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Nutritional Properties, Antioxidant and Antihaemolytic Activities of the Dry Fruiting Bodies of Wild Edible Mushrooms Consumed by Ethnic Communities of Northeast India

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A variety of cultivated mushrooms in Northeast India are well known for their taste, nutritional and medicinal benefits. Many wild-growing mushrooms are also consumed due to their exotic flavours and tastes; however, the scientific exploration of their nutritional and bioactive properties is still negligible. In the present study, the 32 wild edible mushroom samples of 11 species collected from different parts of Northeast India were evaluated for their proximate composition, mineral and vitamin (ascorbic acid and riboflavin) contents, antioxidant and antihaemolytic activity, and profiles of organic and phenolic acids. *Lentinus sajor-caju* and *Lentinus squarrosulus* had the highest carbohydrate content (49.80 g/100 g dry weight (d.w.) and 46.36 g/100 g d.w., respectively), crude protein content (20.72 g/100 g d.w. and 20.54 g/100 g d.w., respectively) and a considerable content of minerals. The highest fat content was determined in *Lentinus velutinus* (7.17 g/100 g d.w.). Among the minerals, potassium was found as the most abundant in all the samples. The extracts of *L. sajor-caju, L. squarrosulus,* and *Pleurotus pulmonarius* were characterized by the highest antioxidant activity, while these of *L. sajor-caju*, *Pleurotus ostreatus*, *P. pulmonarius* and *Agaricus bisporus* showed the highest antihaemolytic potential. The HPLC analysis allowed determining the high contents of ascorbic acid and a few organic and phenolic acids such as lactic acid, gallic acid, 3,4-dihydroxybenzoic acid and *trans*-cinnamic acid in the tested mushrooms. Other compounds *viz.* citric acid, caffeic acid, riboflavin, vanillic acid, pyruvic acid, and *p*-coumaric acid were detected with variations. This study established the nutritional and health benefits of wild edible mushrooms of Northeast India region for consumption as functional foods in the human diet.

INTRODUCTION

Mushrooms (including the members of Basidiomycota and the fruiting body forming Ascomycota) are considered to be one of the important components of the forest ecosystem. They have been gaining in importance since ancient times due to their edibility, psychotropic properties, poisonous nature, and mycorrhizal or parasitic associations with the forest trees. With an estimation of around 1.5 million fungal species on earth [Hawksworth, 2001], more than 31,000 species of Basidiomycota (which form the fruiting bodies) and more than 66,000 species of Ascomycota (a small fraction of which forms the fruiting bodies) are well-characterized [Martins, 2017; Taylor *et al*., 2015]. Among the discovered mushroom species, there are abundant numbers of wild edible mushrooms which are consumed world-wide. These mushrooms need to be evaluated for their nutritional composition and bioactive metabolites.

Many mushrooms are rich in nutrients, medicinal, and plant growth-promoting compounds [Ghate & Sridhar, 2016], whereas, many others contain toxic metabolites. Edible mushrooms contain considerable amount of nutritional compounds including carbohydrates (especially non-reducing sugars), proteins, minerals and vitamins. Presence of phenolics, tocopherols, carotenoids and ascorbic acid in mushroom fruiting bodies make them a good source of natural antioxidants [Sánchez, 2017]. These antioxidant molecules provide biochemical support to the growth of fruiting bodies by neutralizing the oxidative stresses provided by reactive oxygen species and free radicals. Likewise, consumption of foods that are rich in natural antioxidants provide excellent health benefits and protects our body against oxidative stresses and aging signs [Chang, 1996; Lindequist *et al*., 2005]. Recent studies have demonstrated the antihaemolytic potential of a few mushroom species [Madhanraj *et al*., 2019; Sharif *et al*., 2017]. Antihaemolytic compounds are antioxidants that

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inhibit the lysis of red blood cells caused by oxidative agents [Shabbir *et al*., 2013].

The Northeast (NE) India possesses a richness in forests, with an abundance of many tree species and other woody plants. The biodiversity of woody plants can be correlated with an equally diverse mycoflora. Ethnic communities inhabiting different regions of Northeast India regularly consume edible mushrooms collecting from the wild based on their traditional knowledge on mushroom identities and their nutritional benefits. However, the diversity of wild mushrooms from this region is not well documented in terms of nutritional properties and bioactive properties. Earlier studies have identified some of the wild edible mushrooms from the states of NE India including Assam, Arunachal Pradesh, Meghalaya, and Nagaland [Khaund & Joshi, 2013; Parveen *et al*., 2017; Sarma *et al*., 2010]. However, nutritional profiling of majority of these wild edible mushrooms are not well investigated. In our recent study, a molecular genetic analysis was conducted to identify 50 wild mushrooms collected from different regions of five Northeastern states of India, out of which 32 edible samples belonging to 11 different species were detected based on their morphological characters as well as genetic information of the internal transcribed spacer (ITS) region [Kakoti *et al*., 2021]. Most of these edible mushrooms are part of the regular diet of various tribal and non-tribal communities. Therefore, the present investigation was conducted to evaluate the species-wise nutritional profiling including proximate composition, mineral and vitamin (ascorbic acid and riboflavin) contents, bioactivity (antioxidant and anti-haemolytic activities) and contents of organic and phenolic acids of those 32 wild edible mushrooms to establish their edibility as functional food.

MATERIALS AND METHODS

Collection of the fruiting bodies of mushrooms

The fruiting bodies of different mushrooms were collected from different locations of five North-Eastern states of India (Assam, Arunachal Pradesh, Manipur, Meghalaya, and Nagaland). The fruiting bodies were cleaned at the site of collection with distilled water and immediately taken to the laboratory by packing inside the collection bags. A total of 32 wild-edible mushroom samples were used in this study and their fundamental sampling information are described in Table 1. These information are also available online at Barcode of Life Data (BOLD) system (http://www.boldsystems.org/). Morphological description of molecular identities (ITS barcode details) of the samples was provided previously [Kakoti *et al*., 2021]. BOLD submission IDs and GenBank Accession numbers are provided in Table 1.

Preparation of dry powder

The mushroom fruiting bodies were initially shade-dried with dry air to remove the excessive moisture from the samples and placed in a hot air oven at 45°C until the residual moisture was removed. This process took 16–24 h depending on the sample characteristics. Dry mushrooms were then powdered using a grinder and sieved through 0.5 mm net.

Determination of moisture content

Moisture content of the fresh mushrooms was determined using the Association of Official Analytical Chemists (AOAC) standard protocol [AOAC, 1996]. Briefly, about 20 g of freshly collected samples were weighed, shade-dried at room temperature for 2 h inside a laminar air flow hood (to remove the excessive moisture), and placed in a hot-air oven at 105°C for 5 h. The dishes were later cooled in a desiccator and weighed with the lid on. The moisture content of the mushrooms was estimated using the formula:

$$\text{Moisture content of fresh sample (g/100 g)} = \left(\frac{\text{Fresh weight (g)} - \text{Dry weight (g)}}{\text{Fresh weight (g)}}\right) \times 100$$

The residual moisture content in the dry fruiting powders was determined from 1 g dry powder by placing in a hot-air oven at 105°C for 5 h.

$$\text{Moisture content of dry powder (g/100 g)} = \left(\frac{\text{Initial dry weight (g)} - \text{final dry weight (g)}}{\text{Initial dry weight (g)}}\right) \times 100$$

Moisture content of the dry powder was used to calculate the actual dry weight of the samples.

Determination of ash content

The ash content of mushrooms was determined from the dried, fine powders of the mushroom fruiting bodies. One gram of powder was weighed into a crucible, which was placed in a muffle furnace initially at 130°C for 1 h, and finally the temperature was increased to 600°C for about 6 h. The powder was cooled in a desiccator and weighed. The ash content was calculated using the following equation:

$$\text{Ash content (g/100 g)} = \left(\frac{\text{Weight of ash (g)}}{\text{Weight of dry mushroom (g)}}\right) \times 100$$

Finally, ash content of dried mushrooms was expressed as g per 100 g of powder dry weight (d.w.).

Determination of crude protein content

The crude protein in the dried and powdered mushroom tissue was determined using the macro-Kjeldhal method [method 984.13; AOAC, 1990] with necessary modifications. Briefly, 100 mg of the mushroom powder was subjected to acid digestion in a KelPlus digestion apparatus (Pelican equipment, Channai, Tamil Nadu, India). The digested sample was distilled following the alkali treatment and the released ammonia was extracted in 2.5% boric acid using the KelPlus automatic distiller (Pelican equipment). The resultant solution was then titrated manually against 0.02 N sulfuric acid to determine the nitrogen content. The crude protein content was calculated from the nitrogen content by multiplying with a factor of 4.38 [Reis *et al*., 2012]. The results were expressed as g per 100 g of d.w. of mushroom powders.

Determination of total carbohydrate content

Dried mushroom powder (100 mg) was mixed with 2.5 N HCl and boiled in a water bath for 3 h. The hydrolysate was neutralized with sodium carbonate. The volume was made up to 100 mL and supernatant was collected by centrifugation. Carbohydrate content in the supernatant was determined using the anthrone method [Sadasivam & Manickam, 1996]. Total carbohydrate content of mushroom powders was expressed as g per 100 g of d.w.

Determination of fat content

The total fat content of dried mushroom fruiting bodies was determined using the gravimetric method [AOAC, 2007]. Fat was extracted with ethanol : diethyl ether : petroleum ether (5:12:12, *v/v/v*) after hydrolysis of the dry mushroom powder with concentrated HCl. The petroleum ether layer was separated after proper mixing and dried to obtain the fat, which was further weighed. Total fat content in dried mushrooms was calculated as follows:

$$\text{Fat content (g/100 g)} = \left(\frac{\text{Weight of the extracted fat (g)}}{\text{Sample weight (g)}}\right) \times 100$$

The results were expressed as g per 100 g of d.w. of mushroom powders.

Determination of mineral content

The contents of minerals *viz*. calcium, magnesium, potassium, sodium, zinc, iron, copper and manganese, in the dried mushroom fruiting bodies were determined using an iCE3000 atomic absorption spectrometer (Thermo Scientific, Waltham, MA, USA). Extracts were prepared by digesting the powdered mushroom samples in nitric acid and hydrogen peroxide as described earlier [Soylak *et al*., 2005]. The phosphorus content was estimated using the molybdovanadate method [method 965.17; AOAC, 1990]. The content of each element was determined using a calibration curve plotted with known concentrations of the respective standards. Results were expressed based on d.w. of mushroom powders.

Extract preparation from the fruiting bodies

Dry powdered fruiting bodies (1 g) were extracted overnight using 100 mL of methanol and the supernatant was carefully filtered through Whatman No. 42 filter paper (GE Healthcare, Chicago, IL, USA) taking the care that minimal residue was transferred to the filter paper. Supernatant was collected and the residue was extracted with another 100 mL of methanol as described above. For the determination of total phenolic content, the filtered supernatant was directly used in the assay. For antioxidant and antihaemolytic activities analysis, the extracts were evaporated to dryness using a rotary evaporator and re-dissolved in a required volume (to prepare the working solutions) of methanol or phosphate buffered saline (PBS; 10 mM Na_2HPO_4, 1.8 mM KH_2PO_4, 137 mM NaCl and 2.7 mM KCl, pH 7.4), respectively, as per the requirements for further experiments.

