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Research Article

NUTRITIONAL, PHYTOCHEMICAL, ANTIOXIDANT AND ANTIBACTERIAL ANALYSIS OF *Ganoderma lucidum*

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ABSTRACT

Ganoderma lucidum is widely known for its herbal remedial properties and high nutrient value. This study was conducted to examine the nutritional composition (fat, carbohydrates, proteins, crude fibers, ash, moisture and minerals), phytochemicals (phenolics, flavonoids, tannin, saponin, phytate, terpenoids, lycopene, and β-carotene), antioxidants and antimicrobial activity of *G. lucidum*. In our study, *G. lucidum* Philippine strain was cultured on Potato Dextrose Agar, cultivated in a sawdust and rice bran substrate and harvested for the nutritional and phytochemical studies. The mushroom was identified as *G. lucidum* based on sequence analysis using the BLAST database. The nutritional content analysis showed that *G. lucidum* contains protein (10.53%), carbohydrates (20.26%), fat (1.32%), moisture (8.56%), crude fiber (7.81%), and ash (4.97%). The presence of copper (0.133 ± 0.003 mg/g), iron (0.059 ± 0.013 mg/g), manganese (0.022 ± 0.002 mg/g) and zinc (0.030 ± 0.001 mg/g) was observed in the sample. The mushroom also had phenolics (544.04 ± 0.07 mg GAE/100g), flavonoids (194.11 ± 0.04 mg QAE/100g), tannin (1275 ± 0.05 TAE mg/100g), lycopene (1.29 ± 0.06 mg carotenoids/g), β-carotene (2.98 ± 0.02 mg carotenoids/g), saponin (130.27 ± 0.04 mg/100g diosgenin), phytate (96.23 ± 0.03 mg/100g phytic acid) and terpenoid (3.4%). The antioxidant activity (IC_{50}) was found to be 154.8 µg/ml. However, the sample did not show any antimicrobial activity at tested concentrations. Based on the findings of phytochemical and nutritional analysis, *G. lucidum* seems to be a good source of nutrients and antioxidants.

Keywords: Antioxidants, *G. lucidum*, Nutritional composition, Phytochemicals

INTRODUCTION

Ganoderma lucidum is a polypore fungus which has been a part of East Asian medicine for thousands of years due to its healing properties and culinary value (Moncalvo & Ryvarden, 1997; Kumar & Yadav, 2019; Oke et al., 2022; Wu et al., 2024). It is known as "Lingzhi" in China, which means "mushroom of immortality", while in Japan it is referred to as "Reishi", which means "divine mushroom" (Kumar & Yadav, 2019; Oke et al., 2022). This fungus is a facultative parasite and grows in dead or decaying logs and tree stumps (Moncalvo & Ryvarden, 1997; Łakomy & Kwaśna, 2008; Zhou et al., 2015). It is a member of Ganodermataceae family, phylum Basidiomycota, class Agaricomycetes, and belongs to the order Polyporales. The distinguishing feature of *G. lucidum* is its shiny, crimson-hued, kidney-shaped cap, woody consistency, and double-walled basidiospore (Donk, 1964; El Sheikha, 2022). They usually grow in a shelf-like pattern, and their diameter can be more than 60 cm (Cope, 2022).

Reishi mushrooms are increasingly being used as a nutraceutical supplement to ameliorate chronic pathologies and enhance holistic well-being (Raman et al., 2022). Several bioactive components present in this mushroom have captured attention globally (Rahman et al., 2020; El Sheikha, 2022). *G. lucidum* is reported to harbour nearly 400 bioactive compounds, and the major constituents encompass polysaccharides, triterpenoids, nucleotides, sterols, steroids, proteins, fatty acids, and vitamins (Cadar et al., 2023; Dhami et al., 2024). Among these, polysaccharides and triterpenoids are the most pharmacologically efficacious fractions in the mushroom (Subedi et al., 2021). Researchers have found that phytochemical constituents of *G. lucidum* have therapeutic properties, including anti-glycemic, anti-ulcer, antimicrobial, antioxidant, anticancer, anti-inflammatory, anti-diabetic, anti-arthritic, anti-osteoporotic, and anti-aging effects, along with neuroprotective, cardioprotective, hepatoprotective, and immunomodulatory influences

