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A comparative study of taxonomy, physicochemical parameters, and chemical constituents of *Ganoderma lucidum* and *G. philippii* from Uttarakhand, India

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Abstract: The genus *Ganoderma* consists of cosmopolitan polypore mushrooms, many of which can cause different types of rots in plants. Many species of this genus are being used for their medicinal and nutraceutical properties in many countries. The present study provides a comparative evaluation of taxonomy, physicochemical parameters, and chemical constituents of *Ganoderma lucidum* and *G. philippii* collected from different localities of Uttarakhand, India. The macroscopic and microscopic characters on the basis of which *G. lucidum* differs from *G. philippii* include habit, external basidiocarp characteristics, context, pore tube layers and pores, cutis type, and shape and size of basidiospores. The fruiting bodies of both the species were air-dried and ground to powder, which was analyzed for physicochemical parameters and subjected to qualitative chemical screening. The crude powder was subjected to successive Soxhlet extraction for the preparation of various extracts using different solvents. Physicochemical analysis showed variation with respect to foreign matter, moisture content, ash content, extractive values, absorption properties, emulsion properties, foaming properties, dispersibility, and bulk density. Qualitative chemical screening of various extracts showed the presence of carbohydrates, proteins, lipids, glycosides, phenolic compounds, steroids, terpenoids, and saponins in both species.

Key words: *Ganoderma*, polypore mushroom, basidiocarp, Uttarakhand

1. Introduction

Ganoderma P.Karst. is a large, widely distributed genus of the family Ganodermataceae, order Polyporales, class Agaricomycetes, and phylum Basidiomycota with about 80 species distributed worldwide (Kirk et al., 2008). From India, 46 species, including *Ganoderma lucidum* and *G. philippii*, have been reported (Bakshi, 1971; Dhanda, 1977; Sharma, 2000; Foroutan and Vaidya, 2007; Bhosle et al., 2010; Ranadive et al., 2011).

Species of *Ganoderma* are known to cause different kinds of rots in both angiosperms and gymnosperms by lignocellulose degradation. *Ganoderma lucidum* is a common root pathogen that causes the decay and slow decline of numerous forest tree species (Bakshi, 1976; Ko, 2009). *G. philippii* has also been considered a serious root parasite in tropical Asian plantations (Steyaert, 1980; Foroutan and Jafary, 2007). Although species of *Ganoderma* occur as plant pathogens, their fruit bodies have been used in traditional Chinese medicine for more than 2000 years (Galor et al., 2004). Many species of *Ganoderma* yield a formidable pool of bioactive compounds and are a potential source for new and successful commercial products. *G. lucidum* is the leader in terms of medicinal potential (Chang, 1995) and is known as the "king of herbs" in China. It is reported to contain different bioactive compounds, such as alkaloids, terpenoids, polysaccharides, steroids, fatty acids, and proteins (Mizuno, 1995; Russel and Paterson, 2006; Ihayere et al., 2010). However, physicochemical and chemical aspects have not been studied for all species of *Ganoderma*.

In the present investigation, a comparative study of taxonomy, physicochemical parameters, and qualitative chemical screening were carried out on *G. lucidum* and *G. philippii* collected from Uttarakhand, India, with a view to establish standards for their identity, quality, purity, and chemical composition.

2. Materials and methods

2.1. Collection of fungi

The fruiting bodies of *Ganoderma lucidum* and *G. philippii* were collected from different localities of Uttarakhand, India, during the monsoon months (July–September) of the years 2010 and 2011. Field notes concerning the

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habit of basidiocarp, host, name of locality, and other morphological features were recorded for the collected specimens. Voucher specimens of *G. lucidum* (PUN 5077) and *G. philippii* (PUN 5078) have been deposited at the herbarium of the Department of Botany, Punjabi University, Patiala (PUN).

2.2. Taxonomic studies

Different macroscopic studies such as basidiocarp characters pertaining to abhymenial and hymenial surfaces, context, and pore tubes of both the species were examined. Microscopic details of structures such as hyphae, basidiospores, and pilear crust were observed by making crush mounts and free-hand sections in water and 5% KOH solution and staining in cotton blue (1%, in lactophenol), Congo red (1%, in distilled water), phloxine (1%, in distilled water), and Melzer's reagent (Ordynets, 2012). Basidiospore biometrics in terms of mean length, mean width, size range, and spore index were determined by measuring 30 basidiospores (Parmasto et al., 1987).

