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Shahnaz Salamat
Department of Biochemistry, University of Agriculture Faisalabad, Pakistan

Muhammad Shahid
Department of Biochemistry, University of Agriculture, Faisalabad, Pakistan

Jawayria Najeeb
Institute of Chemistry, University of the Punjab, Lahore, Pakistan

Correspondence
Shahnaz Salamat
Department of Biochemistry, University of Agriculture Faisalabad, Pakistan

Proximate analysis and simultaneous mineral profiling of five selected wild commercial mushroom as a potential nutraceutical

Shahnaz Salamat, Muhammad Shahid and Jawayria Najeeb

Abstract
Compositional analysis and mineral quantization of five elected mushrooms *Lentinus edodes, Pleurotus ostreatus, Volvariella volvacea, Pleurotus eryngii* and *Ganoderma lucidum* from the region of Faisalabad was carried out for investigating their nutritional efficacy and pharmaceutical value. It was established that vast amount of biomolecule content such as protein, carbohydrates and fibers was present in the flesh of the examined mushrooms. Maximum concentration of protein was observed in the specimens of *V. volvacea* and *L. edodes* while *P. eryngii* contained highest carbohydrate content. Lower fat content established these mushrooms to be falling under the tab of low-caloric diet. Mineral profiling revealed these specimens to be highly enriched with macronutrient (Ca, Mg and P) as well as micronutrient (Cu, Zn, Mn and Fe) minerals. Overview of acquired results elucidated that these edible mushrooms could be considered as a valuable good quality nutritional dietary supplement for addressing certain malnutrition ailments. The potential implications of this analysis were also discussed for providing an estimation of their viable benefits to the consumers.

Keywords: Edible mushrooms; proximity analysis; trace metals; atomic absorption spectroscopy

1. Introduction
Wild Mushrooms had been recognized as a perpetual constituent of human diet, utilized since olden times not only as component of regular diet but also as a medicinal drug and health promoter, owing to their explicit texture, highly desired taste and rich aroma. These edible mushrooms are generally consumed with substantial popularity in countless realms of the Central and the Eastern Europe and Asia (Kalogeropoulos *et al*., 2013) [17]. Apart from being an integral component of traditional cuisine, recent studies on the wild mushrooms have revealed them to possess various physically and biologically active attributes such as antimicrobial, antioxidant, antitumor, antifungal, anti-cholesterol, anti-inflammatory, antiviral, anti-aromatase and immuno modulatory qualities (Öztürk *et al*., 2011) [25]. These above mentioned characters marked these mushrooms a treasured asset for providing potential therapeutic and as well as nutrition linked applications for practical uses.
With respect to cultivation, edible species are generally either found to abundantly exist in the natural forests or as a regular outdoor commercially harvested food. Wild mushrooms are also employed as a natural fertilizer for improving soil conditions owing to its biodegradation qualities and presence of exceptionally high amount of minerals in their fruiting bodies (Dursun *et al*., 2006) [8]. Macro as well as micronutrient minerals content in mushrooms are significantly higher as compared to cereals, fruits, crops and vegetables. This enhanced concentration was found to be highly influenced by the nature/physiology of the specimen and on its habituating conditions and regional aspects (Lepšová and Mejstřík, 1988; Sesli and Tüzen, 1999) [19, 26]. Similarly, mushrooms were also found to be highly enriched with crude fibers, proteins, carbohydrates and ash contents. The compositional analysis of the same species but with different regional habitat has also confirmed that the nutritional quality of these mushrooms is also dependent on its tropical aspects (Dursun *et al*., 2006; Egwin *et al*., 2011; Okoro & Achuba, 2012) [8, 10, 24]. Normally, edible mushrooms are consumed seasonally by definite group of people but exploration of its nutritional and aromatic qualities have led to extensive increase in its consumption (Dıez and Alvarez, 2001) [1]. In Pakistan, the use of edible mushrooms is also gaining lot of attention. Hence, it is imperative that compositional studies and mineral analysis should be carried out for the specimens occurring in the country.

