable nutritive constituents and this database can be used as a reference which thus necessitated this research.

## 2 Methodology

### 2.1 Sample collection and preparation

The sample was collected from a distance of potential pollution sources during the monsoon season in 2021 at Reiek Tlang, Mizoram (Figure 1). The region is a high rainfall area with dense forest and provides ideal atmospheric conditions for the growth of mushrooms. The collected sample was cleaned thoroughly to remove mud and other extraneous material and kept in an air-tight container before transporting it to the laboratory[9]. Without division into pileus and stipe, the whole fleshy collected mushroom sample was oven dried at 45°C and ground into a fine powder and stored in a tightly stoppered bottle for proximate analysis.

### 2.2 Molecular analysis

DNA was extracted from tissue removed from the inside of fruiting bodies using a CTAB extraction. A small amount of tissue from the inside of the fruiting body was added to a sterile 1.7 ml microcentrifuge tube with glass beads and 500 $\mu$L of CTAB lysis buffer. The centrifuge tube was then vortexed for a minute to homogenize lyse fungal cells. The tubes were then briefly centrifuged to move the larger tissue segments to the bottom of the tube and then the supernatant was transferred to another tube. The new microcentrifuge tube was then placed into a 65°C hot water bath to further lyse the cells. After 20 minutes, the tubes were removed and 500 $\mu$L of chloroform was added to the tube, mixed and then centrifuged at 13,000 rpms for 5 minutes. The top layer of the supernatant was transferred to a new microcentrifuge tube. The amount of liquid transferred was then measured and two-thirds of that amount was added to isopropanol stored in a -20°C freezer. The tube was then incubated for 5 minutes at room temperature before being centrifuged for 7 minutes at 15,000 rpm. The supernatant was removed and 500 $\mu$L of 70% ethanol was added. The tubes were centrifuged again at 15,000 rpm for 3 minutes and the supernatant was removed. The tubes were left open in a hood to allow the last of the ethanol to evaporate before the DNA pellet was re-suspended in 100 $\mu$L of sterile water.

PCR reactions were setup in 0.2 ml centrifuge tubes that contained 12.5 $\mu$l GoTaq Green Mastermix (Promega, Madison, WI), 9.5$\mu$l nuclease-free water, 1$\mu$l forward primer (5M), 1$\mu$l reverse primer (5M) and 1$\mu$l of fungal DNA template for a total reaction volume of 25.5$\mu$l. PCR was performed using primers ITS1-F (5'-CTT GGT CAT TTA GAG GAA GTA A-3') ITS4 (5'- TCC TCC GCT TAT TGA TAT GC-3')[10] with the following parameters; 94°C for 5 minutes, followed by 35 cycles of 94°C for 1 minute, 52°C for 1 minute and 72°C for 1 minute with a final extension step of 72°C. PCR amplicons were verified by electrophoresis on a 1% agarose gel with SYBR green and visualized on a Gel Documentation System. Sequencing was performed using both primers by using Sanger sequencing using a DNA sequencer. A consensus sequence for contigs was trimmed and aligned using the Bioedit sequence alignment editor[11]. A sequence was then compared to those in the GenBank database using the BLASTn[12] search tool for similarities and submitted to Genbank. The sequences were then aligned with Clustal W[13] and the phylogenic tree was established using Maximum Likelihood in RaxML GUI software.

Phylogenetic analysis was conducted based on the ITS gene data using both Maximum Likelihood (ML) and Neighbor-Joining (NJ) approaches. ML and NJ searches were carried out using RaxML GUI. Alignment gaps were treated as missing data. NJ trees were constructed based on the total character differences and bootstrap values were calculated from 1,000 replications.

### 2.3 Proximate and mineral content analysis

In general, moisture, protein, fat, fibre and ash content were determined in accordance with the appropriate standard methods of the Association of Official Analytical Chemists[14] and the contents of total carbohydrate and energy values were calculated using the conversion factors of Crisan and Sands[15]. Sample analysis was done in triplicates on a dry weight basis. Minerals (K, Na, Fe, Zn, Ca, Mn, Cu, Cd and Pb) were determined by using an atomic absorption spectrophotometer (Thermo Scientific iCE 3400 series, USA) after dry ashing of the sample[16].

