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Nutritional and nutraceutical characterization of three wild edible mushrooms from Haryana, India

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Abstract

Mushrooms are included in the category of functional foods due to their culinary and pharmaceutical properties. In the present investigation, three wild edible mushrooms including *Calocybe gambosa* (Fr.) Donk (PUN 3538), *Lentinus squarrosulus* Mont. (PUN 3539), and *Podaxis pistillaris* (L.) Fr. (PUN 7151) collected from Haryana (India) were analyzed for their proximate composition and bioactive compounds. Among these, *L. squarrosulus* was found having highest dietary fiber (38.38±1.96g/100g) and ash content (11.4±0.55g/100g) on dry weight basis in comparison to the other two species evaluated. *C. gambosa* revealed the presence of maximum protein content (20.22±0.07/100g dw). Out of the evaluated species, *P. pistillaris* was evaluated for the presence of maximum levels of fat content (1.97±0.16 /100g dw), total carbohydrates (77.79±0.39g/100g dw) and energy value (387.05±0.28 kCal/100g dw). Amongst the nutraceutical components, *C. gambosa* has been evaluated to possess maximum quantity of phenols (1.53±0.06mg/g dw), flavonoids (1.27±0.04 mg/g dw) and alkaloids (1.85±0.07 mg/100g dw). Other Nutraceutical components including steroids (1.82±0.03mg/100g dw), β-carotene (4.68±0.02µg/g dw) and lycopene (1.23±0.01µg/g dw) were present in maximum proportion in *L. squarrosulus* while *P. pistillaris* contained least quantity of all these bioactive compounds amongst the three-evaluated species.

Key words – Anti-oxidant- FAO/WHO - Health- Monsoon - Sporocarps

Introduction

The edible wild mushrooms growing in their natural habitats are traditionally appreciated for their health promoting attributes (Crisan & Sands 1978). They are recognized as prized source of nutrients with highly desirable flavor and aroma (Wang et al. 2014, Kalac 2016) essentially because of being quiet rich in digestible proteins with significant amount of essential amino acids, carbohydrates, dietary fibers, vitamins and minerals (FAO 1991, Manzi et al. 1999, Yin & Zhou 2008, Heleno et al 2009, Uzun et al. 2009, Liu et al. 2012, Atri et al. 2013, Kumari et al. 2014, Vishwakarma et al. 2017). The high-energy value with low fat content are their natural endowments. Apart from various vitamins and organic nutrients, mushrooms are also considered to be rich in many mineral constituents (Sarikurkcu et al. 2015, Brzezicha-Cirocka et al. 2016). In the contemporary terminology, mushrooms are also called as therapeutic foods or nutraceuticals due to their pharmacological properties (Lindequist et al. 2005, Barros et al. 2007, 2008, Ferreira et al. 2009, Periera et al. 2012, Vaz et al. 2011, Saini and Atri 1999). There are reports demonstrating their anti-tumor (Ferreira et al 2010), anti-viral, anti-diabetic, anti-microbial (Alves et al. 2012), hypocholestrolemic, anti-inflammatory (Jose et al. 2002), immunomodulating (Wasser 2002) and

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antioxidant activities (Puttaraju et al. 2006, Ferreira et al 2009, Dulay et al. 2016). These activities are due to the presence of secondary metabolites like phenols, flavonoids, alkaloids, carotenes, lycopenes and other bioactive compounds in these mushrooms.

Various wild and cultivated species of *Agaricus*, *Pleurotus*, *Lentinus*, *Lentinula*, *Volvariella* and *Calocybe* (Purkayastha & Chandra 1985, Chang & Miles 2004, Agahar-Murugkar & Subbulakshmi 2005, Mallavadhani et al. 2006, Reis et al. 2012, Sharma & Atri 2014) are some of the choice mushrooms for culinary purposes around the globe. In Haryana, cultivated *Agaricus bisporus* is most commonly consumed, while comparatively more range of wild ones are picked up by the local inhabitants of the area. *Calocybe gambosa*, *Podaxis pistillaris*, *Coprinus comatus* various species of *Termitomyces*, *Pleurotus* and *Lentinus* are a few of them. Haryana is a North- Indian state with diverse topography, hot in summers and mild cold in winters, witnessing a good average rainfall in monsoon season during the months from July to September. Its geography and climate makes it a suitable home for growth of wide range of fungi in general and mushrooms in particular.