It should also be mentioned that apart from the unique and beneficial aspects of these mushrooms, literature on the regional variability on the proximity analysis of these mushrooms is quite scarce. This lack of effort for encouraging the documentation of these wild macro fungi and mushrooms could result in loss of valuable data regarding these precious edible mushrooms. Thus, it is now the need of an hour to establish a database for collecting and retaining data on these exceptional species so that conservational steps for these mushrooms and their habitat should be carried out in proper methodical way. This article is a direct effort to address the above mentioned problem and was designed to document the nutritional values of five wild mushrooms through mineral profiling and proximity analysis. To the best of researcher's knowledge, articles related to the cultivation of edible mushrooms in Pakistan have been stated to exist in literature (Shah *et al*., 2004; Sher *et al*., 2011) [27, 28] but no record have been found for indexing the nutritional values for the elected or any other species of mushroom explicitly to Pakistan or Faisalabad region. Hence, a novel and facile approach has been opted for investigating the elected mushrooms *Lentinus edodes, Pleurotus ostreatus, Volvariella volvacea, Pleurotus eryngii* and *Ganoderma lucidum* collected from the city of Faisalabad in Pakistan.

2. Experimental Section

2.1 Reagents and preliminary preparations

All chemicals that were employed for analysis were of analytical-grade standards and were applied as received without any further modification. Calibrated standards were prepared from the commercially available stock solutions acquired from Appli Chem Incorporation. Ultra-purified double de-ionized water was utilized for the preparation of working standards. Glass apparatus (Pyrex brand) was allowed to be immersed in 8N HNO_3 for one night before use and was afterwards rinsed thoroughly several times with de-ionized water. All dimensions were studied at room temperature.

2.2 Opted methodologies

2.2.1 Sample collection and treatment

Five types of commercial mushrooms were used as a raw biomaterial in the context of this work. Strains of *Lentinus edodes, Pleurotus ostreatus, Volvariella volvacea, Pleurotus eryngii* and *Ganoderma lucidum* were personally collected from Medicinal Mushroom Lab of Institute of Horticulture Sciences located in the University of Agriculture, Faisalabad. For preservation, air-tight plastic bags were used. Prior to performing extraction procedure, all samples were shade dried for almost a day and sliced into small chunks with the help of stainless steel knife. The mushroom specimens were afterwards grounded into fine powder by using domestic blender. Temperature of 4℃ was maintained for storage purposes.

2.2.2 Proximity analysis

Analysis of dried mushroom powder was carried out for investigating proteins, fats, fibers, carbohydrates and ash contents in the samples. 1g of fine powder was taken in thimble and was further placed in the extraction tube of Soxhlet apparatus for crude fat content determination (Heleno *et al*., 2015). Extraction was carried out for 16 hours by using petroleum ether. Extract acquired was placed in hot-air oven at 105 ℃ for 30 minutes and fully dried sample was weighed with the digital balance. Equation 1 was applied for crude fat content determination.

$$\text{Crude fat (\%)} = \frac{\text{(Weight of fat in sample (g)}}{\text{(Total weight of sample (g)}} \times 100 \quad (1$$

For crude protein estimation, Macrokjeldahl apparatus was employed. 1g of respective mushroom powder was wrapped in Whitman filter paper 1 and was placed in the Kjeldahl digestion flask. H_2SO_4 along with catalyst (mixture of Na_2SO_4:$CuSO_4$:SeO_2 in 10:5:1) was introduced into flask for aiding the digestion process. For complete digestion, Gallenkamp digestion and Manhan distillation instruments were used as previously reported by (Ayuba *et al*., 2011) [3]. Nitrogen content in each distillate was deduced by titrating it against 0.01N HCl solution. Following two formulas given in equation 2 and 3 were used for crude protein determination in extracts and in the original sample respectively. In these equations, symbols of *a*, *b*, *c*, *d* and *e* represents digested sample titer value, blank sample titer value, volume to which the digested sample was diluted up to, volume of sodium hydroxide used for distillation and weight of dried fat-free sample successively.