2.3. Chemicals

The chemicals used for extraction and qualitative chemical screening were of AR grade (Loba, Merck, India and SD Fine Chemical Ltd., India).

2.4. Physicochemical evaluation

The crude powder was subjected to physicochemical evaluation. All parameters were determined in triplicate.

2.4.1. Foreign matter

Powdered sample (100 g) was weighed, and the pieces of foreign matter were sorted out by visual examination and use of a lens (6×). All portions of foreign matter were pooled and weighed, and percentage yield was calculated (Indian Pharmacopoeia Commission, 2007).

2.4.2. Moisture content

Powdered sample (2 g) was weighed and dried in an oven at a temperature of not more than 105 °C until constant weight was achieved. Moisture content was calculated as percentage of loss of water on drying (Indian Pharmacopoeia Commission, 2007).

2.4.3. Ash content

Powdered sample (2 g) was weighed and incinerated in a weighed crucible at a temperature not exceeding 450 °C until free of carbon. It was then cooled and weighed, and the percentage total ash was calculated. For acid insoluble ash, total ash was boiled with 25 mL of dilute HCl (2 M) for 5 min. The insoluble matter was collected on an ashless filter paper, washed with 5 mL of hot water, and ignited in a weighed crucible at a temperature not exceeding 450 °C until constant weight. The weight of the insoluble part of the ash was obtained by subtracting the weight of the insoluble ash from that of the total ash. Percentage of acid insoluble ash was calculated with reference to the air-dried powdered sample. For water soluble ash determination, 25 mL of chloroform water was taken instead of dilute HCl (Indian Pharmacopoeia Commission, 2007).

2.4.4. Extractive values

Powdered sample (5 g) was weighed and macerated with 100 mL of 90% ethanol in a 250-mL flask for 24 h with frequent shaking for 6 h. It was then filtered, and 25 mL of the filtrate was transferred to a weighed china dish, evaporated to dryness, cooled, and weighed. Alcohol soluble extractive value in percentage w/w (on dry weight basis) was calculated with reference to the air-dried powdered sample. Water soluble extractives were determined by using 100 mL of distilled water instead of alcohol (Indian Pharmacopoeia Commission, 2007).

2.4.5. Absorption properties

Powdered sample (1 g) was weighed and mixed with 10 mL of distilled water or refined soybean oil. It was allowed to stand at room temperature for 1 h and then centrifuged at 2000 rpm for 30 min, and supernatant was collected in a 10-mL graduated cylinder. Water or oil absorption capacity was expressed as volume of water or oil absorbed per gram of the dried powdered sample (Aremu et al., 2007).

2.4.6. Emulsion properties

Powdered sample (1 g) was weighed and blended in a blender with 50 mL of distilled water for 30 s at maximum speed. Refined soybean oil was then added in 5-mL portions with continued blending until separation into 2 layers appeared. The prepared emulsion was then allowed to stand in a graduated cylinder and calculated as volume of emulsion formed per gram of powdered sample. The volume of emulsion which remained stable after 30 min was recorded as emulsion stability (Aremu et al., 2007).

2.4.7. Foaming properties

Powdered sample (1 g) was weighed and dispersed in 50 mL of distilled water. It was then vigorously whipped for 30 min in a blender and poured into a 100-mL graduated cylinder. The volume before and after whipping was recorded, and foaming capacity was calculated in percentage. Foaming stability was determined as the amount of foam that remained stable after 30 min (Aremu et al., 2007).

2.4.8. Dispersibility

Powdered sample (5 g) was weighed in a 100-mL measuring cylinder, and distilled water was added to bring the final volume to 100 mL. It was stirred and allowed to stand for 1 h. The volume of settled particles was subtracted from 100, and the difference was reported as percentage dispersibility (Kulkarni et al., 1991).

2.4.9. Bulk density

Powdered sample (50 g) was weighed and put into a 100-mL measuring cylinder. It was tapped until a constant volume was obtained, and the bulk density was calculated as weight (g) per unit volume (mL) of sample (Oladele and Aina, 2007).

2.5. Preparation of extracts

Dried powdered fruiting bodies (100 g) were subjected to successive Soxhlet extraction for 8 h using solvents in increasing order of their polarity: petroleum ether, chloroform, methanol, and water. Before each extraction, the powder was dried and then extracted with the next solvent. The scheme of preparation of extracts is shown in Figure 1. The extracts were concentrated, dried, and weighed. The percentage yield and organoleptic parameters of each extract were recorded.