Herein, nutritional and nutraceutical analysis of three wild edible mushroom species collected from Haryana (India), namely, *Calocybe gambosa* (Fr.) Donk, *Lentinus squarrosulus* Mont., *Podaxis pistillaris* (L.) Fr. has been presented. Though *L. squarrosulus* is an edible species according to the literature (Nawanze et al. 2006, Giri et al. 2013) but it is less preferred in the Haryana comparatively as per the information gathered by interacting with local people of the area (Mridu & Atri 2015). Some earlier investigators have reported the chemical composition of *C. gambosa* and *L. squarrosulus* from other countries and other parts of India (Barros et al 2008, Vaz et al. 2011, Reis et al. 2012, Giri et al 2013, Vishwakarma et al. 2016). But very scarce and fragmentary information is available in this regard for *P. pistillaris* (Jandaik & Kapoor 1976, Gupta and Singh 1991). Besides this, all of the three wild species were collected and evaluated for the first time from Haryana (India) for their nutritional and nutraceutical aspects which is presented in the manuscript.

Materials & Methods

Mushroom Samples

The fresh mushroom sporocarps of *Calocybe gambosa, Lentinus squarrosulus*, and *Podaxis pistillaris* were collected from different localities of Haryana during monsoon season of years 2013−2016. *C. gambosa* was found growing under *Dalbergia sissoo* Roxb. ex DC. along the sides of a heavy traffic road, *L. squarrosulus* was collected from a stump of *Azadirachta indica* A. Juss. growing in caespitose clusters in clean air surroundings of a village while *P. pistillaris* was scattered on sandy soil near a brick kiln. These sporocarps were air dried and preserved in cellophane paper packets with a small amount of 1, 4-dichlorobenzene to prevent any pathogenic infection. All the samples were identified up to species level by studying their macromorphological and microscopic details (Pegler 1986, Puttarajau et al. 2006, Sharma et al. 2013). The identified air dried samples were depositied in The Herbarium, Depatment of Botany, Punjabi University, Patiala (Punjab) India under PUN. Accession number of each specimen was obtained as for *C. gambosa*- (PUN 7151, August 18, 2014), *L. squarrosulus*- (PUN 3539, September 21, 2014), and *P. pistillaris*- (PUN 7151, August 18, 2014). The desired number of dried samples was finely grounded to make powder for the biochemical analysis.

Chemicals and Reagents

Folin-ciocalteu's phenol reagent, gallic acid, aluminium chloride, sodium hydroxide, 1,4-dichlorobenzene, chloroform, ethyl acetate, acetic anhydride, sulphuric acid, acetone, petroleum ether and methanol were purchased from Loba Chemie Pvt.Ltd. India. Sodium carbonate, quercitin and diosgenin were supplied by HiMedia Laboratories Pvt. Ltd. India.

Sample preparation

Methanolic extracts of the three mushroom samples were prepared using 0.2g of dried mushroom powder dissolved in 5ml methanol. The solution was kept at 25°C and 150 rpm in an incubator shaker followed by filtration through whatmann No. 4 paper. The residue obtained was again extracted using two additional 5ml portions of methanol. The combined methanolic extract was evaporated at 40°C to dryness and finally redissolved in methanol at a concentration of 50mg/ml and subsequently stored at 4°C for further use.