# 3 Results and Discussion

## 3.1 Molecular identification

The nucleotide sequence of the mushroom blasted against sequences from GenBank database revealed the identification of *Pleurotus giganteus*, a fungal isolate from Mizoram.

The ITS1-5.8S-ITS4 sequences of the fungal isolate was compared to 20 corresponding sequences of reference fungal taxa in the database and the list of species, voucher number, GenBank accession number and locality used for the analysis is given in Table 1 and phylogenetic tree in Figure 2.


**Fig 1. Young and matured fruiting body of *Pleurotus giganteus***

**Table 1. List of species, voucher, GenBank accession nos. and locality**

| Sl. no. | Species | Voucher/Strain | NCBI | Locality |
|---|---|---|---|---|
| 1 | *Pleurotus sp.* | DMS2021-8-7 | OK643767 | China |
| 2 | *Pleurotus giganteus* | MRNo556. | LC068800 | Thailand |
| 3 | *Pleurotus giganteus* | MFLU08-1371 | KP120919 | Thailand |
| 4 | *Pleurotus giganteus* | FRI849 | KX018294 | China |
| 5 | *Pleurotus giganteus* | HMAS P1 | KP793688 | China |
| 6 | *Pleurotus giganteus* | NU-BOT-GN-PG-007 | OM717958 | |
| 7 | *Pleurotus giganteus* | P6 | HM245789 | China |
| 8 | *Pleurotus levi* | S.D. Russell iNaturalist # 91369573 | OM972587 | USA |
| 9 | *Pleurotus levi* | S.D. Russell MycoMap # 4187 | ON245348 | USA |
| 10 | *Pleurotus levi* | S.D. Russell Mushroom Observer # 465240 | OM972617 | USA |
| 11 | *Pleurotus levi* | S.D. Russell ONT iNaturalist # 132753423 | OP643485 | USA |
| 12 | *Pleurotus levi* | Mushroom Observer 382406 | MW633064 | USA |
| 13 | *Pleurotus dryisus* | ASI 2123 | AY265823 | Korea |
| 14 | *Pleurotus dryisus* | FLAS-F-61321 | MH211881 | USA |
| 15 | *Pleurotus sp.* | NOM6 | KF415286 | Nigeria |
| 16 | *Pleurotus cystidiosus* | Blao clone A | DQ882570 | Japan |

*Continued on next page*

| *Table 1 continued* | | | | |
|---|---|---|---|---|
| 17 | *Pleurotus cystidiosus* | JZ9 | MG437337 | India |
| 18 | *Pleurotus fuscosquamulosus* | EGDA-Pl23 | MW915606 | Egypt |
| 19 | *Pleurotus fuscosquamulosus* | - | KM111497 | Tanzania |
| 20 | *Ceriporiopsis semisupina* | NHMM | MG719280 | India |