2.6. Qualitative chemical screening

The qualitative chemical examination of the extracts was performed by the standard methods (Harborne, 1973; Trease and Evans, 1989; Kokate, 2004).

2.7. Statistical analysis

The results of basidiospores biometrics and physicochemical studies have been expressed as mean ± standard error of the mean (SEM).

3. Results

3.1. Taxonomic studies

Results pertaining to origin with respect to host and locality, comparison of taxonomic characters, and basidiospore biometrics of *Ganoderma lucidum* and *G. philippii* are given in Tables 1, 2, and 3 respectively.

3.1.1. *Ganoderma lucidum* (Curtis) P.Karst., Revue Mycol., Toulouse 3 (no. 9): 17 (1881)

Syn.: *Boletus lucidus* Curtis, Fl. Londin. 1: 72 (1781).

It is macroscopically characterized by laccate abhymenial surface, stipitate basidiocarps, and duplex context, and microscopically by the presence of hymenioderm pilear crust consisting of claviform cuticular elements, trimitic hyphal system, and ovoid basidiospores (Figure 2a–g).

3.1.2. *Ganoderma philippii* (Bres. & Henn. ex Sacc.) Bres., Iconogr. Mycol. 21: tab. 1014, (1932)

Syn.: *Fomes philippii* Bres. & Henn. ex Sacc., Syll. fung. (Abellini) 9: 180 (1891).

It is macroscopically characterized by a nonlaccate abhymenial surface and sessile basidiocarp, and microscopically by plecodermis type of pilear crust consisting of densely entwined subhyaline hyphae impregnated with melanoid substances forming a layer distinct from the context, trimitic hyphal system, and ovoid to broadly ovoid basidiospores (Figure 2h–m).

3.2. Physicochemical analysis

Results of different physicochemical parameters of the dried, powdered basidiocarps are shown in Table 4. Our results show a high level of ash values, extractive values, foaming properties, and bulk density in the case of *Ganoderma lucidum*, while *G. philippii* has higher values of foreign matter, moisture content, absorption properties, emulsion properties, and dispersibility.

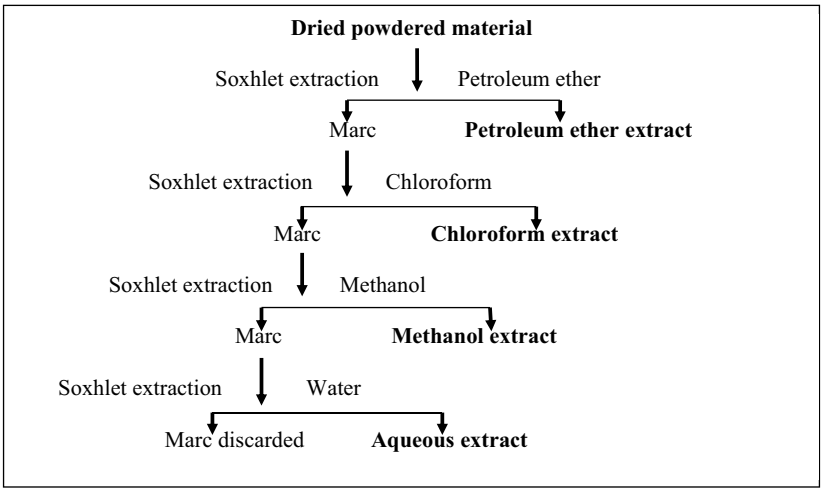

Figure 1. Preparation of extracts.

Table 1. Studied species and their origin (host and locality).

No.	Species	Herbarium no.	Host	Locality
1.	*Ganoderma lucidum*	PUN 5077	*Quercus incana*	Chaukori
2.	*Ganoderma philippii*	PUN 5078	*Quercus incana*	Mussoorie

Table 2. Comparison of taxonomic features of *Ganoderma lucidum* and *G. philippii*.