Methodology for determination of dry matter, proximate composition and energy value

Dry matter of three mushrooms samples was estimated by subtracting the water content from the fresh weight of the sporocarps. The proximate composition was analyzed following AOAC (1995) protocols. The crude protein (N× 4.38) content was determined by Macro-kjeldahl method. Crude fat was estimated by extracting a known weight of sample with petroleum ether; crude fiber content was determined by acid-alkali digestion method given by Maynard (1970). The ash content was determined by incinerating the known weight of sample at 525°C for 4 hours. The moisture content was determined by re-heating of the dried sample at 105°C overnight until constant weight was obtained. Total carbohydrates and energy value was determined by applying the following relations:

Total carbohydrates (g) = 100(g crude protein + g crude fat + g ash)

Total energy (Kcal/100g) = 4(g crude protein + g total carbohydrate) + 9(g crude fat)

Phenols

For the quantification of phenolic compounds, the procedure given by Singleton & Rossi (1965) was followed with some modifications. For this purpose, 1ml of methanolic extract was mixed with 1ml of Folin-Ciocalteu's phenol reagent (ten times diluted with distilled water) followed by addition of 1 ml of saturated sodium carbonate solution to it and further the volume was adjusted to 10ml with distilled water. The reaction mixture was kept in the dark for 90 minutes. After that the absorbance was recorded at 725nm in Labtronics (Model LT-2900) advance double beam UV-Vis spectrophotometer. Gallic acid was used to prepare the standard curve (0.01-0.1 mg/ml). Results were expressed as mg of gallic acid equivalents (GAE) per g of the extract.

Flavonoids

For the estimation of flavonoid content, method given by Yoo et al. (2008) was followed. For this purpose, 1ml of the methanolic extract of mushroom sample was used. To the sample solution, 4ml of distilled water was added to the sample solution followed by the addition of 0.3ml of 5% Sodium nitrate solution. The reaction mixture was then allowed to stand for 5 min after which mixture was treated with 0.3ml of 10% aluminium chloride followed by 2ml of 1 M sodium hydroxide solution. The final volume was raised to 10ml by adding distilled water. Absorbance was read at 510nm against blank. Quercitin was used to prepare calibration curve (0.01-0.1 mg/ml) and flavonoid content was expressed as mg of quercitin equivalents per g dry weight of powdered mushroom samples analysed.

Steroids

For the estimation of steroid content, method described by Okeke & Elekwa (2003) was followed with some modifications. For preparing the extract, 0.1g of powdered sample was weighed accurately and the weighed powder was mixed with 10ml of ethyl acetate. Before the solution was filtered, it was allowed to stand for 2 hrs with occasional shaking. 1ml of the reaction mixture was mixed with 1ml of chloroform. The mixture so obtained was then treated with 1.5ml ice cold acetic anhydride and followed by addition of 2 drops of concentrated sulphuric acid. Absorbance was read at 420nm. The calibration curve (0.01-0.1 mg/ml) was prepared by using diosgenin as standard and steroid content was expressed as mg of diosgenin equivalents per g of dry weight of the mushroom sample.

Alkaloids

For the alkaloid estimation, procedure given by Maxwell et al. (1995) was followed. 5g of

each powdered dried sample was taken to which 100ml of 10% acetic acid was added and left to stand for 4hours. The extracts obtained were filtered and then concentrated to 1/4th of the original volume. To this, 1% ammonium solution was added drop wise until the formation of precipitates. The alkaloids obtained were dried in an oven at 65°C to a constant weight. The percentage of alkaloids was calculated by using following formula:

$$\text{Alkaloids (\%)} = \frac{\text{Weight of residue}}{\text{Weight of sample}} \times 100$$

β- Carotene and Lycopene

100mg of dried methanolic extract was shaken vigorously with 10ml of acetone-hexane mixture (4:6) for 1 min and filtered using whatmann filter paper no.4. The absorbance of the filtrate was read at 453nm, 505nm and 663nm. β- Carotene and Lycopene content was calculated by applying following equations:

$$\beta\text{ - Carotene (mg/100ml)} = 0.216 \times A_{663} - 0.304 \times A_{505} + 0.452 \times A_{453}$$
$$\text{Lycopene (mg/100ml)} = -0.0458 \times A_{663} + 0.372 \times A_{505} - 0.0806 \times A_{453}$$

The results were expressed as μg of carotenoid per g of extract.