$$\text{Crude protein (\%)} = 6.25 \times \text{Nitrogen (\%)} \quad (2$$

$$\text{Crude protein (\%)} = \frac{(a - b) \times 0.01 \times 14.01 \times c \times 100 \times 6.25}{d \times e} \quad (3$$

Investigation of crude fiber content in the elected mushrooms was done by following the reported method of Van with slight adjustments (Van Soest, 1967) [29]. 1g of dried powder was first digested with the help of acid and then afterwards with alkali for 30 minutes. The washed and oven dried residue placed in a crucible was then heated in the oxidizing flame till the smoke formation from the content ceases. After that it was placed in muffle furnace at 550℃ for almost 4 hours. The acquired greyish ash was then cooled and weighed for further analysis. Equation 4 was used for the measurement of crude fiber content. Here, *a* and*b* represents crucible weights before and after the process of ashing respectively.

$$\text{Crude fiber (\%)} = \frac{(100\ (a-b)}{\text{Weight of sample}} \quad (4$$

The same ashing procedure as discussed above was used for investigating the ash content in the samples with the only exception that contact time of material in muffle furnace was enhanced from 4 hours to 6 hours (Ayuba *et al*., 2011) [3]. The formula used for the measuring ash content is given in equation 5.

$$\text{Ash (\%)} = \frac{\text{Weight of ash in sample (g)}}{\text{Weight of sample (g)}} \times 100 \quad (5$$

For carbohydrate content, following equation was used. Basically carbohydrate content was acquired by subtracting summation of moisture, fat, protein and ash content in dry matter from 100.

$$\text{Total carbohydrates (\%)} = 100 - \frac{\text{total moisture + total fat}}{\text{+total protein + total ash}} \quad (6$$

Total energy was calculated according to the following equations (Barros *et al*., 2007) [4]

$$\text{Energy (kcal)} = 4\times [\text{protein(g)+carbohydrate(g)}] + 9\times[\text{lipid(g)}] \quad (7$$

$$\text{Energy (kJ)} = 17\times [\text{protein(g)+carbohydrate(g)}] + 37\times[\text{lipids(g)}] \quad (8$$

2.2.3 Mineral profiling

Weighed amount of dry powder i.e. 1g was ashed at 650℃ for 5-6 hours in the porcelain crucible. The obtained ash was dissolved in HNO_3 solution, cooled, centrifuged and diluted up to 10mL with de-ionized water. Blanks for the analysis were also prepared in a similar way (Mallikarjuna *et al*., 2012) [21]. Hitachi Polarized Zeeman AAS spectrophotometer with model number Z-8200 and manufacturing location of Japan was used as research instrument for the mineral profiling of mushrooms. Studied elements included Calcium (Ca), Copper (Cu), Iron (Fe), Lead (Pb), Magnesium (Mg), Manganese (Mn), Zinc (Zn) and Phosphorus (P).The functional parameters elected for the mineral analysis are summarized in table 1 (Helrich, 1990) [14].

2.2.4 Statistical analysis

Both kinds of statistics i.e. descriptive as well as inferential statistics were applied for the elucidation of the acquired facts. For data analysis, the software of Statistical Package for the Social Sciences (SPSS version 11.0) was used. The summarization and cataloging of the data was achieved by using the mean and standard deviation (descriptive statistics) practices. ANOVA (inferential statistics) was used to investigate the statistically significant differences between the terms.