Determination of total phenolic content

Total phenolic content in the methanol extracts of mushroom samples was estimated spectrophotometrically, based on the procedure described by Singleton & Rossi [1965] with some modifications. First, 1 mL of the extract was mixed with 1 mL of a Folin-Ciocalteu's phenol reagent. After 3 min, 1 mL of a saturated sodium carbonate solution was added to the mixture and adjusted to the total volume to 10 mL with distilled water. The reaction mixture was kept in dark for 90 min, after that the absorbance was recorded at 725 nm. Known concentrations of gallic acid were used to prepare the standard curve. The total phenolic content of the samples was calculated based on the graph and expressed as mg gallic acid equivalents (GAE) per 100 g of d.w. of mushroom powders.

DPPH radical scavenging activity

The 2,2-diphenyl-1-picrylhydrazyl (DPPH, Sigma, Saint Louis, MO, USA) radical scavenging activity was determined by the Blois's method [Blois, 1958] with minor modifications. The extract and reference standard solutions in methanol (1 mL) were prepared in different concentrations and mixed individually with 0.5 mL of 0.15 mM $DPPH^{\bullet}$ solution. α-Tocopherol was used as the reference standard [Boonsong *et al*., 2016]. The percentage of inhibition of $DPPH^{\bullet}$ was obtained by measuring the absorbance at 517 nm using an Evolution 202 UV–Vis double beam spectrophotometer (Thermo Scientific) and calculation using the following formula:

$$\text{\% Inhibition of DPPH radical} = \left(\frac{\text{Absorbance of control} - \text{Absorbance of sample}}{\text{Absorbance of control}}\right) \times 100$$

The % inhibition data was used to calculate the IC_{50} value – concentration of extract that could scavenge 50% of DPPH radicals. Additionally, the results were expressed as the tocopherol equivalent antioxidant activity (TEAA) in mg tocopherol equivalent per 100 g of d.w. of mushroom powder.

Determination of antihaemolytic activity

The antihaemolytic activity of the dried mushrooms was evaluated using the spectrophotometric method described previously by Shabbir *et al*. [2013] with minor modifications. Briefly, the reaction mixture consisted 0.5 mL of mushroom extract with varying concentrations *viz*., 100, 250, 500, 750 and 1000 μg/mL in PBS and 0.5 mL of a red blood cell (RBC) suspension, and the mixture was incubated at room temperature for 20 min. After incubation, 0.5 mL of hydrogen peroxide (H_2O_2) was supplemented to the mixture for induction of the oxidative degradation of membrane lipids. A control was prepared with a similar volume of the reaction mixture without adding the extract. The reaction mixture was then centrifuged at 500×*g*, 4°C for 5 min and the antihaemolytic activity was assessed spectrophotometrically at 540 nm. The percent of haemolysis was calculated using the following formula:

$$\text{\% Inhibition of haemolysis} = \left(\frac{\text{Absorbance of control} - \text{Absorbance of sample}}{\text{Absorbance of control}}\right) \times 100$$

The % inhibition data was used to calculate the IC_{50} value – concentration of extract that could inhibit the haemolysis of RBC by 50%.

Detection of major organic acids and antioxidant compounds

The organic and phenolic acids and some other metabolites were initially extracted from powdered mushroom

TABLE 1. Sampling details of the wild edible mushrooms collected in Northeast India.

No.	Species name	Sample ID	Habitat	Sampling location	Date of collection	Collected by	GenBank Accession No.	BOLD submission ID
1	*Agaricus bisporus* (J.E. Lange) Imbach 1946	MLS2	Soil containing plant litter	East Khasi Hill, Shillong, Meghalaya	11.04.2018	M. Kakoti, D. J. Hazarika	MK855508	ITSA051–20
2	*Auricularia auricula-judae* (Bull.) Quél. 1886	DIM1	Living tree	Dimapur, Nagaland	30.04.2018	M. Kakoti	MK855509	ITSA040–20
3	*Lentinus sajor-caju* (Fr.) Fr. 1838	APK5	Wood surface	Koronu, Lower Dibang Valley, Arunachal Pradesh	26.03.2018	M. Kakoti, D. J. Hazarika	MK851527	ITSA014–19
		DIM3	Decaying wood	Dimapur, Nagaland	30.04.2018	M. Kakoti	MK851526	ITSA016–19
		DH3	Decaying wood	Haflong, Dima Hasao, Assam	03.07.2017	M. Kakoti	MK851528	ITSA015–19
		MIS2	Decaying wood	Missamara, Golaghat, Assam	25.06.2018	M. Kakoti, D. J. Hazarika	MK851531	ITSA017–19
		MIS7	Fully decayed wood	Missamara, Golaghat, Assam	03.07.2018	M. Kakoti, D. J. Hazarika	MK851530	ITSA018–19
		MP3	Decaying wood	Kohima, Manipur	01.02.2018	M. Kakoti	MK851529	ITSA019–19
4	*Lentinus squarrosulus* Mont. 1842	AAU1	Decaying wood	Assam Agricultural University Campus Barbheta, Jorhat, Assam	15.06.2017	M. Kakoti	MK851539	ITSA020–19
		AAU2	Decaying wood	Assam Agricultural University Campus Barbheta, Jorhat, Assam	15.06.2017	M. Kakoti	MK851538	ITSA021–19
		AAU3	Decaying wood	Assam Agricultural University Campus Barbheta, Jorhat, Assam	15.06.2017	M. Kakoti	MK851536	ITSA022–19
		AAU4	Decaying wood	Assam Agricultural University Campus Barbheta, Jorhat, Assam	15.06.2017	M. Kakoti	MK851535	ITSA023–19
		AAU5	Soil	Assam Agricultural University Campus Barbheta, Jorhat, Assam	15.06.2017	M. Kakoti	MK851534	ITSA024–19
		AAU6	Soil	Assam Agricultural University Campus Barbheta, Jorhat, Assam	15.06.2017	M. Kakoti	MK851533	ITSA025–19
		AAU7	Soil	Assam Agricultural University Campus Barbheta, Jorhat, Assam	15.06.2017	M. Kakoti	MK851532	ITSA026–19
		DH1	Decaying wood	Haflong, Dima Hasao, Assam	03.07.2017	M. Kakoti	MK851537	ITSA027–19
		DIM2	Decaying wood	Dimapur, Nagaland	30.04.2018	M. Kakoti	MK855509	ITSA041–20
		KB2	Dead tree	Bokajan, Karbi Anglong, Assam		M. Kakoti, D. J. Hazarika	MK851540	ITSA028–19
5	*Lentinus velutinus* Fr. 1830	KM5	Soil	Kanubari Tea Estate, Sivasagar, Assam	03.05.2017	M. Kakoti, S. Dullah, A. Parveen	MK855514	ITSA045–20
6	*Lycoperdon scabrum*	BP9	Soil	Barpeta, Assam	31.08.2018	M. Kakoti, A. Ghosh	MK851544	ITSA003–19
		DIM8	Soil	Dimapur, Nagaland	17.06.2018	M. Kakoti	MK851545	ITSA004–19
		KM7	Grassland soil	Kanubari Tea Estate, Sivasagar, Assam	03.05.2017	M. Kakoti, S. Dullah, A. Parveen	MK851546	ITSA005–19
		RB6	Soil	Rongbong, Golaghat, Assam	18.06.2018	M. Kakoti, D. J. Hazarika	MK851547	ITSA006–19

TABLE 1. Continued

No.	Species name	Sample ID	Habitat	Sampling location	Date of collection	Collected by	GenBank Accession No.	BOLD submission ID
7	*Panus lecomtei* (Fr.) Corner 1981	APBN3	Wood surface	Bhismaknagar, Roing, Arunachal Pradesh	26.03.2018	M. Kakoti, D. J. Hazarika	MK851549	ITSA036–19
8	*Pleurotus giganteus* (Berk.) Karun. & K.D. Hyde 2011	KM1	Soil with plant litter	Kanubari Tea Estate, Sivasagar, Assam	03.05.2017	M. Kakoti, S. Dullah, A. Parveen	MK851552	ITSA007–19
		KM2	Soil with plant litter	Kanubari Tea Estate, Sivasagar, Assam	03.05.2017	M. Kakoti, S. Dullah, A. Parveen	MK855519	ITSA044–20
9	*Pleurotus ostreatus* (Jacq.) P. Kumm. 1871	MP1	Decaying wood	Kohima, Manipur	01.02.2018	M. Kakoti	MK855520	ITSA046–20
10	*Pleurotus pulmonarius* (Fr.) Quél. 1872 [synonym. *Pleurotus ostreatus* var. *pulmonarius* (Fr.) Iordanov, Vanev & Fakirova 1979]	MLS1	Decaying wood	East Khasi Hill, Shillong, Meghalaya	11.04.2018	M. Kakoti, D. J. Hazarika	MK851551	ITSA008–19
		MP2	Dead tree surface	Kohima, Manipur	01.02.2018	M. Kakoti	MK855521	ITSA047–20
11	*Polyporus arcularius* (Batsch) Fr. 1821 [synonym. *Lentinus arcularius* (Batsch) Zmitr. 2010]	APBN4	Decaying wood	Bhismaknagar, Lower Dibang Valley, Arunachal Pradesh	26.03.2018	M. Kakoti, D. J. Hazarika	MK851553	ITSA030–19
		DH2	Decaying wood	Haflong, Dima Hasao, Assam	03.07.2017	M. Kakoti	MK851555	ITSA031–19
		MLS6	Decaying wood	East Khasi Hill, Shillong, Meghalaya	23.08.2018	M. Kakoti, D. J. Hazarika	MK851554	ITSA032–19

BOLD: Barcode of Life Data.

fruiting body (1 g) with 25 mL of 80% (*v/v*) acetone in water [Barros *et al*., 2009] for 6 h and filtered through Whatman No. 42 filter paper (GE Healthcare) taking the care that minimal residue was transferred to the filter paper. The precipitate was re-extracted with another 25 mL of 80% (*v/v*) acetone as described above. The crude extracts were concentrated under vacuum and re-dissolved in 20 mL of 50% (*v/v*) methanol. The extracts were then filtered using a membrane syringe filter and a 20 μL of sample was separated through a Cosmosil C-18 column (300×4.6 mm, pore size 5 μm; Nacalai Tesque Inc., Kyoto, Japan) installed in a Hitachi Chromaster 3000 series HPLC system with a diode array detector (Hitachi, Tokyo, Japan). The mobile phase used consisted of acetonitrile (A) and 0.1% (*v/v*) phosphoric acid (H_3PO_4) in water in a gradient mode: 5% of A at 0–2 min, 15% of A at 2–5 min, 40% of A at 5–10 min, 60% of A at 10–15 min, 90% of A at 15–18 min, reverting to 5% of A at 20 min and equilibration with 5% of A till 25 min. Detection of compounds was performed in the range of 200–400 nm. The peaks were compared with individual standards of 11 organic acids and antioxidants *viz.*: ascorbic acid (Sigma-Aldrich, Saint Louis, MO, USA), caffeic acid (Sigma-Aldrich), citric acid (Himedia, Mumbai, Maharastra, India), 3,4-dihydroxybenzoic acid (Sigma-Aldrich), gallic acid (Sigma-Aldrich), lactic acid (Sigma-Aldrich), pyruvic acid (Himedia), *p*-coumaric acid (Sigma-Aldrich), riboflavin (Sigma-Aldrich), *trans*-cinnamic acid (Sigma-Aldrich) and vanillic acid (Sigma-Aldrich). The contents of compounds in mushrooms were calculated from the linear portion of the regression curve prepared from the peak areas of individual reference standards.