Statistical Analysis

The assays of all samples were carried out in triplicate. The results were expressed as mean values and standard deviation (SD). The results were analyzed using one-way analysis of variance (ANOVA) followed by Tukey's HSD Test with α=0.05. This analysis was carried out using SPSS v.16.0 software.

Results

Dry matter, proximate composition and energy value

The results of the chemical composition obtained from the study are shown in Table 1. The total carbohydrates being a major component of proximate composition has been evaluated to range between 65.61±0.73g/100g dw in *C. gambosa* and 77.79±0.39g/100g dw in *P. pistillaris* Amongst the three samples evaluated, proteins were present in maximum amount in *C. gambosa* (20.22±0.07g/100g dw) in comparison to the other two species in *L. squarrosulus* (14.45±0.09g /100g dw) and *P. pistillaris* (14.54± 0.18g/100g dw). Low level of fat content was observed varying from 0.33±0.44/100g dw in *L. squarrosulus* to 1.97±0.16g /100g dw in *P. pistillaris.* The level of moisture in the sample has direct bearing on the dry matter. During the present investigation, the level of moisture was evaluated from both, the fresh and dried samples. *L. squarrosulus* revealed maximum amount of dry matter (32.28 ±0.95g/100g fresh weight), moisture content (7.67±0.41g/100g dw) and ash (11.4±0.55g /100g dw) as compared to the other two species evaluated. Amongst these three species, highest energy value was found in *P. pistillaris* (387.05±0.28 kcal/100g dw) in comparison to *C. gambosa* (355.33±0.70kCal/100g dw) and *L. squarrosulus* (325.4±3.30kcal/100g dw).

Nutraceutical composition

The results of phenols, flavonoids, steroids, β–carotene and lycopene content are shown in Table 2. Maximum amount of phenols (1.53±0.06 mg of GAE /g of the extract) and flavonoids (1.27±0.04 mg of quercitin equivalents per g of dw) were detected in *C. gambosa* as compared to *L. squarrosulus* (1.32±0.01mg of GAE/g of the extract and 1.15±0.01mg of quercitin equivalents per g of dw respectively) and *P. pistillaris* (0.97±0.11 mg of GAE /g of extract and 0.64±0.06 mg of quercitin equivalents per g of dw respectively). The number of steroids documented varied from

1.57±0.01 g/100g dw in *P. pistillaris* to 1.82± 0.03 g/100g dw in *L. squarrosulus* and the amount of alkaloids ranged between 0.85±0.12g/100g in *P. pistillaris* and 1.85±0.07g/100g in *C. gambosa.* Highest level of β-carotene was documented in *L. squarrosulus* (4.68±0.02µg/g dw) amongst the evaluated mushrooms in comparison to *P. pistillaris* (0.75±0.02 µg/g dw) and *C. gambosa* (1.93±0.01µg/g dw). On the other hand, lycopene content varied from 0.02±0.02µg/g dw in *P. pistillaris* to 1.23±0.01µg/g dw in *L. squarrosulus.*

Table 1 Dry matter (g/100g) on fresh weight basis, proximate chemical composition (g/100g) and energy value (Kcal/100g) of wild mushrooms on dry weight basis (mean ± SD; n=3)