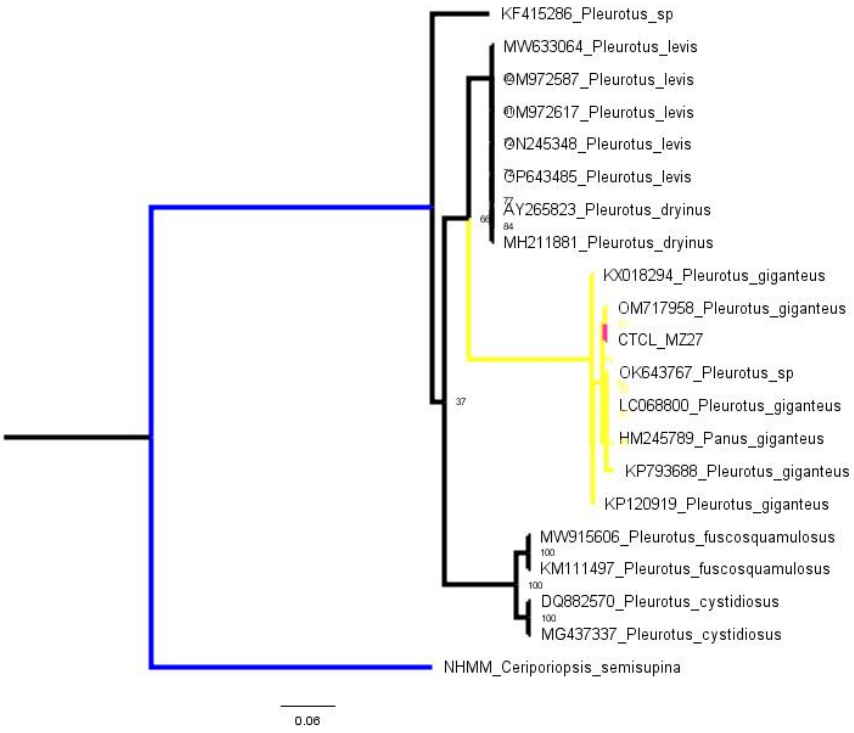


**Fig 2. Phylogenetic tree**

The evolutionary history was inferred by using the Maximum Likelihood method based on the GTR-GAMMA model. The tree is drawn to scale, with branch lengths measured in the number of substitutions per site. Evolutionary analyses were conducted in raxmlGUI 2.0.

In the maximum Likelihood tree generated, the specimen, *Pleurotus giganteus* clustered with the related species with high support value. *Ceriporiopsis semisupina* was used as the Outgroup which is highlighted in blue colour. The fungal isolate collected from Mizoram, *Pleurotus giganteus* (CTCL_MZ27) is highlighted in red colour amongst the *Pleurotus giganteus* clade (indicated in yellow colour).

## 3.2 Proximate and mineral content analysis

The proximate and mineral content of the mushroom sample is given on a dry weight basis (Table 2).

This study revealed that the sample *Pleurotus giganteus* is a good source of protein (23.04%), carbohydrate (49.19%) and fibre (7.98%) and generally low in fat concentration (2.46%). Moisture content (9.73%) can be affected by environmental temperature, relative humidity during growth and storage. Moisture has no nutritional relevance but it is the most important factor which directly affects the nutrient contents of the mushrooms. The nutritional value of some edible *Pleurotus sp*. as well as other species have been documented on a dry weight basis [17–19] which is fair close to the result obtained in this study. Phan *et al* [3] obtained 15.4% of protein, 3.7% of fat, 364 kcal/100 g of energy value, 33.3% of fibre and 67.2% carbohydrates in *P. giganteus*. The carbohydrate and fibre content is noticeably higher than the present value obtained. For instances Kalkoti *et al* [20] obtained 16.52% protein and 38.62% of carbohydrate from *P. giganteus*. In this regard, it is clear that variation can occur in nutrient contents of wild edible mushrooms by their location, developmental stage, substrate as well as the type of mushrooms.

Mineral concentrations of *P. giganteus* were investigated and the data are given in Table 3. Except for chromium and lead, all the minerals were determined in the sample. The most abundant element was found to be K, followed by Na, Fe, Zn and Ca.

**Table 2. Chemical composition of *P. giganteus* in a dried weight basis (g/100g) and energy value in Kcal/100g**

| Chemical composition | Amount |
|---|---|
| Moisture | 9.73 ± 0.09g/100g |
| Protein | 23.04 ± 1.34g/100g |
| Fat | 2.46 ± 0.09g/100g |
| Crude Fibre | 7.98 ± 0.42g/100g |
| Ash | 7.52 ± 0.09 g/100g |
| Carbohydrate | 49.19 ± 1.75 g/100g |
| Energy value | 288.13 ± 3.63 kcal/100g |

Data shown are means and standard deviations of triplicate determinations.

Regarding the microelements, manganese and copper were found at very low concentrations. Variations in the mineral content of the mushrooms can be caused by various environmental factors including soil quality, growth substrate and climate [21].