Statistical analysis

All the statistical analyses were performed using IBM SPSS software, version 25 (Armonk, NY, USA). To test the significant differences among the samples, one-way analysis of variance (ANOVA) with Duncan's multiple range test was used, while non-parametric Kruskal-Wallis test was used for species-wise comparison. Results were considered to be significant with 95% confidence level and $p<0.05$. Pearson's correlation analysis was performed to calculate the correlation coefficient among total phenolic content, antioxidant activity and antihaemolytic activity. All the experiments, including the preparation of extracts, determination of proximate compositions and bioactivities were performed with three independent replicates for each sample. Three data points were generated from three independent replications for statistical analysis.

RESULTS AND DISCUSSION

Nutritional properties of the wild edible mushrooms

In this study, 32 wild edible mushroom samples collected from different locations of Northeast India were assessed for their nutritional properties. Sample-wise as well as species-wise comparisons of the moisture content among different edible samples are represented in Table 2. The highest moisture content (90.35 g/100 g) was recorded in *Auricularia auricula-judae,* while *Polyporus arcularius* (synonym. *Lentinus arcularius*) was recorded with the lowest moisture content

TABLE 2. Sample-wise and species-wise comparison of proximate compositions of the mushroom fruiting bodies.

No.	Species name & sample code	Moisture content of the fresh fruiting bodies (g/100 g)		Moisture content of the dried powder (g/100 g)		Ash (g/100 g dry weight)		Carbohydrate (g/100 g dry weight)		Crude protein (g/100 g dry weight)		Fat (g/100 g dry weight)	
		Average of samples	Average of species	Average of samples	Average of species	Average of samples	Average of species	Average of samples	Average of species	Average of samples	Average of species	Average of samples	Average of species
1.	*Agaricus bisporus*		**84.50 ± 0.44^{c}**		**2.60 ± 0.10^{d}**		**9.23 ± 0.38^{a}**		**36.52 ± 2.22^{f}**		**18.65 ± 0.80^{ab}**		**2.46 ± 0.18^{bc}**
	MLS2	84.50 ± 0.44^{f}		2.60 ± 0.10^{lmn}		9.23 ± 0.38^{a}		36.52 ± 2.22^{p}		18.65 ± 0.80^{klm}		2.46 ± 0.18^{ef}	
2.	*Auricularia auricula-judae*		**90.35 ± 0.41^{a}**		**2.83 ± 0.06^{bc}**		**5.68 ± 0.39^{cd}**		**42.75 ± 2.42^{bc}**		**19.70 ± 0.94^{ab}**		**1.44 ± 0.00^{e}**
	DIM1	90.35 ± 0.41^{a}		2.83 ± 0.06^{hijkl}		5.68 ± 0.39^{n}		42.75 ± 2.42^{ghi}		19.70 ± 0.94^{hij}		1.44 ± 0.00^{hi}	
3.	*Lentinus sajor-caju*		**81.12 ± 1.17^{e}**		**2.63 ± 0.15^{d}**		**7.19 ± 0.50^{c}**		**49.80 ± 3.34^{a}**		**20.72 ± 1.97^{a}**		**0.62 ± 0.55^{g}**
	APK5	82.20 ± 0.66^{gh}		2.53 ± 0.15^{mn}		7.61 ± 0.31^{defgh}		47.76 ± 2.39^{de}		19.93 ± 0.20^{ghi}		0.24 ± 0.06^{m}	
	DH3	80.22 ± 0.33^{klm}		2.73 ± 0.06^{ijklm}		7.05 ± 0.12^{ijk}		52.09 ± 2.32^{ab}		19.05 ± 0.33^{ijkl}		0.24 ± 0.06^{m}	
	DIM3	82.72 ± 0.46^{g}		2.77 ± 0.15^{ijklm}		7.36 ± 0.37^{fghi}		51.63 ± 1.12^{ab}		22.04 ± 0.42^{cde}		0.75 ± 0.22^{jk}	
	MIS2	81.36 ± 0.48^{hij}		2.67 ± 0.12^{jklm}		6.64 ± 0.32^{kl}		49.88 ± 1.29^{bcd}		23.11 ± 0.32^{ab}		0.31 ± 0.10^{lm}	
	MIS7	80.49 ± 0.48^{jkl}		2.43 ± 0.06^{n}		7.74 ± 0.41^{bcdef}		44.39 ± 1.04^{gh}		17.86 ± 0.45^{mn}		1.71 ± 0.21^{gh}	
	MP3	79.72 ± 0.21^{lm}		2.63 ± 0.12^{klmn}		6.73 ± 0.21^{kl}		53.05 ± 0.85^{a}		22.31 ± 0.32^{bcd}		0.48 ± 0.06^{klm}	
4.	*Lentinus squarrosulus*		**80.48 ± 1.40^{e}**		**2.92 ± 0.36^{bc}**		**7.07 ± 0.41^{c}**		**46.36 ± 3.71^{b}**		**20.54 ± 1.72^{a}**		**2.69 ± 0.69^{b}**
	AAU1	82.17 ± 0.72^{gh}		2.83 ± 0.12^{hijkl}		7.57 ± 0.30^{efgh}		50.53 ± 1.08^{abc}		19.49 ± 0.42^{ijk}		2.57 ± 0.00^{ef}	
	AAU2	80.89 ± 0.65^{ijk}		2.53 ± 0.12^{mn}		6.74 ± 0.23^{jkl}		49.69 ± 0.56^{bcd}		22.87 ± 0.27^{abc}		2.36 ± 0.00^{f}	
	AAU3	78.25 ± 1.06^{n}		2.90 ± 0.10^{fghi}		6.53 ± 0.24^{lm}		48.05 ± 0.59^{cd}		21.15 ± 0.25^{ef}		3.26 ± 0.06^{c}	
	AAU4	79.32 ± 0.79^{m}		2.83 ± 0.06^{hijkl}		7.30 ± 0.13^{fghi}		43.06 ± 1.17^{ghi}		20.67 ± 0.25^{fg}		3.95 ± 0.26^{b}	
	AAU5	81.62 ± 0.42^{hi}		2.73 ± 0.06^{ijklm}		7.02 ± 0.16^{ijk}		45.29 ± 1.99^{efg}		23.30 ± 0.45^{a}		3.19 ± 0.10^{c}	
	AAU6	80.82 ± 0.45^{ijk}		2.43 ± 0.49^{n}		6.75 ± 0.14^{jkl}		39.96 ± 0.36^{jklmn}		21.55 ± 0.12^{def}		2.29 ± 0.06^{f}	
	AAU7	82.11 ± 0.71^{gh}		3.53 ± 0.06^{a}		6.67 ± 0.23^{kl}		43.29 ± 1.88^{ghi}		20.61 ± 0.32^{fgh}		2.49 ± 0.27^{ef}	
	DH1	80.93 ± 0.60^{ijk}		3.33 ± 0.06^{abc}		7.28 ± 0.17^{fghi}		45.00 ± 2.48^{fgh}		19.04 ± 0.33^{ijkl}		3.03 ± 0.06^{cd}	
	DIM2	79.44 ± 0.52^{m}		3.13 ± 0.06^{cde}		7.66 ± 0.10^{cdefg}		51.00 ± 1.10^{ab}		18.70 ± 0.26^{jklm}		2.37 ± 0.27^{f}	
	KB2	79.25 ± 0.34^{m}		2.93 ± 0.06^{efgh}		7.21 ± 0.09^{ghij}		47.76 ± 1.68^{de}		17.99 ± 0.65^{mn}		1.41 ± 0.46^{hi}	
5.	*Lentinus velutinus*		**80.59 ± 0.48^{e}**		**3.37 ± 0.06^{ab}**		**8.16 ± 0.20^{ab}**		**41.22 ± 1.20^{cde}**		**15.36 ± 0.13^{d}**		**7.17 ± 0.15^{a}**
	KM5	80.59 ± 0.48^{ijkl}		3.37 ± 0.06^{ab}		8.16 ± 0.20^{b}		41.22 ± 1.20^{ijkl}		15.36 ± 0.13^{q}		7.17 ± 0.15^{a}	