Character	*G. lucidum*	*G. philippii*
Habit	Annual	Perennial
Basidiocarp	Stipitate, laccate, up to 14 × 13 × 2.5 cm	Sessile, nonlaccate, up to 40 × 30 × 20 cm
Pilear crust	Hymenioderm	Plecodermis
Context layer	Up to 1.2 cm thick, whitish to wood colored above, brownish to brown near the tube layer	Up to 1.5 cm, uniformly brown
Tube layer	Up to 1.7 cm, unstratified	Up to 2 cm, stratified
Pores	5–6 per mm, pore surface creamish white when fresh	5–6 per mm, pore surface cinnamon buff when fresh becoming brown on drying
Hyphal system	Trimitic	Trimitic
Basidiospores	9.6–11.2 × 6.6–8.2 µm, ovoid to ovoid	8.1–9.1 × 5.5–6.5 µm, ovoid to broadly ovoid

Table 3. Basidiospore biometrics of *Ganoderma lucidum* and *G. philippii*.

No.	Basidiospore character	*G. lucidum* (mean ± SEM, n = 30)	*G. philippii* (mean ± SEM, n = 30)
1.	Mean length	10.56 ± 0.229	8.777 ± 0.163
2.	Mean width	6.937 ± 0.161	6.060 ± 0.064
3.	Spore index (SI)*	1.522 ± 0.019	1.448 ± 0.012

Spore index (SI)* = spore length / spore width.

Table 4. Physicochemical analysis *Ganoderma lucidum* and *G. philippii*.

No.	Parameter	*G. lucidum* (mean ± SEM, n = 3)	*G. philippii* (mean ± SEM, n = 3)
1.	Foreign matter (%)	0.036 ± 0.007	0.066 ± 0.008
2.	Moisture content (%)	10.700 ± 0.208	11.330 ± 0.882
3.	Ash values (%)		
	Total ash	8.323 ± 0.602	7.670 ± 0.953
	Acid insoluble ash	3.727 ± 0.164	3.233 ± 0.433
	Water soluble ash	6.13 ± 0.082	5.600 ± 0.231
4.	Extractive values (%)		
	Alcohol soluble extractives	4.167 ± 0.120	3.800 ± 0.115
	Water soluble extractives	6.700 ± 0.058	4.833 ± 0.120
5.	Absorption properties (mL g^{-1})		
	Oil absorption capacity	10.250 ± 0.520	12.000 ± 0.770
	Water absorption capacity	11.67 ± 0.333	12.33 ± 0.601
6.	Emulsion properties (mL g^{-1})		
	Emulsifying capacity	9.000 ± 0.866	10.830 ± 0.441
	Emulsifying stability	7.167 ± 0.601	7.500 ± 0.577
7.	Foaming properties (%)		
	Foaming capacity	48.800 ± 0.611	41.510 ± 1.610
	Foaming stability	37.630 ± 1.695	36.210 ± 0.550
8.	Dispersibility (%)	53.970 ± 0.639	59.600 ± 0.513
9.	Bulk density (g L^{-1})	0.498 ± 0.016	0.457 ± 0.013