**Table 3. Total elemental compositions of *P. giganteus* in a dried weight basis (ppm) ND: Not detectable**

| Minerals | Concentrations (in ppm) |
|---|---|
| Potassium | 1259.81 |
| Sodium | 217.15 |
| Iron | 63.28 |
| Zinc | 58.96 |
| Calcium | 18.64 |
| Manganese | 0.36 |
| Copper | 0.32 |
| Cadmium | ND |
| Lead | ND |

## 4 Conclusion

This study essentially helps to enhance the nutritional distribution of the mushroom *P. giganteus*. It contains a considerable amount of protein, carbohydrates and fibre, which serve as a good source of nutrients for the human body and can be consumed unreservedly without any health risk. High carbohydrate content can be a good source of carbohydrates for diabetic patients. They have a low-fat content making them ideal components in several diets and daily consumption. It also appears to be a good source of minerals and trace elements that are essential for human health. Nevertheless, inadequate information is available concerning the nutritional properties of wild edible mushrooms in Mizoram and further studies are needed to assess and document the nutritional database of edible macrofungi.

## 5 Declaration

Presented in 4$^{th}$ Mizoram Science Congress (MSC 2022) during 20$^{th}$ & 21$^{st}$ October 2022, organized by Mizoram Science, Technology and Innovation Council (MISTIC), Directorate of Science and Technology (DST) Mizoram, Govt. of Mizoram in collaboration with science NGOs in Mizoram such as Mizo Academy of Sciences (MAS), Mizoram Science Society (MSS), Science Teachers' Association, Mizoram (STAM), Geological Society of Mizoram (GSM), Mizoram Mathematics Society (MMS), Biodiversity and Nature Conservation Network (BIOCONE) and Mizoram Information & Technology Society (MITS). The Organizers claim the peer review responsibility.

## 6 Acknowledgements

The authors would like to sincerely thank the support vide research project no. DBT-NER (No. DBT-NER/AAB/64/2017 dated 14.10.2019) for providing necessary laboratory facilities. Thanks, are due to University Grants Commission, New Delhi for financial support under National Fellowship for ST.