TABLE 2. Continued

No.	Species name & sample code	Moisture content of the fresh fruiting bodies (g/100 g)		Moisture content of the dried powder (g/100 g)		Ash (g/100 g dry weight)		Carbohydrate (g/100 g dry weight)		Crude protein (g/100 g dry weight)		Fat (g/100 g dry weight)	
		Average of samples	Average of species	Average of samples	Average of species	Average of samples	Average of species	Average of samples	Average of species	Average of samples	Average of species	Average of samples	Average of species
6.	*Lycoperdon scabrum*		**87.42 ± 1.10^{b}**		**2.85 ± 0.13^{c}**		**5.62 ± 0.37^{d}**		**38.55 ± 1.17^{ef}**		**17.31 ± 0.74^{c}**		**0.57 ± 0.16^{g}**
	BP9	86.13 ± 0.24^{de}		2.77 ± 0.06^{ijklm}		5.47 ± 0.21^{n}		38.43 ± 1.08^{nop}		16.41 ± 0.26^{p}		0.62 ± 0.18^{jkl}	
	DIM8	88.71 ± 0.48^{b}		2.87 ± 0.06^{hijk}		5.44 ± 0.17^{n}		37.70 ± 1.55^{op}		17.14 ± 0.25^{nop}		0.41 ± 0.10^{klm}	
	KM7	87.58 ± 1.10^{c}		2.73 ± 0.06^{ijklm}		6.16 ± 0.08^{m}		39.44 ± 0.77^{klmn}		18.08 ± 0.64^{lmn}		0.51 ± 0.10^{jklm}	
	RB6	87.27 ± 0.39^{c}		3.03 ± 0.06^{efg}		5.42 ± 0.30^{n}		38.61 ± 1.01^{mnop}		17.63 ± 0.39^{no}		0.72 ± 0.10^{jk}	
7.	*Panus lecomtei*		**81.39 ± 0.77^{de}**		**3.47 ± 0.12^{a}**		**7.21 ± 0.29^{c}**		**41.44 ± 1.42^{cd}**		**16.52 ± 0.90^{cd}**		**0.86 ± 0.06^{f}**
	APBN3	81.39 ± 0.77^{hij}		3.47 ± 0.12^{ab}		7.21 ± 0.29^{ghij}		41.44 ± 1.42^{ijk}		16.52 ± 0.90^{p}		0.86 ± 0.06^{j}	
8.	*Pleurotus giganteus*		**82.93 ± 1.10^{d}**		**3.42 ± 0.08^{a}**		**8.49 ± 0.46^{ab}**		**38.62 ± 1.76^{def}**		**16.07 ± 1.31^{cd}**		**3.43 ± 0.83^{b}**
	KM1	83.87 ± 0.56^{f}		3.37 ± 0.06^{ab}		8.88 ± 0.17^{a}		39.52 ± 1.34^{klmn}		17.18 ± 0.39^{nop}		4.07 ± 0.26^{b}	
	KM2	81.98 ± 0.28^{gh}		3.47 ± 0.06^{ab}		8.10 ± 0.20^{bc}		37.72 ± 1.89^{op}		14.96 ± 0.62^{q}		2.80 ± 0.65^{de}	
9.	*Pleurotus ostreatus*		**87.58 ± 0.42^{b}**		**3.27 ± 0.06^{abc}**		**7.13 ± 0.13^{c}**		**39.28 ± 1.04^{cdef}**		**19.28 ± 1.09^{ab}**		**1.79 ± 0.12^{d}**
	MP1	87.58 ± 0.42^{c}		3.27 ± 0.06^{bcd}		7.13 ± 0.13^{hijk}		39.28 ± 1.04^{klmn}		19.28 ± 1.09^{ijk}		1.79 ± 0.12^{gh}	
10.	*Pleurotus pulmonarius*		**86.44 ± 0.84^{b}**		**2.98 ± 0.16^{bc}**		**7.18 ± 0.43^{c}**		**41.48 ± 1.32^{c}**		**18.42 ± 1.13^{b}**		**2.15 ± 0.30^{cd}**
	MLS1	87.06 ± 0.55^{cd}		3.10 ± 0.10^{def}		7.37 ± 0.35^{fghi}		40.58 ± 0.94^{ijklm}		19.29 ± 0.83^{ijk}		1.93 ± 0.06^{g}	
	MP2	85.81 ± 0.53^{e}		2.87 ± 0.12^{hijk}		6.98 ± 0.47^{ijkl}		42.39 ± 1.03^{hij}		17.56 ± 0.51^{no}		2.37 ± 0.27^{f}	
11.	*Polyporus arcularius*		**60.36 ± 1.46^{f}**		**3.17 ± 0.33^{abc}**		**8.04 ± 0.21^{b}**		**46.64 ± 2.84^{b}**		**16.41 ± 1.14^{cd}**		**1.34 ± 0.10^{e}**
	APBN4	58.67 ± 0.89^{q}		2.73 ± 0.06^{ijklm}		8.05 ± 0.19^{bcd}		49.42 ± 0.93^{bcd}		17.37 ± 1.01^{nop}		1.41 ± 0.06^{hi}	
	DH2	61.70 ± 0.63^{o}		3.33 ± 0.06^{abc}		8.13 ± 0.26^{bc}		43.16 ± 0.44^{ghi}		15.23 ± 0.37^{q}		1.34 ± 0.10^{hi}	
	MLS6	60.73 ± 0.40^{p}		3.43 ± 0.06^{ab}		7.95 ± 0.21^{bcde}		47.34 ± 0.75^{def}		16.65 ± 0.72^{op}		1.28 ± 0.12^{i}	

All the sample-wise data are represented as average ± standard deviations (SD) of three independent replications, while species-wise data are represented as average ± SD of all the triplicate data belonging to a single species. The different lowercase letters (a, b, c, d, and so on) after each data in columns indicate the significant difference among the samples/species ($p<0.05$).

(60.36 g/100 g). Moisture contents vary among species to species depending on their types of fruiting bodies. Although, differences in moisture content among the members of the same species may vary depending upon the environmental factors such as relative humidity, temperature, and relative amount of metabolic water [Crisan & Sands, 1978; Singdevsachan *et al*., 2014]. Dry fruiting body powders of the mushrooms also retained the minimal amount of moisture ranging from 2.43 g/100 g to 3.53 g/100 g (Table 2). The highest ash content was determined in *Agaricus bisporus* (9.23 g/100 g d.w.), while the lowest one in *Lycoperdon scabrum* (5.62 g/100 g d.w.) and *A. auricula-judae* (5.68 g/100 g d.w.).

Total crude protein content of the edible dried mushrooms showed variations among different species (Table 2). Species-wise comparisons showed that the crude protein content was the highest in *Lentinus sajor-caju* (20.72 g/100 g d.w.), and *Lentinus squarrosulus* (20.54 g/100 g d.w.). Although, there were no significant differences ($p<0.05$) observed in the crude protein content of these two species with that of *A. auricula-judae* (19.70 g/100 g d.w.), *Pleurotus ostreatus* (19.28 g/100 g d.w.) and *A. bisporus* (18.65 g/100 g d.w.). Our results were comparable to the previous findings on the protein contents of edible mushroom species [Kalač, 2013; Phan *et al*., 2012; Reis *et al*., 2012]. However, different researchers found differences in the protein contents based on the external growing parameters. For instance, the protein content in *Pleurotus pulmonarius* was reported to vary from ~14 g/100 g d.w. to 26 g/100 d.w. depending on different carbon sources supplemented during their cultivation process [Smiderle *et al*., 2012]. Therefore, it can be concluded that protein content in wild mushrooms may vary depending upon the substrates on which they grow.

Among the edible mushroom species, *L. sajor-caju* showed the highest carbohydrate contents (49.80 g/100 g d.w.), which was followed by *P. arcularius* (46.64 g/100 g d.w.), *L. squarrosulus* (46.36 g/100 g d.w.) and *A. auricula-judae* (42.75 g/100 g d.w.) (Table 2). Our results could be compared with the carbohydrate content of edible mushrooms as reported earlier [Johnsy *et al*., 2011; Nwanze *et al*., 2005]. Carbohydrates are the most abundant constituents of mushrooms, which include sugars (monosaccharides, their derivatives and oligosaccharides) as well as both reserved and construction polysaccharides [Kalač, 2013]. Compared to the small amount of reducing sugars present in mushrooms, chitin and starch constitute the major fraction of total carbohydrates [Manzi *et al*., 2001]. Mushrooms contain digestible carbohydratess (such as glucose, glycogen, mannitol, and trehalose) as well as non-digestible carbohydrate (such as β-glucan, chitin and mannans). Both of these carbohydrate forms constitute the total carbohydrates in mushroom fruiting bodies [Ho *et al*., 2020].

Species-wise comparison showed the highest total fat content in *Lentinus velutinus* (7.17 g/100 g d.w.), which was followed by *Pleurotus giganteus* (3.43 g/100 g d.w.) and *L. squarrosulus* (2.69 g/100 g d.w.). The lowest total fat content was determined in the samples of *L. scabrum* (0.57 g/ 100 g d.w.) and *L. sajor-caju* (0.62 g/100 g d.w.) (Table 2). Typically, mushrooms have been reported to have a low fat content compared to the carbohydrate and protein contents. Fruiting bodies of edible mushrooms mostly contain *cis*-linoleic acid as a major fatty acid which varies from 22–65% in abundance of total fat. The other major fatty acids in mushrooms include *cis*-oleic acid, palmitic acid, and stearic acids [Günç Ergönül *et al*., 2013].

The mineral content analysis of the edible dried mushrooms revealed that there were significant differences among the tested samples. Table 3 and Table 4 show the species-wise average contents of macro- and microelements, respectively, of the mushroom samples. Among all the minerals, potassium (K) content was the highest in all the samples. Species-wise comparison showed that potassium content varied among different species and the highest content was in *P. ostreatus* (2074.0 mg/100 g d.w.), along with *A. bisporus*, *P. pulmonarius*, *L. squarrosulus*, *L. sajor-caju*, *A. auricula-judae* and *Panus lecomtei* (Table 3). Previous studies also reported potassium as the predominant macroelement among different mushroom species [Dursun *et al.*, 2006; Gençcelep *et al.*, 2009]. The phosphorus content was the highest in *L. velutinus* (318.8 mg/100 g d.w.), which was followed by that in *P. pulmonarius* (294.3 mg/100 g d.w.) and *P. ostreatus* (285.2 mg/100 g d.w.). The highest calcium (Ca) content was found in *L. sajor-caju* (232.0 mg/100 g of d.w.), which was non-significantly higher ($p\geq0.05$) than in *A. auricula-judae* (222.3 mg/100 g of d.w.), and few other species (Table 3). There were very little differences in the magnesium (Mg) content among different species. The average sodium (Na) content of *A. bisporus* was the highest among the analysed mushroom species (Table 3). On the other hand, the lowest sodium content was found in *P. lecomtei*. Four microelements, namely iron (Fe), zinc (Zn), copper (Cu), and manganese (Mn), were also determined using atomic absorption spectroscopy (Table 4). The findings revealed exceptionally high iron content in *A. auricula-judae* (97.30 mg/100 g d.w.) compared to the samples of other species. Iron contents of *L. squarrosulus*, *L. sajor-caju*, *P. pulmonarius* and *A. bisporus* were also found high. Compared to iron contents, other three elements (Zn, Cu and Mn) were determined at lower levels, which was consistent with findings of other authors [Dursun *et al*., 2006; Gençcelep *et al*., 2009]. As suggested by previous findings, the mineral contents of mushrooms are greatly affected by geographical locations, growing substrates and several other internal and external factors including growth conditions and genetic factors [Gençcelep *et al.*, 2009; Mallikarjuna *et al.*, 2013; Uzun *et al.*, 2017]. It was also reported that bioavailability of some elements in mushrooms, especially copper, is low for human due to limited absorption from the small intestine [Schellmann *et al*., 1980].

Total phenolic content (TPC) in the dry mushrooms

Phenolic compounds are a major class of secondary plant metabolites with an important role in the protection against oxidation processes [Croft, 1999]. Numerous studies have proved that mushrooms also contain many phenolics equivalent to plant phenolics with potent radical scavenging ability [Elmastas *et al*., 2007; Turkoglu *et al*., 2007]. Here, total phenolic contents of the wild edible mushrooms were determined spectrophotometrically using the Folin-Ciocalteu reagent after extraction with methanol. Methanol can be considered as the most suitable solvent for the extraction of organic compounds including phenolics. Previously, it was reported that extraction of phenolics with methanol resulted in the highest TPC compared to ethanol, acetone and water [Do *et al*., 2020]. In the present study, the total phenolic content ranged from 59.2 to 1051.5 mg GAE/100 g d.w. for the dried mushrooms (Table 5). Species-wise comparisons showed that the highest TPC was found in the samples of *L. sajor-caju* (831.3 mg GAE/100 g of d.w.), which was followed by *P. lecomtei* (780.9 mg GAE/100 g of d.w.) and *P. pulmonarius*. Samples belonging to the species *P. arcularius* had the lowest TPC (109.1 mg GAE/100 g of d.w.) compared to those of other species (Table 5). There are extensive reports concerning the phenolic contents of mushrooms; however, comparison of findings is difficult due to diversity in research materials, environmental conditions, habitats, analytical methods or ways of expressing the findings [Nowacka *et al*., 2014]. Our study demonstrated higher total phenolic contents in wild mushrooms (such as *L. sajor-caju, P. ostreatus,* and *P. pulmonarius*) compared to the cultivated strains of those species described earlier [Jeena *et al*., 2014]; however, total phenolic contents as high as 2.17–36.19 mg/g d.w. have been described earlier for a few edible mushrooms [Boonsong *et al*., 2016].