	Calocybe gambosa (PUN 3538)	***Lentinus squarrosulus*** (PUN 3539)	***Podaxis pistillaris*** (PUN 7151)
Dry matter	21.13 ± 0.61^{b}	32.28 ± 0.95^{a}	15.06 ± 0.43^{c}
Crude Protein	20.22 ± 0.07^{a}	14.45 ± 0.09^{b}	14.54 ± 0.18^{b}
Crude Fat	1.33 ± 0.31^{b}	0.33 ± 0.44^{c}	1.97 ± 0.16^{a}
Dietary Fiber	6.04 ± 0.04^{c}	38.38 ± 1.96^{a}	23.87 ± 2.02^{b}
Ash	$10.\ 7 \pm 0.15^{b}$	11.4 ± 0.55^{a}	1.36 ± 0.24^{c}
Moisture	2.67 ± 0.80^{c}	7.67 ± 0.41^{a}	4.33 ± 0.12^{b}
Total Carbohydrates	65.61 ± 0.73^{b}	66.15 ± 0.97^{b}	77.79 ± 0.39^{a}
Energy value	355.33 ± 0.70^{b}	325.4 ± 3.30^{c}	387.05 ± 0.28^{a}

In each row different letters mean significant differences ($p<0.05$).

Table 2 Nutraceutical components of the studied mushroom species.

	Calocybe gambosa (PUN 3538)	***Lentinus squarrosulus*** (PUN 3539)	***Podaxis pistillaris*** (PUN 7151)
Phenols (mg/g)	1.53 ± 0.06^{a}	1.32 ± 0.01^{b}	0.97 ± 0.11^{c}
Flavonoids (mg/g)	1.27 ± 0.04^{a}	1.15 ± 0.01^{b}	0.64 ± 0.06^{c}
Steroids(mg/g)	1.63 ± 0.01^{b}	1.82 ± 0.03^{a}	1.57 ± 0.01^{b}
Alkaloids (g/100g)	1.85 ± 0.07^{a}	1.22 ± 0.07^{b}	0.85 ± 0.12^{c}
β-carotene (µg/g)	1.93 ± 0.01^{b}	4.68 ± 0.02^{a}	0.75 ± 0.02^{c}
Lycopene (µg/g)	0.17 ± 0.01^{b}	1.23 ± 0.01^{a}	0.02 ± 0.02^{c}

In each row different letters mean significant differences ($p<0.05$).

Discussion

Dry matter, proximate composition and energy value

The results of the present studies are in conformity with the reports of earlier investigators (Kalac 2016, Barros et al. 2008, Pereira et al. 2012). The investigated mushrooms like other edible mushrooms are quiet rich in proteins, carbohydrates and dietary fiber and the level of fat they contain is very low and the energy value is high. Barros et al. (2008) documented 43.01g of carbohydrate content in 100g of *C. gambosa* sample on dry weight basis. On the other hand, in the presently evaluated sample of *C. gambosa* it was found to be 65.61g± 0.073/100g dw. Vaz et al. (2011) reported lesser proportion of protein (15.46g/100g dw of *C. gambosa*) in comparison to 20.22g± 0.07 /100g dw evaluated in the presently investigated Indian sample of *C. gambosa*. While working with *L. squarrosulus*, Giri et al. (2013) reported 21.54g of protein content in 100g of its sample from West Bengal, India. While, we documented 14.45g ± 0.09 protein/100g of the evaluated sample from Haryana, India. Nwanze et al. (2006) reported 18.32g/100g dw and 27.25g/100g dw of crude protein in the stipe and the pileus of *L. squarrosulus*, respectively. As reported by Gupta & Singh (1991), *P. pistillaris* contained 32.9% protein content however, Jandaik & Kapoor (1976) documented it at 37.3% which was calculated by 6.25 as conversion factor thus reflecting the values at higher level in comparison to 14.54g/100g dw of protein evaluated

during the present investigation. Barros et al. (2008) reported 1566.23 KJ/100g dw energy value for *C. gambosa* which has been evaluated at about 1486.70 KJ/100g dw (≈ 355.33 Kcal/100g dw) in the presently investigated sample. Comparable results as have been documented during present study have been reported by Kalac (2016). Since edible mushrooms are rich in proteins and carbohydrates and rank in between legumes and meat in their nutritional profiles in FAO/WHO report (1989) because of which these have been categorized as 'meat for vegetarians'.