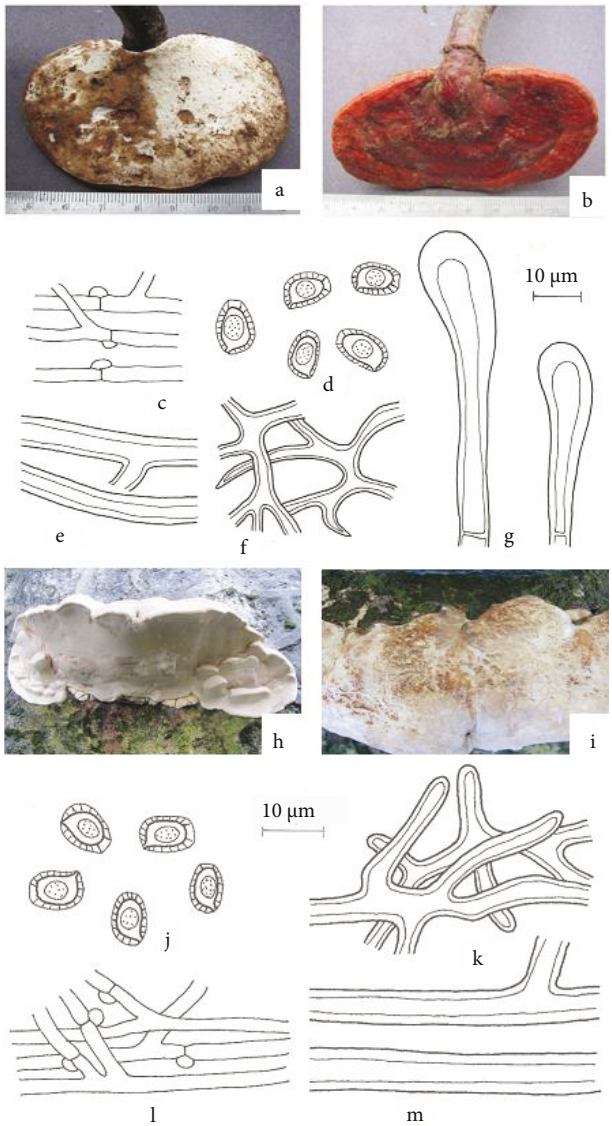

Figure 2. *Ganoderma lucidum*: a- basidiocarp showing hymenial surface, b- basidiocarp showing abhymenial surface, c- generative hyphae, d- basidiospores, e- skeleto-binding hyphae, f- binding hyphae, g- cuticular elements. *Ganoderma philippii*: h- basidiocarp showing hymenial surface, i- basidiocarp showing abhymenial surface, j- basidiospores, k- binding hyphae, l- generative hyphae, m- skeleto-binding hyphae.

3.3. Qualitative chemical studies

The percentage yield and organoleptic parameters of the various extracts of *Ganoderma lucidum* and *G. philippii* are reported in Tables 5 and 6. The results of qualitative chemical screening of the prepared extracts are given in Tables 7 and 8, and comparisons of the presence of different chemical constituents present in *G. lucidum* and *G. philippii* are shown in Table 9. Qualitative chemical screening of various prepared extracts revealed the presence of carbohydrates, proteins, amino acids, lipids, steroids, terpenoids, glycosides, phenolic compounds, alkaloids, and saponins, while tannins and mucilage were not detected in either of the species studied.

4. Discussion

Standardization of natural products is essential to ensure their identity, quality, and purity. Macroscopy and microscopy are the simplest methods to establish the correct identity of source materials (Jafari et al., 2013). *Ganoderma lucidum* can be differentiated from *G. philippii* on the basis of annual, stipitate, and laccate basidiocarps in comparison to perennial, sessile, and nonlaccate basidiocarps; hymenioderm type of pilear crust in comparison to plecodermis type; duplex context in comparison to single layer of context; and bigger basidiospores (9.6–11.2 × 6.6–8.2 µm in comparison to 8.0–9.1 × 5.5–6.5 µm).

Physicochemical parameters like foreign matter, moisture content, ash content, and extractive values are used to determine quality and purity (WHO, 1998). A drug containing appreciable quantities of foreign matter may produce a critical impact on health. Therefore, the parameter must not be neglected. The permissible limits for foreign matter as per standards should not be more than 2% (Soni et al., 2011). High moisture content may lead to the activation of enzymes and promotes susceptibility to microbial growth, which accelerates spoilage. The percentage moisture content values of the samples are comparable to the values for *G. lucidum* (10.54%, w/w) reported previously (Usman et al., 2012). High ash content of a drug gives an idea about earthy matter or inorganic composition and other impurities present along with the drug. The results of the present studies show that the ash content values are comparatively higher than those reported for *G. lucidum* (5.93%, w/w) previously (Usman et al., 2012). Extractive values give an indication about the nature of the chemical constituents present in the drug. Water soluble extractives were higher as compared to alcohol soluble extractives, which showed that *G. lucidum* and *G. philippii* had more water soluble polar constituents. Our study showed that absorption properties, emulsion properties, and foaming properties were also favorable, making *Ganoderma* powder available for use in many drug formulations where foaming, emulsification, reconstitutability, and retention of flavor are required. Absorption properties describe the ability of association of powder and water or oil, which is a useful indication of whether powder or isolates can be incorporated into aqueous or oily food and drug formulations (Udensi and Okoronkwo, 2006). Emulsion properties determine the ability of the powder to emulsify oil. Emulsions play an important role in pharmaceutical preparations such as cosmetics, pastes, or cod liver oil. Emulsions have

Table 5. Percentage yield and organoleptic parameters of extracts of *Ganoderma lucidum*.