on diverse organ systems (Kladar et al., 2016; Wang et al., 2017; Ahmad, 2018; Chandrasekaran et al., 2018; Cör et al., 2018; Fraile-Fabero et al, 2021; Cör Andrejč et al., 2022; Akçakaya, 2024). It has also been employed in the therapies of myriad maladies, including hypertension, insomnia, asthma, arthritis, liver and kidney disorders, migraines, and bronchitis (Sohretoglu & Huang, 2018; Kumar, 2021).

Extracts of *G. lucidum* exhibit promising potential in enhancing the textural, nutritional, and sensory aspects of a variety of foods like sausages, wine, cheese, and baked goods. Teas, coffees, smoothies, energy bars, body lotions, soaps and toothpastes enriched with Reshi are becoming popular among consumers (Rahman et al., 2020; Peng et al., 2024; Plosca et al., 2025). As per the reports by Research and Market, the global market for *G. lucidum* is projected to increase from $4.2 billion in 2024 to $7.4 billion by the end of 2033 (Research and Markets).

The endonyms for the Reishi mushroom in Nepal are Dadu Chyau, Rato Chyau, Kanchatak, and Dhi Shyamu (Adhikari, 2014; Raut et al., 2022). Nepal exports a profusion of *Ganoderma* mushrooms to the global market. Also, the domestic market for this mushroom is experiencing a burgeoning demand (Raut et al., 2022). Nepal is a major cultivator of Reishi mushroom, yet there is a lack of awareness about the benefits of its consumption in the Nepalese community. So far, little is known about the nutritional composition of *G. lucidum* in Nepal. Hence, the present study, which is the first research to elucidate the nutritional, phytochemical, antioxidant and antimicrobial properties of locally cultivated *G. lucidum in* Nepal, has been carried out.

MATERIALS AND METHODS

G. lucidum culture and spawn production

G. lucidum Philippine strain was inoculated on Potato Dextrose Agar. The plates were incubated at 28°C for 7 days. Wheat grains weighing 200 g were boiled, carefully washed, and allowed to cool. After that, the grains were combined with 1% $CaCO_3$ and 1% gypsum, taken into sterile polythene bags, sealed, and sterilized for an hour at 121°C. This was followed by the inoculation of *G. lucidum* culture and incubation in a completely dark room until the bag was completely colonized by mycelia (Farimani & Farsi, 2023).

G. lucidum cultivation, substrate preparation

The sawdust (90%) and rice bran (18%) were mixed with 1% gypsum and 1% $CaCO_3$ and autoclaved in plastic bags. The bags were then inoculated with 200g of mature spawn, which was then gently shaken to disperse the spawn. It was left at room temperature in dark conditions for the spawn run. When the mycelium reached the bottom of the bag, it was put in the cultivation room for the fruiting process. Water was regularly added to the bags to maintain a moisture level of 75–85% (Farimani & Farsi 2023; Rana et al., 2024). When the pilei were fully grown, the mushrooms were harvested from Mushroom Seed Nepal and Research Center (March 2023) and transported in a clean polythene bag to Nepal Academy of Science and Technology (NAST). The mushrooms were then oven-dried for 48 hours at 35°C, ground into a powder and kept in a plastic bag.

PCR, sequencing, and phylogeny

DNA was isolated using Cetyltrimethylammonium bromide (CTAB) technique, followed by Polymerase Chain Reaction (PCR) for the amplification of the internal transcribed spacer (ITS) region. The primer sequences used for amplification were ITS U1 (5′ TCCGTAGGTGAACCTGCGG 3′) and ITS U4 (5′ TCCTCCGCTTATTGATATGC 3′). Sequencing was conducted at Molecular Biotechnology Unit, NAST, based on the Sanger Dideoxy Chain Termination method.