Nutraceutical composition

The values obtained for the nutraceutical components during the present study are in close proximity to the results documented by Barros et al. (2008) in case of *C. gambosa*, Vaz et al. (2011) reported that the mushroom produced 45.02 mg/kg of total phenol acids which is lesser than our results i.e., 1.53 mg/g. Sharma et al. (2014) evaluated lower proportion of alkaloid content in *L. squarrosulus* (0.65%) as compared to what has been evaluated presently (1.22g/100g dw) The differences in composition with earlier reports may be because of the substrate on which mushroom is growing, mushroom stain/type, time of harvest and many other such factors (Manzi et al. 2001).

Conclusion

The results obtained from the study revealed that the three species *C. gambosa*, *L. squarrosulus* and *P. pistillaris* are rich in proteins and carbohydrates and low in fat content hence can form an important constituent of supplementary food. These mushrooms are also a good source of dietary fiber. Presence of secondary metabolites such as phenols, flavonoids, steroids, β-carotene and lycopene make them important antioxidant sources. In addition, mushrooms are rich sources of nutritional and nutraceutical components and hence can be good culinary option for mycophagic society.

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References

Agahar-Murugkar D, Subbulakshmi G. 2005 - Nutritional value of edible wild mushrooms collected from the Khasi hills of Meghalaya. Food Chemistry 89, 599–603.

Alves MJ, Ferreira ICFR, Dias J, Teixeira V, Martins A, Pintado M. 2012 - A Review on Antimicrobial Activity of Mushroom (Basidiomycetes) Extracts and Isolated Compounds. Planta Medica 78(16), 1707-1718.

AOAC 1995 - Official methods of analysis (16th Ed.). Arlington VA, USA: Association of Official Analytical Chemists.

Atri NS, Sharma SK, Joshi R, Gulati A, Gulati A. 2013 - Nutritional and Neutraceutical composition of five wild culinary-medicinal species of Genus *Pleurotus* (Higher Basidiomycetes) from Northwest India. International Journal of medicinal mushrooms 15(1), 49-56.

Barros L, Cruz T, Baptista P, Estevinho LE, Ferreira ICFR. 2008 - Wild and commercial mushrooms as source of nutrients and nutraceuticals. Food and Chemical Toxicology, 46, 2742–2747.

Barros L, Ferreira MJ, Queiros B, Ferreira I, Baptista P. 2007 - Total phenols, ascorbic acid, beta-carotene and lycopene in Portuguese wild edible mushrooms and their antioxidant activities. Food Chemistry 103(2), 413-419.

Brzezicha-Cirocka J, Mędyk M, Falandysz J, Szefer P. 2016 - Bio- and toxic elements in edible wild mushrooms from two regions of potentially different environmental conditions in eastern Poland. Environmental Science Pollution Research 23, 21517–21522.

Chang ST, Miles PG. 2004 - Culture preservation. In: Chang ST, Miles PG (eds) Mushrooms cultivation, nutritional value, medicinal effect and environmental impact. CRC press. Boca Raton. Florida pp 189–201.

Crisan EV, Sands A. 1978 - Edible mushrooms: Nutritional value. In: Chang ST, Hayes WA (eds.) The biology and cultivation of edible mushrooms, Academic Press, New York, pp. 137–165.

Dulay RMR, Vicente JJA, Dela Cruz AG, Gagarin JM, Fernando W, Kalaw SP and Reyes RG. 2016 - Antioxidant activity and total phenolic content of *Volvariella volvacea* and *Schizophyllum commune* mycelia cultured in indigenous liquid media. Mycosphere 7(2): 131–138.

FAO (Food and Agriculture Organization) .1991 - Protein Quality Evaluation. Rome: Food and Agricultural Organization of the United Nations.

FAO/WHO. 1989 - Protein quality evaluation. Report of the joint FAO/WHO expert consultation. Food and Nutrition Paper 51; Food and Agriculture Organizations and the World Health Organization:Rome, Italy.

Ferreira ICFR, Barros L, Abreu RMV. 2009 - Antioxidants in wild mushrooms. Current Medicinal Chemistry 16, 1543–1560.