3. Results and Discussion

3.1 Proximate analysis

Complete proximity analysis details of all the five mushroom specimens are provided in table 1 and figure 1. The analysis confirmed that the fundamental components of these mushrooms were found to be carbohydrate, fibers and protein. With respect to crude protein, the distribution range for five elected commercial samples was recorded in %age dry weight/weight ratio and was observed to be from 16% to 23%. The *L. edodes* and *V. volvacea* possessed the highest content of protein i.e. 23% each while the lowest concentration of protein (16% w/w) was recorded in *G. lucidum*. Obtained results correlates with the work of (Okoro and Achuba, 2012) [24] who depicted the range of 12-27% (protein) in their study. Edible mushrooms have been highly regarded owing to the presence of higher protein sum in them. As a result, these are often used as a dietary supplement for cereals and other edibles (Chang and Buswell, 1996) [5]. The variation in the protein amount among mushrooms from 16 to 23% could also be attributed to the number of factors as protein amount get directly influenced by the nature/kind of mushroom, its developmental stage, its sampled part and the availability of N_2 to the growing mushrooms (Barros *et al*., 2007) [7]. The protein quantities in the ranges 15-26% (Yang *et al*., 2001) [30] and 14-26% (Mau *et al*., 2001) [23] have also been reported in the literature which is also comparable with our studies.

Analysis further confirmed that the crude fat content in these mushrooms was found to be way lower as compared to protein. The gilled oyster mushrooms i.e. *P.ostreatus* and *P.eryngii* possessed highest fat concentration of 2%. All other mushrooms were found to have very lower percentage than them i.e. 0.064% (*G. lucidum*), 0.88% (*L. edodes*) and 1.75% (*V. volvacea*) of fats. Several researchers have already reported these low fat and high protein edible and commercial mushrooms (Aletor, 1995; Liu *et al*., 2010; Okoro and Achuba, 2012) [2, 20, 24]. In case of carbohydrate, under-study mushrooms showed very high concentration under the range of 65-82% of dry weight. The respective carbohydrate content for mushrooms were found to be 82%, 76%, 72%, 66% and 65% for *G. lucidum*, *P. eryngii*, *L. edodes*, *V. volvacea* and *P. ostreatus* respectively. The acquired range of the carbohydrates was established to be noticeably comparable with the reported ranges of 44-74% and 16-75% except from the highest carbohydrate content (82%) found in *G. lucidum* (Liu *et al*., 2010) [20]. This difference could be ascribed to the various cultural local techniques and different growing soil conditions in respective countries.

The fairly high fiber sum (i.e. 6-52%), particularly in *G. lucidum*, was examined during the proximate analysis. This extraordinary fiber content is pretty desired characteristics as fibers are generally highlighted by the nutritionists for optimal growth of human beings. Hence, fruit bodies of these mushrooms can be employed for providing required fiber content to consumers. Similarly ash content was reported to be in the range of 2-9% with *V. volvacea* illustrating the highest and *G. lucidum* representing the lowest value of ash percentage. Outcomes of our study corresponded with the findings of several scholars (Liu *et al*., 2010; Mau *et al*., 2001; Yang *et al*., 2001) [20, 23, 30]. In this study, the proximity analysis showed that mushroom *G. lucidum* possess the highest energy content of 394.30 kcal/100g while *L. edodes* keeps the lowest energy content of 342.20 kcal/100g.

To be precise, it could be established that the nutritional value and chemical composition of these Pakistani commercial edible mushrooms elucidates their potential use as a vital source for the availability of key nutrients like proteins, fats, fibers and carbohydrates to consumers. The most distinguished feature of this study is the recorded amount of protein, carbohydrates and fats concentration in these mushrooms. The protein value for *V. volvacea* and *L. edodes* was recorded to be 23% which is comparable with the values of some generally known protein-rich sources i.e. (22.5%) cowpea seeds and (23%) lima beans etc.(Egwin, Elem & Egwuche 2011) [10]. Hence mushrooms can be used as their alternatives. Also the data acquired also confirms that with respect to ash, proteins and crude fiber values these mushrooms are not only comparable but at some instances found to be exceeding than the values testified for most of the legumes. However, African ground nuts and soybeans values were still higher than the recorded mushroom sample values (Aletor and Aladetimi, 1989; Okoro and Achuba, 2012) [1, 24]. Moreover, lower fat contents also predict their potential use as a healthy replacement for low caloric diets. Thus, the anti-tumorigenic characters and hypochlestrolaemic related beneficial qualities owing to its lower fat content further implies their use as a natural medicinal food for the people suffering from some cholesterol linked ailments. Findings of (Chihara, 1993; Kadiri and Fasidi, 1990) [6, 15] also indicates the same results. Using this proximate analysis, it could be concluded that studied mushrooms scores the middle position between legumes and protein rich meat and can be employed as a protein dietary supplement not only for human but also

for live stocks as well and can also aids in dealing with various protein linked malnutrition problems.