Antioxidant activity

DPPH radical scavenging activity of the mushroom samples was evaluated and the species-wise results were compared based on the IC_{50} of the methanolic extracts, as well as the tocopherol equivalent antioxidant activity (TEAA). The results suggested that the samples of the species *L. sajor-caju, L. squarrosulus,* and *P. pulmonarius* exhibited higher antioxidant activity indicated by the lower IC_{50} and higher TEAA as compared to other species (Table 5). IC_{50} signifies the ability of the extract to scavenge the DPPH radical in a concentration-dependent manner. Based on the IC_{50}, our results were comparable with those of earlier reports, which suggested that 40–60% inhibition of DPPH radical occurred in the presence of ~500 μg/mL mushroom extracts [Boonsong *et al*., 2016]; although, concentrations as high as 5–20 mg/mL for scavenging 40–60% of DPPH radical were also reported for few edible mushroom extracts [Cheung *et al*., 2003; Jeena *et al*., 2014; Wong & Chye, 2009]. Extraction solvents play a crucial role in the determination of antioxidant activity of biological samples. Previous studies reported a high extraction yield of antioxidants from mushrooms with high antioxidant properties using methanol and ethyl acetate [Akata *et al.*, 2019; Lakshmi *et al.*, 2004]. In our study, there was a positive correlation between total phenolic content and TEAA, with a correlation coefficient of 0.544 ($p<0.01$), suggesting the major role of phenolic compounds in antioxidant activity of mushroom powders. It was earlier reported that the antioxidant properties of button mushrooms varied between 5.49 and 10.48 nmol Trolox equivalent/mg d.w. based on their growing stages, and the antioxidant activity of those samples correlated with the ergosterol content [Shao *et al.*, 2010].

Antihaemolytic activity

Antihaemolytic activity of the extracts was tested in goat RBC cells in the presence of the haemolytic agent H_2O_2. Extracts from the mushroom powders showed inhibition of haemolytic activity, which was found to be increased with increasing concentrations of the extracts (data not shown). Table 4 shows sample-wise and species-wise comparisons of the antihaemolytic activities of the dried fruiting body extracts. The samples belonging to the species *L. sajor-caju*, *P. ostreatus*, *P. pulmonarius* and *A. bisporus* showed the highest antihaemolytic activity compared to the samples of other species. Few extracts of *L. squarrosulus* indicated low IC_{50} values, suggesting to have prominent antihaemolytic activity. The antihaemolytic activity of the mushroom extracts can be correlated to their antioxidative potential, or total plenolic content [Afsar *et al.*, 2016]. Haemolytic agents, like H_2O_2, oxidize the lipids in the plasma membrane of RBC cells, due to which haemoglobins release to the extracellular matrix. Phenolic compounds in the mushroom extracts inhibit the oxidation of lipids by H_2O_2 due to their antioxidant potential. There are plenty of reports demonstrating the antihaemolytic activity of phytoconstituents from different plant species [Alinezhad *et al*., 2013; Besbas *et al*., 2020; Chansiw *et al*., 2018]; however, only few studies have described the antihaemolytic potential of the extracts from the fruiting bodies of mushrooms. In an earlier study [Sharif *et al*., 2017], haemolytic inhibitory activity was evaluated in five different extracts (obtained using methanol, ethanol, ethyl acetate, *n*-hexane and water) of *Ganoderma lucidum* against human erythrocytes. The results suggested that two extracts (water and *n*-hexane) showed the antihaemolytic activity but, the other two extracts (ethyl acetate and ethanol) were detected as toxic. The decrease in toxicity of the five extracts was found to be in the order of ethyl acetate>ethanol>methanol>*n*-hexane>water [Sharif *et al*., 2017].

Content of organic acids, phenolic acids and vitamins (ascorbic acid and riboflavin) in mushrooms

The presence of organic and phenolic acids and other metabolites in the mushroom extracts was determined using the HPLC analysis by comparing the retention times (t_R) and the absorption maxima of the separated peaks with these of reference standards (supplementary Table S1). The chromatograms of selected mushroom extract (DIM1) and 11 commercially available reference substances used for the identification of mushroom powder compounds are shown in Figure 1. Few phenolic acids, including 3,4-dihydroxybenzoic acid (t_R: 10.2 min), gallic acid (t_R: 8.5 min), and *trans*-cinnamic acid (t_R: 15.4 min), were identified in most of the tested samples (Table 6). Other non-phenolic acids, including ascorbic acids (t_R: 3.8 min) and lactic acid (t_R: 4.8 min), were also detected abundantly in most of the samples. Few other organic and phenolic acids, like citric acid (t_R: 6.0 min), caffeic acid (t_R: 9.7 min), vanillic acid (t_R: 10.6 min), pyruvic acid (t_R: 14.4 min), and *p*-coumaric acid (t_R: 14.6 min), showed species-specific variation in their presence and contents (Table 6). Riboflavin was detected with moderate to low content (9–65 mg/100 g d.w.) in few species only. The presence of compounds with antioxidant activities has supported the earlier findings of this study. Previous studies also reported some major non-phenolic and phenolic acids, such as ascorbic acids, citric acid, caffeic acid, vanillic acid, gallic acid, and *trans*-cinnamic acid, in edible mushroom

TABLE 3. Macroelement contents (mg/100 g dry weight) of the dried mushroom fruiting bodies.

No.	Species name & sample code	Ca		K		Mg		Na		P	
		Average of samples	Average of species	Average of samples	Average of species	Average of samples	Average of species	Average of samples	Average of species	Average of samples	Average of species
1.	*Agaricus bisporus*		**158.6±10.2**^{ab}		**1882.8±23.8**^{a}		**35.86±0.2**^{a}		**99.3±1.0**^{a}		**247.4±5.3**^{c}
	MLS2	158.6±10.2^{g}		1882.8±23.8^{e}		35.9±0.2^{bcd}		99.3±1.0^{a}		247.4±5.3^{e}	
2.	*Auricularia auricula-judae*		**222.3±9.2**^{a}		**1625.2±17.5**^{a}		**36.43±0.1**^{a}		**97.6±0.1**^{b}		**199.9±7.5**^{d}
	DIM1	222.3±9.2^{cd}		1625.2±17.5^{i}		36.4±0.1^{a}		97.6±0.1^{b}		199.9±7.5^{k}	
3.	*Lentinus sajor-caju*		**232.0±142.1**^{ab}		**1702.1±269.4**^{a}		**34.82±0.7**^{b}		**47.9±8.0**^{de}		**201.3±17.7**^{d}
	APK5	155.8±4.0^{fg}		1853.2±19.7^{e}		35.5±0.0^{e}		49.8±1.3^{l}		177.1±6.6^{n}	
	DH3	83.2±0.9^{jkl}		2008.8±11.7^{d}		34.4±0.1^{ijk}		45.7±0.3^{mn}		211.6±5.8^{ij}	
	DIM3	61.7±0.8^{lm}		2003.4±49.0^{d}		33.9±0.2^{l}		49.3±0.4^{l}		228.9±6.4^{fg}	
	MIS2	348.7±1.9^{b}		1508.8±8.6^{j}		34.4±0.0^{jk}		62.8±0.3^{hi}		188.5±5.6^{lm}	
	MIS7	421.4±0.3^{a}		1461.1±28.1^{k}		34.9±0.1^{fgh}		39.1±0.2^{q}		197.8±6.42^{kl}	
	MP3	321.0±0.3^{b}		1377.5±17.3^{l}		35.8±0.1^{cde}		40.6±0.5^{pq}		203.9±3.2^{jk}	
4.	*Lentinus squarrosulus*		**135.9±93.5**^{a}		**1795.9±262.8**^{a}		**35.8±0.6**^{a}		**68.4±24.1**^{c}		**227.4±31.2**^{c}
	AAU1	157.3±1.7^{fg}		1731.8±21.4^{fgh}		36.7±0.1^{a}		87.6±0.6^{d}		230.2±6.1^{fg}	
	AAU2	60.3±3.7^{lm}		2371.8±12.4^{a}		35.8±0.1^{cde}		73.4±1.8^{e}		198.2±3.45^{kl}	
	AAU3	47.7±1.1^{mn}		2188.7±23.3^{b}		35.5±0.1^{e}		52.2±1.1^{k}		235.3±6.7^{fg}	
	AAU4	114.8±1.3^{hij}		1745.7±38.2^{fg}		35.8±0.1^{cde}		93.9±0.18^{c}		287.7±6.1^{c}	
	AAU5	118.8±7.1^{hi}		1703.7±27.1^{gh}		35.7±0.0^{cde}		56.6±2.2^{j}		265.3±2.4^{d}	
	AAU6	240.3±8.4^{c}		1517.7±8.6^{j}		35.8±0.3^{bcde}		71.7±0.7^{f}		235.6±7.5^{f}	
	AAU7	58.8±2.2^{lm}		1758.2±12.3^{f}		36.0±0.1^{bc}		99.4±1.4^{a}		207.9±4.4^{ijk}	
	DH1	119.3±0.9^{hi}		1599.1±29.2^{i}		35.0±0.1^{fg}		39.7±0.4^{q}		182.7±4.0^{mn}	
	DIM2	94.9±2.8^{ijk}		1756.0±20.8^{f}		34.7±0.1^{hij}		23.1±0.2^{s}		199.2±3.0^{k}	
	KB2	346.8±98.7^{b}		1586.3±24.7^{i}		36.6±0.1^{a}		86.2±1.2^{d}		232.0±4.3^{fg}	
5.	*Lentinus velutinus*		**42.7±1.7**^{c}		**1337.3±17.3**^{b}		**35.6±0.1**^{ab}		**95.9±0.6**^{c}		**318.8±7.6**^{a}
	KM5	42.7±1.7^{mn}		1337.3±17.3^{l}		35.6±0.1^{de}		95.9±0.6^{b}		318.8±7.6^{a}	