Ferreira ICFR, Vaz JA, Vasconcelos MH, Anabela M. 2010 - Compounds from Wild Mushrooms with Antitumor Potential. Anti-Cancer Agents in Medicinal Chemistry 10 (5), 424-436.

Giri S, Mandal SC, Acharya K. 2013 - Proximate analysis of three wild edible mushrooms of West Bengal, India. International Journal of PharmTech Research 5(2), 365-369.

Gupta S, Singh SP. 1991 - Nutritive value of Mushrooms *Podaxis pistillaris*. Indian Journal of Mycology and Plant Pathology 21 (3), 273-276.

Heleno SA, Barros L, Sousa MJ, Martins A, Ferrerira ICFR. 2009 - Study and characterization of selected nutrients in wild mushrooms from Portugal by gas chromatography and high performance liquid chromatography. Microchemical Journal 93, 195–199.

Jandaik CL, Kapoor JN. 1976 - Amino acid composition of the protein of *Podaxis pistillaris* (L.ex Pers.) Morse-an edible mushroom. Indian Journal of Mushroom 2 (2), 33-37.

Jose N, Ajith TA, Janardhanan KK. 2002 - Antioxidant, Anti-inflammatory, and Antitumor Activities of Culinary-Medicinal Mushroom *Pleurotus pufmonanus* (Fr.) Quel. (Agaricomycetideae). International Journal of Medicinal Mushrooms 4(4), 329-335.

Kalac P (2016) Edible Mushrooms: Chemical Composition and Nutritional Value. Academia Press, USA.

Kumari B, Atri NS. 2014 - Nutritional and nutraceutical potential of wild edible macrolepiotoid mushrooms of north India. International Journal of Pharmacy and Pharmaceutical Sciences 6 (2), 200-204.

Lindequist U, Niedermeyer THJ, Jülich, WD. 2005 - The pharmacological potential of mushrooms. Evidence-Based Complementary and Alternative Medicine 2, 285–299.

Liu YT, Sun J, Luo ZY, Rao SQ, Su YJ, Xu R, et al. 2012 - Chemical composition of five wild edible mushrooms collected from southwest China and their antihyperglycemic and antioxidant activity. Food and Chemical Toxicology 50, 1238–1244.

Mallavadhani UV, Sudhakar AVS, Satyanarayana, Mahapatra, Li W, VanBreemen RB. 2006 - Chemical and analytical screening of some edible mushrooms. Food Chemistry 95, 58-64.

Manzi I, Gambelli L, Mariconi S, Vivanti V, Pizzoferrato I. 1999 - Nutrients in edible mushrooms: an interspecies comparitive study. Food Chemistry 65, 477- 482.

Manzi P, Aguzzi A, Pizzoferrato L. 2001 - Nutritional value of mushrooms widely consumed in Italy. Food Chemistry 73, 321–325.

Maxwell A, Speeris M, Pingal R, Mootoo DR, Reynolds WFC. 1995 - 3B amino S spirosalane steroidal alkaloids from Solanumtriste. Journal of Natural Products 58, 625-628.

Maynard, AJ. 1970 - Extraction methods and separation processes. In: Joslyan, A. M. *methods of Food Analysis*. 2nd ed. Academic Press. New York, pp. 141-155.

Mridu, Atri NS. 2015 - *Podaxis pistillaris*- A common wild edible mushroom from Haryana (India) and its sociobiology. Kavaka 44, 34-37.

Nwanze PI, Jatto W, Oranusi S, Josiah SJ. 2006 - Proximate analysis of *Lentinus squarrosulus* (Mont.) Singer and *Psathyrella atroumbonata* Pegler. African Journal of Biotechnology 5(4), 366-368.

Okeke CU, Elekwa I. 2003 - Phytochemical study of the extract of *Gongronema latifolium* Benth. Journal of Health and Visual Sciences 5 (1), 47-55.