Sequences were retrieved from GenBank for phylogenetic analysis. Multiple sequence alignment was done using Clustal Omega version 1.2.4. The neighbor-joining tree was inferred using MEGA 11 with 1000 bootstrap replicates.

Determination of nutritional composition

The moisture content was calculated based on the Association of Official Analytical Chemists (AOAC 2023). The fat was measured by dry ashing method using petroleum ether and subsequent Soxhlet extraction of the powdered sample (Chew et al., 2011). The modified Anthrone reagent method was used to estimate the amount of carbohydrates with standard Glucose (Osborne & Voogt, 1978). A modified Bradford assay was employed to determine the protein content using Bovine Serum Albumin as a standard (Bradford, 1976). The calibration curve used in the above tests ranged from 0 to 500 µg/mL. The ash content was analyzed at 550°C (Kakoti et al., 2021). The crude fiber content was determined as per the methodology by Aina et al. (2012). The mineral analysis was performed using an Atomic Absorption Spectrophotometer following a dry ashing digestion method (Paul et al., 2014; Gebrelibanos et al., 2016).

Preparation of the extracts and analysis of phytochemicals

Initially, the mushroom's phytochemical constituents were extracted using a methanolic extraction method. Approximately 5 g samples were introduced into 50 mL of methanol. The extraction was performed in a shaking incubator maintained at 37°C for a duration of 24 hours at 100 rpm. After that, the solution was filtered. The supernatant was collected and dried using a water bath at 40°C to evaporate methanol (Thakur et al., 2022; Dawadi et al., 2023).

A modified Folin-Ciocalteu method was employed to quantify the phenolic content using the standard Gallic acid. It was represented as mg gallic acid equivalents in 100g (mg GAE/100g) (Singleton et al., 1999). The flavonoid content was calculated by a modified Aluminum chloride assay with a standard quercetin solution, as described by Zhishen et al. (1999). It was presented as mg Quercetin equivalents in 100g (mg QAE/100g). The tannin content was assessed using the Folin-Ciocalteu procedure with Tannic acid as a standard, and expressed as mg tannic acid equivalents in 100g (mg TAE/100g) as mentioned by Mythili et al. (2014). The terpenoid content was estimated as per Indumathi et al. (2014). The method outlined by Nagata and Yamashita (1992) was used to quantify the amounts of lycopene and β-carotene. The saponin content was quantified by vanillin-sulfuric acid method with diosgenin as standard (Le et al., 2018). The phytate content was determined by Norhaizan and Nor Faizadatul Ain (2009) with phytic acid as standard. The calibration curve for different standards used in the above tests ranged from 0 to 500 µg/mL. All the measurements were carried out in triplicate.

Antioxidant activity

The antioxidant activity was measured using the DPPH (2,2-diphenyl-1-picrylhydrazyl) assay with few modifications (Singh et al., 2002).

Determination of antimicrobial activity of *G. lucidum*

Crude extract preparation

10 grams of mushroom powder was added to 100 ml of ethanol. The extraction was carried out in a shaking incubator at 37°C for 24 h at 100 rpm. The obtained solution was filtered using a Whatman filter paper. The supernatant was collected and dried by evaporating ethanol in a water bath at 40°C. The dried extract was stored at 4°C (Dawadi et al., 2023).

Sample preparation

The antibacterial potential of the extracts was tested against *Escherichia coli* ATCC 25922, *Pseudomonas aeruginosa* ATCC 27853, *Klebsiella pneumoniae* ATCC 70062, *Enterobacter faecalis* ATCC 29212, and *Staphylococcus aureus* ATCC 25923, using the agar well diffusion method. The dried mushroom extracts were dissolved in 5% dimethyl sulfoxide at concentrations of 100 mg/mL, 50 mg/mL, 25 mg/mL, and 12.5 mg/mL. A 40 µL volume was added to each well for each concentration. Dimethyl sulfoxide (5%) served as a negative control, and chloramphenicol was used as a positive control. The zones of inhibition (mm) were noted after 24 hours of incubation at 37°C (Mbwambo et al., 2007).