No.	Extract	Yield(% w/w, dry weight basis)	Color	Odor	Consistency
1.	Petroleum ether	2.04	Golden yellow to brown	Characteristic faint	Sticky semi-solid
2.	Chloroform	1.31	Yellowish brown to dark brown	Characteristic faint	Soft, slightly sticky solid
3.	Methanol	3.04	Chocolate dark brown	Characteristic faint	Soft solid
4.	Aqueous	2.90	Black	Characteristic	Solid

Table 6. Percentage yield and organoleptic parameters of extracts of *Ganoderma philippii*.

No.	Extract	Yield (% w/w, dry weight basis)	Color	Odor	Consistency
1.	Petroleum ether	1.11	Yellowish gray	Characteristic faint	Sticky semisolid
2.	Chloroform	1.22	Dark brown	Characteristic faint	Sticky semisolid
3.	Methanol	1.86	Dark brown	Characteristic faint	Soft solid
4.	Aqueous	2.47	Dark brown	Characteristic	Solid

Table 7. Phytochemical screening of extracts of *Ganoderma lucidum*.

No.	Phytoconstituents/ chemical test	Petroleum ether extract	Chloroform extract	Methanol extract	Aqueous extract
1.	Carbohydrates				
A.	General tests				
	Molisch's test	--	++	++	++
	Anthrone test	--	--	++	++
B.	Reducing sugars				
	Fehling's test	--	++	++	++
	Benedict's test	--	++	--	--
	Picric acid test	--	++	++	++
2.	Proteins				
	Full saturation test	--	--	++	--
	Acetic acid test	--	++	++	--
	Biuret test	--	++	++	--
3.	Amino acids				
	Ninhydrin test	--	--	++	--
	Xanthoproteic test	--	++	++	--
4.	Fats and oils				
	Spot test	++	--	--	--
	Sudan-3 test	++	--	--	--
5.	Steroids				
	LB test	++	--	--	--
	Salkowski's test	++	++	--	--
	Antimony trichloride test	++	--	--	--
	Zimmermann's test	--	--	--	--

Table 7. (continued).

6.	Terpenoids				
	LB test	--	--	--	--
	Salkowski's test	--	--	--	--
	Trichloroacetic acid test	++	--	--	--
7.	Alkaloids				
	Mayer's test	--	--	--	--
	Wagner's test	--	--	++	--
	Hager's test	--	--	++	--
	Dragendorff's test	--	--	--	--
	Tannic acid test	--	--	++	--
8.	Phenolic compounds				
A.	General tests				
	Ford's test	--	++	++	++
	Conc. sulfuric acid test	--	--	++	--
B.	Tannins				
	Bramer's test	--	--	--	--
	Lead acetate test	--	--	--	--
	Potassium dichromate test	--	--	--	--
	Vanillin hydrochloride reduction test	--	--	--	--
	Gelatin test	--	--	--	--
C.	Flavonoids				
	Shinoda's test	--	--	--	--
	Lead acetate test	--	--	++	--
	Alkaline reagent test	--	--	++	--
	Ammonia test	--	--	--	--
	Zinc hypochloride reduction test	--	--	--	--
9.	Saponins				
	Froth test	--	--	--	++
10.	Glycosides				
A.	Anthraquinone glycosides				
	Borntrager's test	--	++	++	++
	Modified Borntrager's test	--	++	++	++
B.	Cardiac glycosides				
	Keller–Kiliani test (deoxy sugar)	--	--	++	++
	Legal's test (lactone)	--	--	--	--
	Baljet's test	--	--	++	++
	LB test (steroidal)	++	--	--	--
	Kedde's test	--	--	++	--
C.	Cyanogenetic glycosides				
	Hydrogen cyanide test	--	--	--	--
11.	Mucilages				
	Ruthenium test	--	--	--	--
	Swelling test	--	--	--	--

++: present, -- absent.

Table 8. Phytochemical screening of extracts of *Ganoderma philippii*.