Pegler DN. 1986 - Agaric flora of Sri Lanka. Kew Bulletin Additional Series XII. HMSO London. pp. 519.

Pereira E, Barros L, Martins A, Ferreira ICFR 2012 - Towards chemical and nutritional inventory of Portuguese wild edible mushrooms in different habitats. Food Chemistry 130, 394–403.

Purkayastha RP, Chandra A. 1985 - Manual of Indian Edible Mushrooms, Today & Tomorrow's Printers and Publishers, New Delhi, India.

Puttaraju NG, Venkateshaiah SU, Dharmesh SM, Somasundaram R. 2006 - Antioxidant activity of indigenous edible mushrooms. Journal of Agricultural and Food Chemistry, 54, 9764–9772.

Reis FS, Barros L, Martins A, Ferreira ICFR. 2012 - Chemical composition and nutritional value of the most widely appreciated cultivated mushrooms: An inter-species comparative study. Food and Chemical Toxicology 50, 191-197.

Saini SS, Atri NS. 1999 - Exploring mushroom diversity for pharmaceutical utility. In: Singh J and Aneja KR (eds) From ethnomycology to fungal biotechnology exploiting fungi from natural resources for novel products Kluwer Academic/ Plenum Publishers, New York, pp 41-49.

Sarikurkcu C, Tepe B, Kocak MS, Uren MC. 2015 - Metal concentrations and antioxidant activity of edible mushrooms from Turkey. Food Chemistry 175, 549-555.

Sharma SK, Atri NS, Sharma BM, Gulati A. 2013 - Comparative Study of Alkaloid Composition in Ten Wild Fungal Species from North West India. African Journal of Basic & Applied Sciences 5 (3), 121-125.

Sharma SK, Atri NS. 2014 - Nutraceutical composition of wild species of genus *Lentinus* Fr. from Northern India. Current Research in Environmental & Applied Mycology 4(1), 11–32.

Singleton V L , Rossi JA. 1965 - Colorimetry of total phenolics with phosphomolybdic-phosphotungstic acid reagents. American Journal of Enology and Viticulture 16, 144-158.

Uzun Y, Gençcelep H, Tunçtürk Y, Demirel K. 2009 - Determination of protein and nitrogen fractions of wild edible mushrooms. Asian Journal of Chemistry 21, 2769–2776.

Vaz JA, Barros L, Martins A, Santos-Buelga C, Vasconcelos MH, Ferreira, ICFR. 2011 - Chemical composition of wild edible mushrooms and antioxidant properties of their water soluble polysaccharidic and ethanolic fractions. Food Chemistry 126, 610-616.

Vishwakarma P, Singh P, Tripathi NN. 2016 - Nutritional and antioxidant properties of wild edible macrofungi from North-Eastern Uttar Pradesh, India. Indian Journal of Traditional Knowledge 15(1), 143-148.

Vishwakarma P, Singh P, Tripathi NN. 2017 – *In-vitro* antioxidant activity and nutritional value of four wild oyster mushroom collected from North-Eastern Part of Uttar Pradesh. Mycosphere 8(4), 592-602.

Wang XM, Zhang J, Wu LH, Zhao YL, Tao L, Li JQ, Wang YZ, Liu HG. 2014 - A mini-review of chemical composition and nutritional value of edible wild-grown mushroom from China. Food Chemistry 151, 279–285.

Wasser SP. 2002 - Medicinal mushrooms as a source of antitumor and immunomodulating polysaccharides. Applied Microbiology and Biotechnology 60, 258–274.

Yin JZ, Zhou LX. 2008 - Analysis of nutritional components of 4 kinds of wild edible fungi in Yunnan. Food Research and Development 29, 133–136.

Yoo YM, Nam JH, Kim MY, Choi J, Park HJ. 2008 - Pectolinarin and pectolinarigenin of *Cirsium setidens* prevent the hepatic injury in rats caused by d-galactosamine via an antioxidant mechanism. Biological and Pharmaceutical Bulletin 31, 760–764.