Statistical analysis

The data were presented as mean ± standard deviation, and the data analysis was done in Microsoft Excel 365. All the measurements were carried out in triplicate.

RESULTS AND DISCUSSION

Collection of samples

The colonial characteristics, mother spawn culture, and the macroscopic appearance of the *G. lucidum* used in our study are shown in Fig. 1.

Figure 1. (a) Colony of *G. lucidum* on Potato Dextrose Agar (b) Mother spawn culture (c) Cultivated mushroom from Mushroom Seed Nepal and Research Center

PCR, sequencing, and phylogeny

The sequence files were processed, and primer sequences were trimmed, resulting in a final amplicon of 606 base pairs (Fig. 2). BLAST analysis showed a 100% match with *G. lucidum* (GenBank: MH708512.1), covering the entire query sequence (Fig. 3).

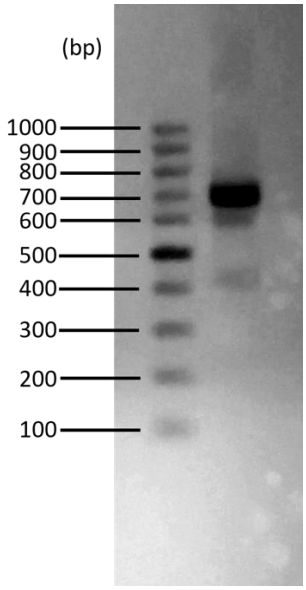

Figure 2. PCR-amplified DNA band visualized on a 1.5% agarose gel using the Vivantis VC 100bp DNA Ladder