TABLE 3. Continued

No.	Species name & sample code	Ca		K		Mg		Na		P	
		Average of samples	Average of species	Average of samples	Average of species	Average of samples	Average of species	Average of samples	Average of species	Average of samples	Average of species
6.	*Lycoperdon scabrum*		**103.5 ± 29.6^{b}**		**1003.0 ± 110.4^{c}**		**34.5 ± 0.5^{bc}**		**47.3 ± 10.8^{ef}**		**232.5 ± 16.4^{c}**
	BP9	135.7 ± 0.18^{gh}		862.6 ± 22.4^{pq}		33.9 ± 0.1^{l}		35.5 ± 0.6^{r}		256.5 ± 6.3^{de}	
	DIM8	116.0 ± 0.1^{hij}		1154.6 ± 43.8^{m}		34.5 ± 0.1^{ijk}		42.6 ± 0.4^{o}		224.6 ± 1.7^{gh}	
	KM7	58.6 ± 0.1^{lm}		990.0 ± 16.1^{n}		35.0 ± 0.1^{fg}		63.6 ± 0.0^{h}		215.9 ± 6.7^{hi}	
	RB6	103.7 ± 2.4^{hij}		1004.9 ± 8.6^{n}		34.5 ± 0.7^{ij}		47.3 ± 0.6^{m}		232.9 ± 3.9^{fg}	
7.	*Panus lecomtei*		**156.1 ± 4.3^{ab}**		**1538.8 ± 17.1^{a}**		**34.2 ± 0.0^{c}**		**35.3 ± 0.2^{f}**		**197.8 ± 5.0^{d}**
	APBN3	156.1 ± 4.3^{fg}		1538.2 ± 17.1^{j}		34.2 ± 0.0^{k}		35.3 ± 0.2^{r}		197.8 ± 5.0^{kl}	
8.	*Pleurotus giganteus*		**22.6 ± 2.3^{d}**		**968.3 ± 51.7^{c}**		**33.3 ± 2.0^{bc}**		**57.2 ± 4.8^{cde}**		**242.2 ± 13.9^{c}**
	KM1	20.7 ± 0.6^{n}		1014.7 ± 11.2^{n}		31.6 ± 0.1^{m}		52.9 ± 0.9^{k}		254.2 ± 4.0^{e}	
	KM2	24.4 ± 1.8^{n}		921.9 ± 10.0^{o}		35.1 ± 0.1^{f}		61.5 ± 0.3^{i}		230.1 ± 5.8^{fg}	
9.	*Pleurotus ostreatus*		**187.2 ± 0.2^{a}**		**2074.0 ± 72.6^{a}**		**34.6 ± 0.0^{bc}**		**58.2 ± 0.4^{cde}**		**285.2 ± 9.2^{b}**
	MP1	187.215 ± 0.2^{ef}		2074.0 ± 72.6^{c}		34.6 ± 0.0^{hij}		58.2 ± 0.4^{j}		285.2 ± 9.2^{c}	
10.	*Pleurotus pulmonarius*		**116.6 ± 54.1^{ab}**		**1774.5 ± 97.7^{a}**		**35.3 ± 0.9^{abc}**		**64.8 ± 24.7^{cde}**		**294.3 ± 12.5^{b}**
	MLS1	67.3 ± 3.1^{klm}		1688.9 ± 23.3^{h}		36.1 ± 0.1^{b}		87.4 ± 0.7^{d}		284.6 ± 9.9^{c}	
	MP2	165.9 ± 0.8^{fg}		1860.2 ± 35.9^{e}		34.6 ± 0.0^{ij}		42.2 ± 0.9^{op}		304.0 ± 3.6^{b}	
11.	*Polyporus arcularius*		**207.6 ± 98.0^{ab}**		**820.2 ± 56.9^{d}**		**34.6 ± 0.2^{bc}**		**66.1 ± 18.6^{cd}**		**227.2 ± 18.9^{c}**
	APBN4	94.5 ± 2.7^{ijk}		882.3 ± 13.5^{op}		34.5 ± 0.0^{ijk}		87.3 ± 1.1^{d}		205.6 ± 4.2^{jk}	
	DH2	320.3 ± 7.4^{b}		755.7 ± 26.6^{r}		34.66 ± 0.06^{hij}		44.7 ± 0.2^{n}		248.2 ± 6.7^{e}	
	MLS6	207.9 ± 9.5^{de}		822.6 ± 2.4^{q}		34.73 ± 0.42^{ghi}		66.4 ± 3.6^{g}		227.8 ± 1.9^{fg}	

All the sample-wise data are represented as average ± standard deviations (SD) of three independent replications, while species-wise data are represented as average ± SD of all the triplicate data belonging to a single species. The different lowercase letters (a, b, c, d, and so on) after each data in columns indicate the significant difference among the samples/species ($p<0.05$).

TABLE 4. Microelement contents (mg/100 g dry weight) of the dried mushroom fruiting bodies.

No.	Species name & sample code	Cu		Fe		Mn		Zn	
		Average of samples	Average of species	Average of samples	Average of species	Average of samples	Average of species	Average of samples	Average of species
1.	*Agaricus bisporus*		**3.46±0.03**^{a}		**24.73±1.15**^{bc}		**3.48±0.02**^{b}		**8.34±0.19**^{a}
	MLS2	3.46±0.03^{a}		24.73±1.15^{kl}		3.48±0.02^{fg}		8.34±0.19^{c}	
2.	*Auricularia auricula-judae*		**1.98±0.03**^{b}		**97.30±4.52**^{a}		**15.15±0.61**^{a}		**7.15±0.39**^{ab}
	DIM1	1.98±0.03^{d}		97.30±4.52^{a}		15.15±0.61^{a}		7.15±0.39^{e}	
3.	*Lentinus sajor-caju*		**1.12±0.56**^{c}		**19.01±7.52**^{c}		**2.54±0.64**^{c}		**4.60±0.51**^{bc}
	APK5	1.57±0.01^{h}		32.36±0.85^{gh}		3.50±0.16^{fg}		5.45±0.07^{fg}	
	DH3	0.32±0.01^{q}		7.67±0.16^{rs}		2.54±0.18^{l}		4.28±0.07^{klm}	
	DIM3	0.53±0.00^{o}		15.55±0.50^{o}		2.79±0.04^{jk}		4.95±0.07^{hi}	
	MIS2	1.69±0.02^{g}		19.49±0.14^{n}		1.58±0.04^{o}		4.01±0.05^{mnop}	
	MIS7	1.00±0.04^{k}		19.85±0.53^{n}		2.81±0.02^{jk}		4.45±0.33^{k}	
	MP3	1.60±0.04^{h}		19.17±0.04^{n}		1.99±0.01^{n}		4.49±0.24^{jk}	
4.	*Lentinus squarrosulus*		**1.33±0.51**^{c}		**35.64±16.98**^{b}		**3.75±0.94**^{b}		**5.47±1.94**^{abc}
	AAU1	1.62±0.03^{h}		57.75±1.55^{c}		4.70±0.04^{c}		8.76±0.17^{b}	
	AAU2	1.09±0.01^{j}		40.77±1.31^{f}		2.58±0.05^{l}		4.99±0.07^{h}	
	AAU3	0.70±0.01^{n}		9.18±0.28^{qr}		5.00±0.04^{b}		3.67±0.12^{q}	
	AAU4	1.33±0.02^{i}		19.87±0.92^{n}		4.51±0.06^{cd}		4.34±0.11^{kl}	
	AAU5	0.72±0.02^{n}		22.74±1.05^{m}		4.40±0.08^{d}		3.96±0.28^{nop}	
	AAU6	1.87±0.04^{f}		49.77±0.18^{d}		2.22±0.01^{m}		5.52±0.17^{fg}	
	AAU7	1.93±0.05^{e}		26.58±0.85^{ij}		2.99±0.04^{ij}		5.54±0.13^{fg}	
	DH1	0.58±0.00^{o}		46.76±0.57^{e}		3.22±0.09^{hi}		4.35±0.11^{kl}	
	DIM2	1.58±0.01^{h}		23.13±0.20^{lm}		4.43±0.03^{d}		4.14±0.09^{lmno}	
	KB2	1. 87±0.04^{f}		59.88±1.34^{b}		3.41±0.05^{gh}		9.38±0.08^{a}	
5.	*Lentinus velutinus*		**0.74±0.02**^{cd}		**7.05±0.40**^{e}		**4.08±0.20**^{b}		**2.31±0.02**^{d}
	KM5	0.74±0.02^{mn}		7.05±0.40^{s}		4.08±0.20^{e}		2.31±0.02^{r}	
6.	*Lycoperdon scabrum*		**0.88±0.07**^{c}		**11.26±0.66**^{d}		**0.72±0.04**^{d}		**4.35±0.38**^{c}
	BP9	0.97±0.02^{k}		10.97±0.40^{p}		0.76±0.02^{qr}		4.22±0.09^{klmn}	
	DIM8	0.88±0.02^{l}		12.13±0.59^{p}		0.75±0.01^{qr}		3.90±0.08^{opq}	
	KM7	0.78±0.03^{m}		10.65±0.12^{pq}		0.67±0.03^{rs}		4.91±0.09^{hi}	
	RB6	0.88±0.02^{l}		11.28±0.07^{p}		0.72±0.01^{qr}		4.35±0.01^{kl}	
7.	*Panus lecomtei*		**0.25±0.02**^{d}		**7.12±0.30**^{e}		**0.75±0.02**^{d}		**5.35±0.06**^{abc}
	APBN3	0.25±0.02^{r}		7.12±0.30^{s}		0.75±0.02^{qr}		5.35±0.06^{g}	
8.	*Pleurotus giganteus*		**0.86±0.48**^{cd}		**5.95±2.84**^{e}		**0.92±0.70**^{d}		**2.54±1.64**^{d}
	KM1	0.42±0.02^{p}		3.37±0.21^{t}		0.29±0.06^{t}		1.04±0.06^{s}	
	KM2	1.30±0.03^{i}		8.53±0.39^{rs}		1.55±0.06^{op}		4.03±0.12^{mnop}	
9.	*Pleurotus ostreatus*		**0.78±0.03**^{cd}		**33.12±0.09**^{b}		**0.47±0.04**^{d}		**3.82±0.03**^{d}
	MP1	0.78±0.03^{m}		33.12±0.09^{g}		0.47±0.04st		3.82±0.03^{pq}	
10.	*Pleurotus pulmonarius*		**1.43±0.64**^{bc}		**30.82±0.66**^{b}		**3.31±0.48**^{b}		**6.25±1.67**^{abc}
	MLS1	2.02±0.02^{d}		30.65±0.96^{h}		3.69±0.38^{f}		7.77±0.12^{d}	
	MP2	0.85±0.01^{l}		30.99±0.27^{h}		2.94±0.04^{j}		4.72±0.01^{ij}	
11.	*Polyporus arcularius*		**2.10±0.45**^{b}		**25.68±2.31**^{b}		**0.96±0.32**^{d}		**5.65±1.32**^{abc}
	APBN4	1.58±0.01^{h}		23.03±0.22^{lm}		1.33±0.03^{p}		4.13±0.09^{lmno}	
	DH2	2.61±0.02^{b}		28.25±0.16^{i}		0.59±0.03^{rs}		7.15±0.07^{e}	
	MLS6	2.10±0.11^{c}		25.74±0.87^{jk}		0.97±0.06^{q}		5.66±0.28^{f}	

All the sample-wise data are represented as average ± standard deviations (SD) of three independent replications, while species-wise data are represented as average ± SD of all the triplicate data belonging to a single species. The different lowercase letters (a, b, c, d, and so on) after each data in columns indicate the significant difference among the samples/species ($p<0.05$).

TABLE 5. Total phenolic content, DPPH radical scavenging activity and antihaemolytic activity of the mushroom samples.