## References


1) Lustenhouwer N, Maynard DS, Bradford MA, Lindner DL, Oberle B, Zanne AE, et al. A trait-based understanding of wood decomposition by fungi. *Proceedings of the National Academy of Sciences*. 2020;117(21):11551–11558. Available from: https://doi.org/10.1073/pnas.1909166117.
2) Rhaman SMSA, Naher L, Siddiquee S. Mushroom Quality Related with Various Substrates' Bioaccumulation and Translocation of Heavy Metals. *Journal of Fungi*. 2021;8(1):1–17. Available from: https://doi.org/10.3390/jof8010042.
3) Phan CW, Wang JK, Tan EYY, Tan YS, Seelan JSS, Cheah SC, et al. Giant oyster mushroom, Pleurotus giganteus (Agaricomycetes): Current status of the cultivation methods, chemical composition, biological, and health-promoting properties. *Food Reviews International*. 2019;35(4):324–341. Available from: https://doi.org/10.1080/87559129.2018.1542710.
4) Atri NS, Kumari B, Kumar S, Upadhyay RC, Gulati A, Lata, et al. Nutritional Profile of Wild Edible Mushrooms of North India. In: Fungi. CRC Press. 2018;p. 372–395.
5) Raman J, Jang KY, Oh YL, Oh M, Im JH, Lakshmanan H, et al. Cultivation and Nutritional Value of Prominent Pleurotus spp.: An Overview. *Mycobiology*. 2021;49(1):1–14. Available from: http://dx.doi.org/10.1080/12298093.2020.1835142.
6) He J, Evans NM, Liu H, Shao S. A review of research on plant-based meat alternatives: Driving forces, history, manufacturing, and consumer attitudes. *Comprehensive Reviews in Food Science and Food Safety*. 2020;19(5):2639–2656. Available from: https://doi.org/10.1111/1541-4337.12610.
7) Vabeikhokhei JMC, Mangaiha Z, Zothanzama J, Lalrinawmi H. Diversity Study of Wood Rotting Fungi from Two different Forests in Mizoram, India. *International Journal of Current Microbiology and Applied Sciences*. 2019;8(4):2775–2785. Available from: http://dx.doi.org/10.20546/ijcmas.2019.804.323.
8) Mangaiha Z, Vabeikhokhei JM, Zothanzama J, Lalrinawmi H. Ganoderma Species of Mizoram, India. *International Journal of Current Microbiology and Applied Sciences*. 2019;8(4):2871–2879. Available from: http://dx.doi.org/10.20546/ijcmas.2019.804.335.
9) Zothanzama J. Wood Rotting Fungi of Mizoram. In: Lalramnghinglova H, Lalnunmawia F, editors. Forest Resources of Mizoram: Conservation and Management. Department of Environmental Science, Mizoram University. 2011;p. 326–345.
10) White TJ, Bruns T, Lee S, Taylor J. Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. *PCR Protocols*. 1990;p. 315–322. Available from: http://dx.doi.org/10.1016/b978-0-12-372180-8.50042-1.
11) Hall T. BioEdit: A User-Friendly Biological Sequence Alignment Editor and Analysis Program for Windows 95/98/NT. *Nucleic Acids Symposium Series*. 1999;41:95–98. Available from: https://scholar.google.com/citations?view_op=view_citation&hl=en&user=25lPJlMAAAAJ&citation_for_view=25lPJlMAAAAJ:b0M2c_1WBrUC.
12) Altschul SF, Gish W, Miller W, Myers EW, Lipman DJ. Basic local alignment search tool. *Journal of Molecular Biology*. 1990;215(3):403–410. Available from: http://dx.doi.org/10.1016/S0022-2836(05)80360-2.
13) Larkin MA, Blackshields G, Brown NP, Chenna R, Mcgettigan PA, Mcwilliam H, et al. Clustal W and Clustal X version 2.0. *Bioinformatics*. 2007;23(21):2947–2948. Available from: https://doi.org/10.1093/bioinformatics/btm404.
14) AOAC. Official Methods of Analysis. 15th Edition. Washington DC, USA. Association of Official Analytical Chemist. 1990.
15) Crisan EV, Sands A. Nutritional Value. In: The Biology and Cultivation of Edible Mushrooms. 1978;p. 137–168. Available from: http://dx.doi.org/10.1016/b978-0-12-168050-3.50012-8.
16) Gençcelep H, Uzun Y, Tunçtürk Y, Demirel K. Determination of mineral contents of wild-grown edible mushrooms. *Food Chemistry*. 2009;113(4):1033–1036. Available from: http://dx.doi.org/10.1016/j.foodchem.2008.08.058.
17) Sifat N, Lovely F, Zihad SMNK, Hossain MG, Shilpi JA, Grice ID, et al. Investigation of the nutritional value and antioxidant activities of common Bangladeshi edible mushrooms. *Clinical Phytoscience*. 2020;6(88):1–10. Available from: https://doi.org/10.1186/s40816-020-00235-3.
18) Finimundy TC, Barros L, Calhelha RC, Alves MJ, Prieto MA, Abreu RMV, et al. Multifunctions of Pleurotus sajor-caju (Fr.) Singer: A highly nutritious food and a source for bioactive compounds. *Food Chemistry*. 2018;245:150–158. Available from: https://doi.org/10.1016/j.foodchem.2017.10.088.
19) Kumari N, Srivastava AK. Nutritional analysis of some wild edible mushrooms collected from Ranchi District Jharkhand. *International Journal of Recent Scientific research*. 2020;11(03):37670–37674. Available from: http://recentscientific.com/sites/default/files/15897-A-2020.pdf.
20) Kakoti M, Hazarika DJ, Parveen A, Dullah S, Ghosh A, Saha D, et al. Nutritional Properties, Antioxidant and Antihaemolytic Activities of the Dry Fruiting Bodies of Wild Edible Mushrooms Consumed by Ethnic Communities of Northeast India. *Polish Journal of Food and Nutrition Sciences*. 2021;71(4):463–480. Available from: https://doi.org/10.31883/pjfns/144044.
21) Bellettini MB, Fiorda FA, Maieves HA, Teixeira GL, Ávila S, Hornung PS, et al. Factors affecting mushroom Pleurotus spp. *Saudi Journal of Biological Sciences*. 2019;26(4):633–646. Available from: https://doi.org/10.1016/j.sjbs.2016.12.005.