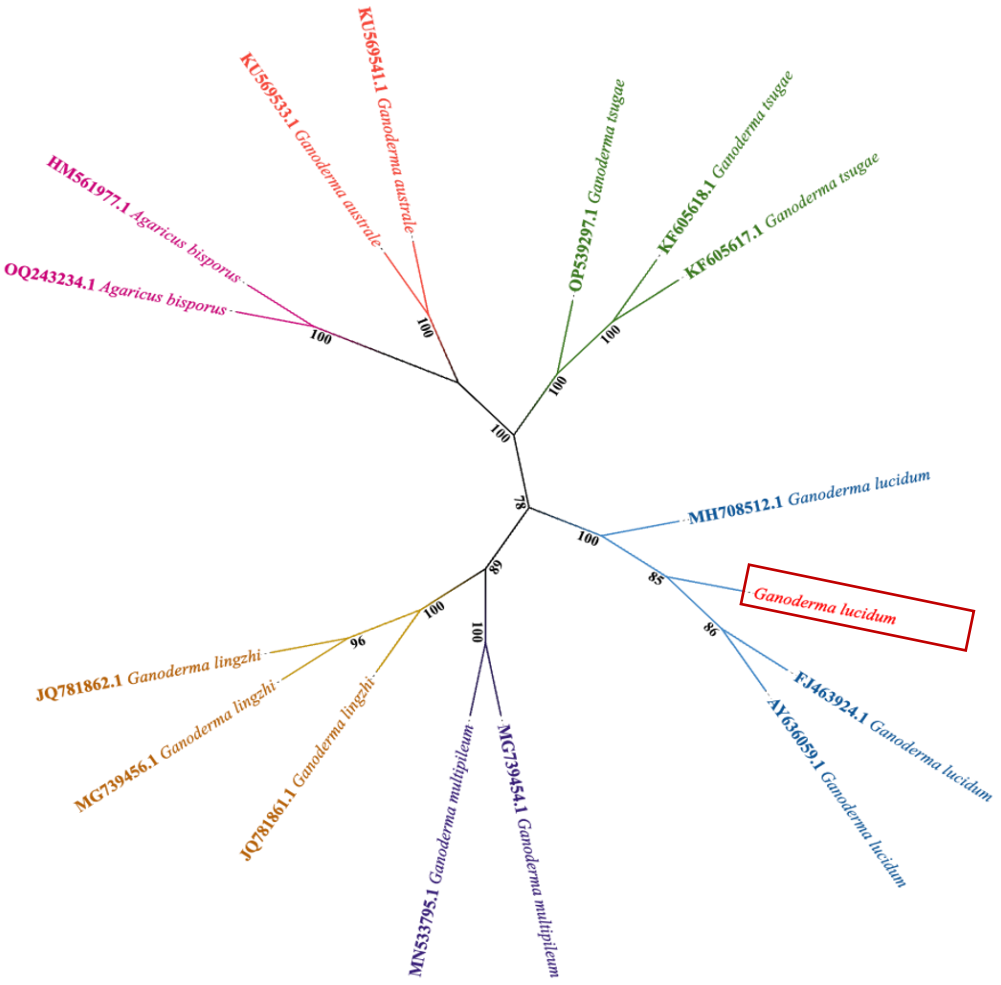

Figure 3. Neighbour joining phylogenetic tree as inferred in MEGA 11 with 1000 bootstrap replicates (bootstrap >70 shown)

Our species, *G. lucidum*, along with other *Ganoderma* species, formed a distinct clade separate from the outgroup *Agaricus bisporus*. Phylogenetic analysis showed that *G. lucidum* is more closely related to *G. tsugae* and *G. lingzhi* than *G. australe,* suggesting a more recent common ancestry and potential functional or ecological similarities among these species. Furthermore, *G. lucidum* is distinctly positioned within a unique clade, setting it apart from *G. tsugae* and *G. lingzhi,* which indicates a genetic divergence that may correspond to specific adaptations or biochemical properties unique to *G. lucidum.*

Nutritional analysis

Our study analyzed ash, carbohydrates, protein, fat and crude fiber content of the collected mushroom and the result is shown in Figure 4.

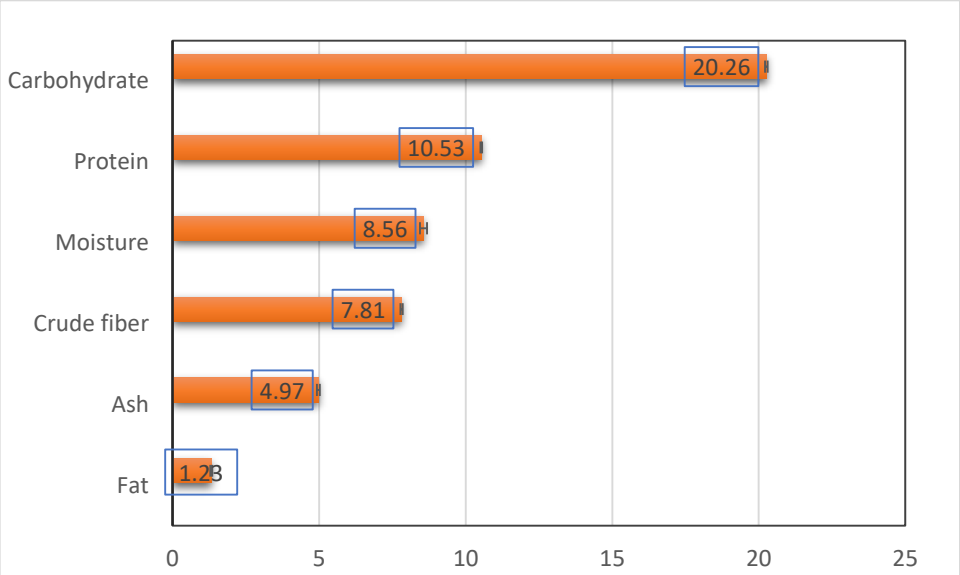

Figure 4. Nutritional profile of *G. lucidum%*

Carbohydrate evaluation is an important for food scientists as they play a crucial structural role in the sensory, nutritional, and functional qualities of food. In the present study, the carbohydrate content of *G. lucidum* was observed to be 20.26%. Researchers revealed that *G. lucidum* mushrooms contain different components of carbohydrates such as glycopeptides, beta-glucan, and hetero-mannans which showed strong antibacterial, and anti-tumor activity (Ferreira et al., 2015). A study by Upadhyaya et al. (2017) reported a lower carbohydrate content of 7.058%. However, other studies demonstrated a higher carbohydrate content (Sharif et al., 2016; Singh et al., 2020; Rahman et al., 2020). Factors such as different substrates, cultivation techniques, harvest stage, and time between harvest and evaluation methods also impact the carbohydrate composition in the mushroom (Rahman et al., 2020).