No.	Species name & sample code	Total phenolic content (mg GAE/100 g dry weight)		DPPH radical scavenging activity				Antihaemolytic activity; IC_{50} (μg/mL of extract)	
				IC50 (μg/mL of extract)		TEAA (mg/100 g dry weight)			
		Average of samples	Average of species	Average of samples	Average of species	Average of samples	Average of species	Average of samples	Average of species
1.	*Agaricus bisporus*		**299.2±21.0**^{c}		**979.3±51.9**^{a}		**120.2±6.5**^{de}		**462.9±2.6**^{cd}
	MLS2	299.2±21.0^{pq}		979.3±51.9^{a}		120.2±6.5^{op}		462.9±2.6^{j}	
2.	*Auricularia auricula-judae*		**172.5±3.6**^{d}		**828.7±39.8**^{b}		**93.9±4.6**^{e}		Not determined
	DIM1	172.5±3.6^{rs}		828.7±39.8^{c}		93.9±4.6^{q}		Not determined	
3.	*Lentinus sajor-caju*		**831.3±156.9**^{a}		**330.6±52.4**^{f}		**345.9±38.0**^{a}		**340.9±58.5**^{d}
	APK5	622.5±60.7^{gh}		277.5±3.3^{m}		396.1±4.7^{a}		283.8±36.1^{lmn}	
	DH3	677.1±45.8^{fg}		322.0±7.6^{ijkl}		341.4±8.1^{c}		299.3±20.9^{m}	
	DIM3	923.7±67.7^{b}		434.8±8.6^{h}		296.4±5.9^{gh}		316.8±24.1^{lm}	
	MIS2	836.1±26.4^{cd}		292.0±11.7^{lm}		389.7±15.8^{a}		342.2±22.6^{l}	
	MIS7	876.6±82.4^{bc}		333.8±10.9^{ijk}		318.0±10.4^{e}		438.9±28.1^{jk}	
	MP3	1051.5±41.4^{a}		323.7±3.1^{ijk}		333.6±3.2^{cd}		364.1±43.3^{kl}	
4.	*Lentinus squarrosulus*		**418.6±158.6**^{c}		**361.8±73.9**^{def}		**328.5±46.7**^{a}		**481.1±142.3**^{c}
	AAU1	254.8±7.3^{qr}		249.6±4.5^{n}		394.9±7.1^{a}		325.0±59.0 ^{klm}	
	AAU2	175.4±49.8^{rs}		339.0±15.3^{ij}		324.6±15.0^{de}		409.4±5.5^{k}	
	AAU3	247.7±30.3^{qr}		352.7±6.6^{i}		317.1±5.9^{e}		281.8±1.2^{n}	
	AAU4	561.6±45.6^{hi}		466.4±35.2^{g}		269.1±20.2^{jk}		671.2±1.9^{cd}	
	AAU5	297.4±6.3^{pq}		431.5±14.0^{h}		294.4±9.4^{gh}		663.2±5.00^{cd}	
	AAU6	398.7±30.9^{lmno}		317.8±15.2^{jkl}		394.0±19.0^{a}		589.15±4.9^{e}	
	AAU7	520.8±17.5^{ijk}		328.8±9.4^{ijk}		357.4±10.3^{b}		557.7±3.9^{g}	
	DH1	568.0±14.5^{hi}		339.7±8.7^{ij}		312.5±7.9^{ef}		457.3±7.2^{j}	
	DIM2	612.5±15.0^{gh}		486.7±8.7^{g}		260.9±4.6^{k}		552.8±2.4^{g}	
	KB2	549.4±15.8^{hij}		305.5±4.8^{klm}		359.7±5.6^{b}		303.9±1.2^{m}	
5.	*Lentinus velutinus*		**248.0±31.6**^{c}		**833.1±12.9**^{b}		**120.5±1.9**^{de}		**579.3±1.3**^{bc}
	KM5	248.0±31.6^{qr}		833.1±12.9^{c}		120.5±1.9^{op}		579.3±1.3^{f}	
6.	*Lentinus scabrum*		**396.6±57.5**^{c}		**711.4±32.3**^{c}		**141.5±14.9**^{c}		**630.7±64.9**^{b}
	BP9	382.5±12.3^{mnop}		731.4±17.0^{d}		139.3±3.2^{n}		727.2±17.3^{c}	
	DIM8	321.1±2.9^{opq}		677.8±8.3^{e}		164.9±2.0^{m}		639.7±15.0^{d}	
	KM7	411.2±13.9^{lmn}		688.7±14.2^{e}		129.3±2.7^{nop}		579.3±1.3^{f}	
	RB6	471.4±16.2^{jkl}		747.7±10.7^{d}		131.8±1. 9no		576.7±13.7^{f}	
7.	*Panus lecomtei*		**780.9±14.6**^{ab}		**417.6±6.0**^{def}		**276.8±4.0**^{b}		**550.9±2.2**^{c}
	APBN3	780.9±14.6^{de}		417.6±6.0^{h}		276.8±4.0^{ij}		550.9±2.2^{g}	
8.	*Pleurotus giganteus*		**330.6±18.7**^{c}		**444.1±109.2**^{de}		**266.3±39.9**^{b}		**1037.5±114.1**^{a}
	KM1	330.2±18.8^{nopq}		344.6±6.0^{ij}		302.5±5.24^{fg}		937.7±10.3^{b}	
	KM2	331.0±22.8^{nopq}		543.6±7.0^{f}		230.1±3.0^{l}		1137.2±50.8^{a}	
9.	*Pleurotus ostreatus*		**461.3±38.0**^{bc}		**426.9±13.5**^{d}		**284.3±9.2**^{ab}		**350.4±7.6**^{cd}
	MP1	461.3±38.0^{klm}		426.9±13.5^{h}		284.3±9.2^{hi}		350.4±7.6^{l}	
10.	*Pleurotus pulmonarius*		**662.1±139.6**^{ab}		**332.4±10.0**^{ef}		**342.4±21.3**^{a}		**357.5±154.6**^{cd}
	MLS1	608.9±199.4^{gh}		339.0±6.2^{ij}		324.2±5.9^{de}		498.4±1.6^{h}	
	MP2	715.3±22.6^{ef}		325.8±9.0^{ijk}		360.7±10.01		216.6±13.8^{o}	
11.	*Polyporus arcularius*		**109.1±46.9**^{e}		**914.6±17.7**^{a}		**124.4±7.3**^{d}		**487.7±7.3**^{c}
	APBN4	156.7±5.9^{s}		921.8±13.6^{b}		115.1±1.7^{p}		485.9±1.5^{i}	
	DH2	59.2±27.7^{t}		917.6±18.6^{b}		130.1±2.6^{nop}		496.9±0.8^{h}	
	MLS6	111.4±29.4st		904.5±21.8^{b}		127.8±3.1^{nop}		480.4±1.5^{i}	
12.	Reference standard (Tocopherol)			18.9±2.3^{o}				286.5±2.1^{n}	

All the sample-wise data are represented as average ± standard deviations (SD) of three independent replications, while species-wise data are represented as average ± SD of all the triplicate data belonging to a single species. The different lowercase letters (a, b, c, d, and so on) after each data in columns indicate the significant difference among the samples/species ($p<0.05$). GAE: gallic acid equivalents; TEAA: tocopherol equivalent antioxidant activity.

TABLE 6. Contents of the organic acids, phenolic acids riboflavin and ascorbic acid in dried mushroom fruiting bodies (mg/100 g d.w.) determined using HPLC.