No.	Phytoconstituents/ chemical test	Petroleum ether extract	Chloroform extract	Methanol extract	Aqueous extract
1.	Carbohydrates				
A.	General tests				
	Molisch's test	--	++	++	++
	Anthrone test	--	--	++	++
B.	Reducing sugars				
	Fehling's test	--	--	++	++
	Benedict's test	--	--	--	--
	Picric acid test	--	--	++	++
2.	Proteins				
	Full saturation test	--	--	++	--
	Acetic acid test	--	++	++	--
	Biuret test	--	--	++	--
3.	Amino acids				
	Ninhydrin test	--	--	++	--
	Xanthoproteic test	--	++	++	--
4.	Fats and oils				
	Spot test	++	--	--	--
	Sudan-3 test	++	--	--	--
5.	Steroids				
	LB test	++	--	--	--
	Salkowski's test	++	--	--	--
	Antimony trichloride test	++	--	--	--
	Zimmermann's test	--	--	--	--
6.	Terpenoids				
	LB test	--	--	--	--
	Salkowski's test	--	--	--	--
	Trichloroacetic acid test	++	--	--	--
7.	Alkaloids				
	Mayer's test	--	--	--	--
	Wagner's test	--	--	++	--
	Hager's test	--	--	++	--
	Dragendorff's test	--	--	--	--
	Tannic acid test	--	--	++	--
8.	Phenolic compounds				
A.	General tests				
	Ford's test	--	--	++	--
	Conc. sulfuric acid test	--	--	++	--
B.	Tannins				
	Bramer's test	--	--	--	--
	Lead acetate test	--	--	--	--
	Potassium dichromate test	--	--	--	--
	Vanillin hydrochloride reduction test	--	--	--	--
	Gelatin test	--	--	--	--

Table 8. (continued).

C.	Flavonoids				
	Shinoda's test	--	--	--	--
	Lead acetate test	--	--	++	--
	Alkaline reagent test	--	--	++	--
	Ammonia test	--	--	--	--
	Zinc hypochloride reduction test	--	--	--	--
9.	Saponins				
	Froth test	--	--	--	++
10.	Glycosides				
A.	Anthraquinone glycosides				
	Borntrager's test	--	++	++	++
	Modified Borntrager's test	--	++	++	++
B.	Cardiac glycosides				
	Keller–Kiliani test (deoxy sugar)	--	++	++	++
	Legal's test (lactone)	--	--	--	--
	Baljet's test	--	--	++	++
	LB test (steroidal)	++	--	--	--
	Kedde's test	--	--	++	--
C.	Cyanogenetic glycosides				
	Hydrogen cyanide test	--	--	--	--
11.	Mucilages				
	Ruthenium test	--	--	--	--
	Swelling test	--	--	--	--

++ present, -- absent.

Table 9. Comparison of presence of different phytoconstituents in *Ganoderma lucidum* and *G. philippii*.

No.	Extract	Phytoconstituents present	
		G. lucidum	*G. philippii*
1.	Petroleum ether	Lipids, steroids, terpenoids	Lipids, steroids, terpenoids
2.	Chloroform	Carbohydrates, reducing sugars, proteins, amino acids, steroids, anthraquinone glycosides	Carbohydrates, anthraquinone glycosides
3.	Methanol	Carbohydrates, reducing sugars, proteins, amino acids, alkaloids, phenolic compounds, flavonoids, anthraquinone glycosides	Carbohydrates, reducing sugars, proteins, amino acids, alkaloids, phenolic compounds, flavonoids, anthraquinone glycosides
4.	Aqueous	Carbohydrates, reducing sugars, proteins, alkaloids, phenolic compounds, flavonoids, saponins, anthraquinone glycosides	Carbohydrates, reducing sugars, proteins, alkaloids, saponins, anthraquinone glycosides

also been used for treating skin diseases and lacerations and for drug delivery, etc. (Khan et al., 2011). Foaming properties determine the ability of a powder to form foam. The foaming ability is related to the amount of solubilized protein (Odoemelam, 2005). Saponins are also involved in the process of foam formation. Foaming properties are important in the preparation of shampoos, liquid detergents, toothpastes, and beverages (Chen et al., 2010). Bulk density is a measure of heaviness of a powder sample, which determines the relative volume of the packaging material required. The dispersibility of powder in water indicates its reconstitutability (Kulkarni et al., 1991).

The results of qualitative chemical screening are in correlation with previous reports on mushrooms (Kadiri and Fasidi, 1992; Joseph et al., 2009; Ogbe et al., 2009; Asuquo and Etim, 2011; Ede et al., 2012). The presence of these primary and secondary metabolites points to the high nutritional and medicinal values of *G. lucidum* and *G. philippii*.

Hence, we conclude that the present study provides useful standards that will help to identify the genuine species and check for adulteration of intact fruit bodies and powder available commercially. The preliminary chemical tests are helpful in finding the chemical constituents that may have medicinal properties and can be utilized for the treatment of various diseases.

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