The proteins present in mushrooms typically meet dietary requirements, with essential amino acid profile. They are less costly than those found in plants and animals. The protein content of our sample was determined to be 10.53%, which was lower than those reported in earlier investigations, where the protein level ranged from 11.70 to 15.78% (Sharif et al., 2016; Singh et al., 2020). Therefore, it could be suggested that the substantial protein content of *Ganoderma* could be used as ingredient to enhance the functional qualities of food. Additionally, the proteins found in mushroom have antioxidant, antitumor, and antipathogenic qualities contributing to a good health (Ayimbila & Keawsompong, 2023). The substrate influence the protein concentration in the fruiting bodies and mycelium of the mushroom (Lu et al., 2020).

The result has shown that the fat value of *G. lucidum* was 1.32%. There is a evidence that *G. lucidum* contains many important fatty acids, such as arachidic, lignoceric, margaric, cis-vaccenic acids (Fraile-Fabero et al., 2021). They also serve as the structural and functional components of membranes, and act as thermal insulators. Moreover, they support healthy digestion and provide energy for better metabolism (Ahmed et al., 2025). Other researchers mentioned

higher fat content 2.87%, (Singh et al., 2020), and 3.33 % (Sharif et al., 2017). On the contrary, Fraile-Fabero et al. (2021) found a slightly lower fat value (1.26 %).

The moisture content indicates the degree of water activity present in the sample and its significant impact on storage quality (Frazier & Westhoff, 1988; Vera Zambrano et al., 2019). This research reported the moisture value of 8.56%. In terms of fresh weight, the mushroom contains 90% water. The water content, however, drops significantly from 3 to 13% after drying (Golianek & Mazurkiewicz-Zapałowicz, 2016; Dimopoulou et al., 2022; Ijimbili & Adenipekun, 2023). The moisture content of this study was lower than other findings (Garuba et al., 2020; Hussien, 2022; Peng et al., 2024). Various factors, including temperature, storage area, and humid environment affect the moisture value of mushrooms (Agrahar-Murugkar & Subbulakshmi, 2005).

The crude fiber in *G. lucidum* was found to be 7.81%. Another investigations recorded the crude fiber value between 14-15% (Upadhyaya et al., 2017; Garuba et al., 2020). Fiber has numerous potential health advantages and is made up of a class of indigestible carbohydrate polymers. It also functions as a prebiotic, encourages the production of short-chain fatty acids, reduces blood sugar and cholesterol, and improves digestive tract health (Marc et al., 2024).

The ash content is an indicator of the total amount of minerals in food. It is an important step in proximate analysis (Harris & Marshall, 2017). 4.97% of ash content was detected in our sample. This is consistent with the previous research work by Harris & Marshall (2017), which found that ash contents of fresh foods are usually below 5%.

Mineral content

Table 1. Mineral analysis of *G. lucidum*

Micronutrients (mg/g)	**Values (mg/g ± SD)**
Copper	0.133 ± 0.003
Lead	Negligible
Iron	0.059 ± 0.013
Manganese	0.022 ± 0.002
Zinc	0.030 ± 0.001

Values represent mean ± standard deviation of three replicates

Minerals including copper, iron, manganese, and zinc are important trace elements that support several metabolic processes by giving proteins structural support or serving as co-factor for enzymes (Pajarillo et al., 2021). Various researchers have pointed out the key minerals in *G. lucidum*. The minerals include calcium, copper, zinc, iron, cobalt, potassium, sodium, chromium, and magnesium (Hussien, 2022; Plosca et al., 2025). In the current study, the copper concentration was found to be the highest among the detected minerals, with a concentration of 0.133 ± 0.003 mg/g, followed by iron content (0.059 ± 0.013 mg/g). The manganese and zinc concentrations were lower, with 0.022 ± 0.002 mg/g and 0.030 ± 0.001 mg/g, respectively (Table 1). The lead, which is a hazardous metal, was absent in our sample. According to Ijimbili & Adenipekun (2023) reports, the mineral value in various *G. lucidum* is not consistent and may vary significantly based on post-harvest processing, growing techniques, and environmental factors.