Sample ID	Ascorbic acid (t_R=3.8 min)	Lactic acid (t_R=4.8 min)	Citric acid (t_R=6.0 min)	Gallic acid (t_R=8.5 min)	Caffeic acid (t_R=9.7 min)	3,4-Dihydroxybenzoic acid (t_R=10.2 min)	Riboflavin (t_R=10.6 min)	Vanillic acid (t_R=10.8 min)	Pyruvic acid (t_R=14.4 min)	*p*-Coumaric acid (t_R=14.6 min)	*trans*-Cinnamic acid (t_R=15.4 min)
MLS2	114.2 ± 5.6^{g}	109.5 ± 9.2^{i}	116.5 ± 14.2^{d}	13.6 ± 0.3^{g}	ND	19.6 ± 1.9^{m}	9.2 ± 2.7^{e}	26.7 ± 2.6^{a}	2.4 ± 1.0^{g}	ND	30.4 ± 1.3^{e}
DIM1	63.5 ± 4.2^{ij}	52.4 ± 5.0^{k}	ND	2.3 ± 0.0^{k}	2.7 ± 0.9^{g}	36.6 ± 0.3^{k}	42.7 ± 3.1^{b}	13.2 ± 3.7^{bc}	2.3 ± 0.7^{g}	1.1 ± 0.3^{e}	14.5 ± 4.1^{hij}
APK5	31.2 ± 0.8^{l}	140.5 ± 2.9^{gh}	73.7 ± 7.4^{e}	2.6 ± 0.7^{k}	8.0 ± 0.3^{d}	14.5 ± 0.7^{n}	ND	4.2 ± 4.2^{def}	ND	1.4 ± 0.0^{e}	9.2 ± 1.0^{j}
DIM3	79.2 ± 1.3^{hi}	120.9 ± 11.2^{h}	18.6 ± 2.0^{h}	104.3 ± 7.6^{cd}	ND	61.1 ± 1.3^{i}	65.1 ± 7.6^{a}	4.9 ± 2.3^{ef}	21.7 ± 1.0^{e}	2.1 ± 0.1^{d}	13.4 ± 1.5^{hi}
DH3	55.2 ± 2.1^{j}	192.7 ± 8.9^{f}	ND	6.9 ± 0.7^{i}	ND	9.3 ± 0.1^{o}	ND	ND	2.3 ± 0.3^{g}	ND	11.3 ± 1.3^{ij}
MIS2	18.3 ± 2.7^{mn}	74.4 ± 7.2^{j}	ND	10.4 ± 1.5^{h}	4.4 ± 0.0^{f}	17.1 ± 0.9^{m}	ND	ND	ND	ND	14.5 ± 2.1^{hi}
MIS7	86.5 ± 6.7^{h}	150.3 ± 12.1^{g}	25.1 ± 3.9^{f}	ND	6.0 ± 0.7^{e}	11.0 ± 1.2^{no}	ND	ND	ND	ND	12.3 ± 0.7^{i}
MP3	77.3 ± 4.3^{hi}	89.9 ± 9.8^{ij}	ND	7.0 ± 0.9^{i}	ND	21.4 ± 2.1^{lm}	11.5 ± 1.3^{e}	ND	10.8 ± 1.0^{f}	ND	39.0 ± 1.6^{c}
AAU1	36.8 ± 2.1^{k}	68.7 ± 10.1^{j}	3.7 ± 1.9^{j}	2.3 ± 0.3^{k}	ND	30.4 ± 2.7^{kl}	ND	ND	ND	ND	12.3 ± 0.7^{i}
AAU2	170.6 ± 2.3^{e}	150.9 ± 2.1^{g}	ND	2.3 ± 0.3^{k}	ND	25.2 ± 2.9^{l}	ND	ND	ND	ND	10.2 ± 0.3
AAU3	398.1 ± 31.2^{a}	643.2 ± 4.7^{a}	ND	99.91^{d}	ND	282.3 ± 2.3^{c}	ND	ND	ND	ND	19.8 ± 1.2^{g}
AAU4	$85.4\pm8.4hi^{hi}$	145.1 ± 12.5^{g}	3.00 ± 0.7^{j}	17.6 ± 3.1^{fg}	ND	51.4 ± 2.6^{j}	ND	ND	ND	ND	11.5 ± 2.1^{i}
AAU5	125.2 ± 3.8^{f}	148.6 ± 23.8^{fg}	ND	18.5 ± 2.6^{fg}	ND	36.6 ± 6.3^{k}	ND	ND	1.5 ± 0.7^{gh}	ND	11.7 ± 0.3^{i}
AAU6	347.9 ± 3.9^{b}	469.8 ± 28.5^{c}	ND	14.5 ± 0.5^{g}	ND	73.6 ± 4.6^{h}	ND	ND	ND	ND	12.1 ± 0.7^{i}
AAU7	6.9 ± 4.1^{op}	62.04 ± 8.7^{jk}	8.6 ± 1.3^{i}	4.7 ± 2.3^{jk}	ND	17.7 ± 0.6^{m}	ND	ND	ND	ND	11.8 ± 0.3
DH1	19.8 ± 0.9^{m}	32.8 ± 8.2^{l}	20.18 ± 1.8^{gh}	5.2 ± 0.5^{j}	ND	20.1 ± 0.3^{lm}	ND	ND	ND	ND	35.8 ± 1.8^{cd}
DIM2	167.6 ± 10.5^{e}	174.8 ± 7.3^{f}	45.6 ± 7.2^{f}	9.6 ± 0.7^{h}	ND	61.1 ± 4.5^{i}	29.1 ± 1.7^{c}	9.4 ± 0.7^{d}	2.0 ± 0.3^{gh}	ND	15.1 ± 0.7^{h}
KB2	9.12 ± 3.7^{o}	95.3 ± 11.8^{i}	ND	9.8 ± 0.5^{h}	ND	34.0 ± 1.7^{k}	ND	ND	ND	ND	14.3 ± 0.3^{h}
KM5	17.42 ± 2.8^{mn}	38.5 ± 13.8^{l}	ND	13.6 ± 0.3^{g}	2.8 ± 0.3^{g}	1.5 ± 0.8^{p}	12.5 ± 2.3^{de}	ND	ND	ND	14.5 ± 1.3^{h}
BP9	165.81 ± 3.7^{e}	269.4 ± 14.6^{e}	141.0 ± 3.1^{c}	66.7 ± 1.3^{e}	25.6 ± 2.7^{c}	351.5 ± 10.3^{a}	ND	7.9 ± 1.6^{d}	31.6 ± 3.5^{d}	1.4 ± 0.0^{e}	41.1 ± 2.3^{c}
DIM8	36.77 ± 4.3^{k}	123.9 ± 12.1	18.7 ± 3.3^{h}	15.4 ± 1.0^{g}	25.6 ± 0.3^{c}	140.6 ± 6.1^{f}	ND	3.8 ± 0.7^{f}	80.8 ± 2.7^{a}	50.8 ± 2.1^{b}	77.3 ± 1.4^{a}
KM7	55.2 ± 2.1^{j}	155.2 ± 8.2^{fg}	18.7 ± 4.1^{h}	18.0 ± 5.7^{fg}	25.9 ± 1.6^{c}	164.8 ± 5.9^{e}	ND	3.8 ± 1.0^{f}	80.8 ± 4.6^{a}	53.8 ± 4.6^{b}	66.7 ± 3.2^{b}
RB6	92.1 ± 4.7^{h}	202.2 ± 11.4^{f}	141.0 ± 12.1^{c}	24.2 ± 3.0^{f}	25.6 ± 0.7^{c}	199.4 ± 13.6^{d}	ND	3.8 ± 1.3^{f}	36.51 ± 2.0^{c}	39.2 ± 0.7^{c}	20.7 ± 1.7^{g}
APBN3	81.0 ± 10.5^{hi}	184.6 ± 16.1^{f}	165.5 ± 10.0^{b}	26.9 ± 0.8^{f}	25.6 ± 0.0^{c}	178.6 ± 4.8^{d}	ND	3.8 ± 1.3^{f}	41.43 ± 2.7^{c}	45.1 ± 3.9^{b}	30.4 ± 1.3^{e}
KM1	20.18 ± 4.1^{m}	166.6 ± 14.2^{fg}	ND	64.5 ± 0.6^{e}	12.5 ± 2.8^{d}	49.0 ± 1.9^{j}	16.3 ± 0.7^{d}	1.9 ± 0.3^{g}	1.0 ± 0.3^{hi}	ND	14.5 ± 1.6^{h}
KM2	283.78 ± 21.3^{c}	178.1 ± 7.8^{f}	ND	164.1 ± 2.7^{b}	38.7 ± 1.3^{b}	175.2 ± 3.5^{d}	38.9 ± 4.5^{b}	12.1 ± 0.0^{c}	2.0 ± 0.3^{g}	ND	15.6 ± 1.7^{h}
MP1	352.0 ± 5.8^{b}	463.6 ± 12.4^{c}	190.0 ± 8.6^{a}	197.3 ± 3.5^{a}	48.5 ± 1.3^{a}	322.1 ± 4.9^{b}	ND	16.3 ± 1.4^{b}	64.83^{b}	71.2 ± 3.1^{a}	68.8 ± 2.1^{b}
MLS1	407.3 ± 9.2^{a}	537.1 ± 21.6^{b}	ND	119.8 ± 10.7^{c}	ND	88.7 ± 2.1^{h}	71.5 ± 3.1^{a}	16.3 ± 0.7^{b}	3.3 ± 1.0^{g}	ND	26.1 ± 0.3^{f}
MP2	213.7 ± 8.5^{d}	351.0 ± 18.4^{d}	92.1 ± 4.8^{e}	146.3 ± 13.6^{bc}	ND	109.5 ± 2.8^{g}	ND	7.9 ± 1.3^{d}	2.0 ± 0.2^{g}	ND	32.6 ± 3.2^{de}
APBN4	13.73 ± 3.1^{no}	39.6 ± 5.6^{l}	ND	2.4 ± 0.5^{k}	ND	11.8 ± 1.4^{no}	ND	ND	1.8 ± 0.0^{h}	1.4 ± 0.6^{e}	35.8 ± 3.8^{cd}
DH2	52.44 ± 5.7^{j}	59.76 ± 5.7^{jk}	86.0 ± 7.1^{e}	11.4 ± 2.5^{gh}	2.8 ± 0.3^{g}	67.1 ± 6.9^{i}	70.3 ± 2.3^{a}	ND	1.3 ± 0.4^{h}	1.1 ± 0.3^{e}	32.6 ± 1.3^{de}
MLS6	11.75 ± 3.4^{o}	91.58 ± 2.1^{i}	3.0 ± 0.7^{j}	2.6 ± 3.8^{k}	2.6 ± 0.0^{g}	9.3 ± 2.3^{no}	11.3 ± 1.9^{e}	ND	1.3 ± 0.3^{h}	1.1 ± 0.0^{e}	12.3 ± 0.7^{ij}

All the sample-wise data are represented as average ± standard deviations (SD) of three independent replications. The different lowercase letters (a, b, c, d, and so on) after each data in columns indicate the significant difference among the samples/species (p<0.05). ND: not detected; t_R: retention time.

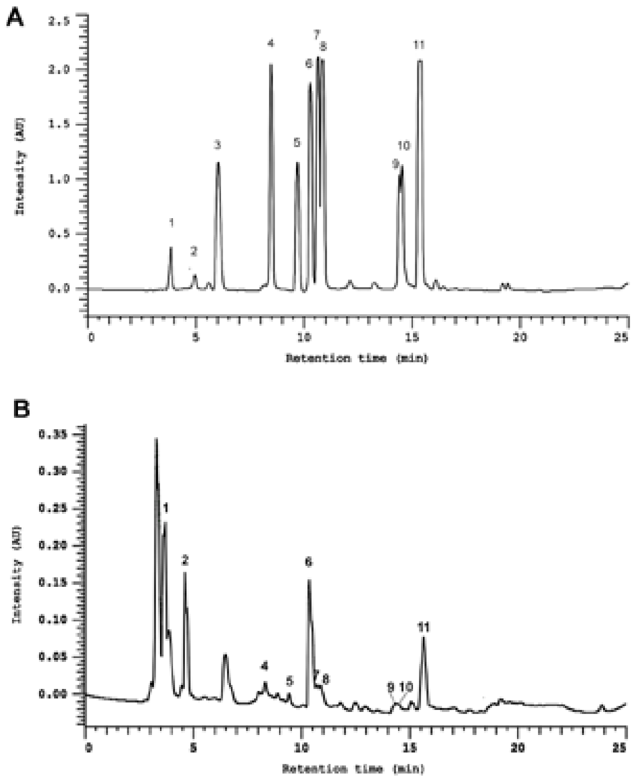

FIGURE 1. High performance liquid chromatography (HPLC) separation of the reference standards (A) and mushroom extract of DIM1 sample (B). Peaks for different compounds are designated with numbers: 1. ascorbic acid, 2. lactic acid, 3. citric acid, 4. gallic acid, 5. caffeic acid, 6. 3,4-dihydroxybenzoic acid, 7. riboflavin, 8. vanillic acid, 9. pyruvic acid, 10. *p*-coumaric acid, and 11. *trans*-cinnamic acid.

samples [Gąsecka *et al*., 2018; Valentão *et al*., 2005; Yahia *et al*., 2017]. It is noteworthy that apart from the selected peaks, there were other peaks in the HPLC chromatograms which were not identified using standards. Therefore, we do not deny the presence of other compounds in the mushroom extracts as they were not targeted for evaluation in this study. It was previously reported that the organic acid profile varied among different wild growing species of *Agaricus*, where lactic acid and succinic acid were found most abundantly in the tested mushrooms [Gąsecka *et al*., 2018]. In the present study, similar findings were recorded with heterogeneous distribution of organic acids among different mushroom species with intra-specific variations in the relative abundance of few organic acids. The presence of important phenolic acids in the fruiting bodies of edible mushrooms make them functional foods as they can protect human body from different diseases due to their strong antioxidant properties [Ribeiro *et al*., 2015; Valentão *et al*., 2005].

CONCLUSIONS

Based on the findings of our study, the dried edible mushrooms, especially *L. sajor-caju* and *L. squarrosulus* had a high nutritive value and a potent antioxidant activity. The samples of other mushroom species including, *P. ostreatus*, *P. pulmonarius*, *A. bisporus* and *A. auricle-judae*, also featured considerable nutritional and antioxidant properties. The high nutritional value of these wild edible mushrooms may enlighten their scope for domestication and cultivation, thereby contributing towards the complementation of food security and nutritional demands among the indigenous communities of Northeast India, especially, the people preferring the vegetarian diet. Moreover, mushroom extracts could be an emerging source of natural antioxidants, like phenolic acids (3,4-dihydroxybenzoic and *trans*-cinnamic acids) and ascorbic acid. Our study has demonstrated the antihaemolytic activity of several wild edible mushrooms from Northeast India, which contained several important organic acids and mentioned antioxidant metabolites. Consumption of such wild edible mushrooms with radical scavenging activity and antihaemolytic potential might be beneficial to combat oxidative damages in the human body.

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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SUPPLEMENTARY MATERIALS

The following are available online at http://journal.pan.olsztyn.pl/Nutritional-Properties-Antioxidant-and-Antihaemolytic-Activities-of-the-Dry-Fruiting,144044,0,2.html

Supplementary Table S1: Retention times and absorption maxima of the 11 standards used for the identification of the compounds in the mushrooms.

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