Phytochemical analysis

Our phytochemical analysis of *G. lucidum* detected several bioactive substances, including tannins, phenols, terpenoids, and flavonoids (Table 2).

Bioactive compounds, such as polyphenols and flavonoids, found in mushroom are well known for their anti-inflammatory, antimicrobial, and antioxidant properties. According to the results of this study, the phenolic content was determined to be 544.04 ± 0.07 mg GAE/100g. Previous experiments recorded the phenolic levels ranging from 64 to 5900 mg GAE/100g (Ihayere & Okhuoya, 2022; Bacallao-Escudero et al., 2023; Peng et al., 2024). It is indicated that the primary sites for phenols are the spores and the fruiting body (Masjedi et al., 2022). Similarly, our sample also showed the flavonoid content of 194.11 ± 0.04 mg QAE/100 g., which align within the range of 53-93 mg QAE/100g noted by Bacallao-Escudero et al. (2023). *Ganoderma*-dwith phenolics and flavonoids have continuously proved good antioxidant properties (Cadar et al., 2023).

Table 2. Phytochemical Analysis of *G. lucidum*

Content	***G. lucidum***
Phenolic (GAE mg/100g)	544.04 ± 0.07
Flavonoids (QAE mg/100g)	194.11 ± 0.04
Tannin (TAE mg/100g)	1275 ± 0.05
Terpenoid (%)	3.4
β-carotene (mg carotenoids/g)	2.98 ± 0.02
Lycopene (mg carotenoids/g)	1.29 ± 0.06
Saponin (diosgenin mg/100g)	130.27 ± 0.04
Phytate (phytic acid mg/100g)	96.23± 0.03

Values represent mean ± standard deviation of three replicates

Tannins are widely present in almost all the plant species. They have capacity to disrupt the enzyme activities which lowers the digestibility of the protein. However, tannin consumption in moderate limits has been linked to a number of health advantages (Panwar et al., 2023). This study recorded the tannin content 1275 ± 0.05 mg TAE/100 g. Varying tannin content in *G. lucidum* has been mentioned by earlier works (Ihayere & Okhuoya, 2022; Thapa et al., 2022; Bhusal et al., 2024). There are several possible reasons for the observed variance in tannin content, such as differences in geographical origin, environmental conditions, and quantification techniques (Erbiai et al., 2023).

The result of terpenoid content was 3.4%. Triterpenoids have shown potential as anti-inflammatory agents and could be utilized as functional foods aimed at preventing inflammation (Wu et al., 2019). Ihayere & Okhuoya (2022) stated a lower terpenoid content (1.82 ± 0.08%). Several other findings have revealed the presence of terpenoids in *G. lucidum* (Thapa et al., 2022; Bhusal et al., 2024).

β-Carotene and lycopene belong to carotenoids with antioxidant properties that help to neutralize free radicals. They are commonly used in food, cosmetics, and pharmaceuticals due to their health advantages (Kopylchuk et al., 2023). In the current research, *β*-carotene concentration was found to be 2.98 ± 0.02 mg/g. This concentration was higher than the values mentioned by Erbiai et al. (2023) and Celık (2014), which were 0.24 ± 0.01 mg/g and 0.224 ± 0.0040 mg/g, respectively. This implies that compared to the prior investigation, our sample has higher antioxidant potency.

Lycopene can be useful in treating disorders linked to oxidative stress and inflammation because of its potent antioxidant and anti-inflammatory properties (Emilija et al., 2022). In this research, lycopene concentration was observed to be 1.29 ± 0.06 mg/g, which was much greater than the 0.11 mg/g, 0.38 mg/g and 0.253 mg/100 g recorded by past researchers (Celık, 2014; Gharib et al., 2022; Erbiai et al., 2023).

The saponin concentration of *G. lucidum* was estimated to be 130.27 ± 0.04 mg/100g diosgenin, which was notably higher than the saponin content of 126 ± 60 mg/100g as mentioned by Ogbe & Obeka (2013). The presence of saponins in *G. lucidum* has also been documented in previous research (Thapa et al., 2022; Bhusal et al., 2024). According to Hussien (2022), saponin levels depend on the species, and sample processing. This emphasizes the necessity of standardization to ensure a constant level of bioactive content.

Phytic acid are anti-nutrients that are found in the plants which functions as a chelator of minerals by binding with them to create phytate salts that lowers the availability of ions. On the contrary, the phytate also contribute to the antioxidant properties (Panwar et al., 2023). Therefore, the minimal concentration is required to ensure the bioavailability of minerals and reduce the risk of disease. The present study showed the phytate level of 96.23 ± 0.03 mg/100g phytic acid. This is in contrast to the finding of Ogbe & Obeka (2013), who reported significantly higher phytate content of 2430 ± 90 mg/100g..

Antioxidant activity

The antioxidant potential of *G. lucidum* extracts is determined by its bioactive compounds, including

polyphenols, flavonoids, and triterpenoids (Skalicka-Woźniak et al., 2012). In our analysis, the IC_{50} of *G. lucidum* was found to be 154.8 µg/ml. This value differs from earlier reports by Sharif et al. (2017) and Bhusal et al. (2024) where the reported values were 45.16±5.37 µg/mL and 53.88±0.62 µg/ml, respectively. The antioxidants from *G. lucidum* can help reduce mutation rates and inhibit tumor formation by neutralizing free radicals generated through oxidative stress (Bhusal et al., 2024). Additionally, they help to protect skin from aging and damage caused by free radicals. Due to this, they are increasingly being used in cosmetic products (Taofiq et al., 2017).

Antibacterial activity

The *G. lucidum* extract in our study exhibited no antibacterial activity against the tested pathogens. However, *G. lucidum* has been shown to have strong antimicrobial properties in several studies. Research by Shah et al. (2014) showed antibacterial effects against *Escherichia coli, Bacillus cereus*, *Pseudomonas aeruginosa*, and *Entereobacter aerogenes*, whereas Al-Jumaili Ahjel (2020) and Cheng et al. (2021) addressed its potential antiviral properties. Additionally, Wang & Ng (2006) and Yang et al. (2022) have documented antifungal activity. The absence of antibacterial activity may be due to the low concentration of bioactive substances in our extract, resulting in no inhibitory effects on the tested bacteria. The difference in the extraction method used across the study could also be the cause of these discrepancies in antimicrobial potency of mushrooms (Cadar et al., 2023).

CONCLUSION

The present study revealed that *G. lucidum* is a good source of phytochemicals such as, phenolic, flavonoid, terpenoid, tannin, lycopene, and β-carotene, macronutrients including protein, carbohydrates, fat, crude fiber, ash, micronutrients (copper, iron, manganese and zinc) and natural antioxidants, with application potential as nutraceuticals and functional food. However, further research is needed in domestication and isolation of bioactive constituents from wild *Ganoderma* species from various parts of the country.

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AUTHORS CONTRIBUTION

Conceptualization: AB, IS, LRB, MS; Investigation: IS, MS; Methodology: IS, MAS, MS; Data curation: IS, MAS, MS; Data Analysis: MAS, MS; Writing-original draft: IS, MA, MAS, MS; Writing-review and editing: CK, IS, JM, LRB, MS.

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CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest regarding the publication of this article.

DATA AVAILABILITY STATEMENT

The data will be made available by the corresponding author upon reasonable request.

SUPPLEMENTARY INFORMATION

None

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