3.2 Mineral analysis

Recent pharmacological, biological and chemical studies on mushrooms have illustrated that aside from essentially enriched in biologically active compounds of proteins, fats, carbohydrates and fibers, certain peculiar minerals have also been reported to be present in the flesh/fruiting body of commercial mushrooms. Beneficial electrolytes such as Sodium (Na), Magnesium (Mg), Phosphorous (P), Potassium (K) and Calcium (Ca); the essential micronutrients like Zinc (Zn), Iron (Fe), Manganese (Mn) and Copper (Cu); and some hazardous non-essential nutrients like lead (Pb), Mercury (Hg) etc. were reported to be present in edible mushrooms (Falandysz *et al*., 2013) [11]. A detailed mineral analysis was carried out in this research for studying the advantageous aspects linked to the providence of macro and micro mineral nutrients through the mushrooms to the consumers. Similarly, cytotoxicity and environmental parametric aspects were also discussed by the quantization of trace minerals in collected mushrooms. The Pb quantization was specifically done to get the descriptive idea of pollutant bioaccumulation process in the vicinity of sampling sites. The summarization of acquired data is given in table 3.

Comparative mineral analysis of macronutrients like essential cations and anions (Na, Ca and P) is pictorially presented in figure 2. It could be deduced that among the macronutrient, anionic nutrient of Phosphorus was the most abundant mineral while among the involved mushrooms, fruiting body of *G. lucidum* contained the highest concentration of it i.e. 1221.01mg/g. With respect to the Magnesium, samples of *G. lucidum* and *V. volvacea* were found to be richest with the values of 145.60mg/g and 125.40mg/g respectively. Calcium was the least abundant mineral in this category. The maximum content (109.20mg/g) of Ca was found in the strain of *L. edodes*. Overview of the above mentioned results showed that adequate level of macronutrient was present in the flesh of mushrooms. High Phosphorus levels are indicative of the fact that the soil in the sampling site is enriched with the essential cations and anions and is adequately optimized for mushroom growth. Furthermore, the augmentation of these micronutrients also implies that these edible mushrooms can also be employed as a dietary supplement for dealing with nutrient deficiencies particularly in young children. Since the essential macronutrients are required in grave quantities by the human beings, no maximum permissible limit for these minerals has been detailed in literature (Mariam *et al*., 2004) [22]. As a result, higher concentrations of macronutrients are always welcomed by the consumers. Results inferred and the macro nutrient ranges established in this study correlates with the outcomes of (Edeoga and Gomina, 2001; Egwin *et al*., 2011; Kalač and Stašková, 1991) [9, 10, 16].

Comparative mineral analysis of trace minerals (including Pb, Cu, Mn, Zn and Fe) in elected mushrooms is depicted in figure 3. Lead is one of the non-essential micro-pollutant that has been causing tremendous concerns worldwide owing to its bioaccumulation capacities in the environment and has been commonly known to be the cause of fetal ailment of lead-blood poisoning reported to be occurring among children at very high rates. Its concentration is also used as a pointer of the quality of the environment. Polluted environments have been reported to have very high concentrations of deposited lead in biological organic substances. Mushrooms have also been recorded to be used as bioindicators of pollution by several researchers (Kalač and Stašková, 1991; Lepšová *et al*., 1988) [16, 18]. Current study reveals that lead has not been detected in any of the fruiting body of the involved mushroom. This further consolidates the above mentioned conjecture that the sampling environment is highly unpolluted and is well improved for the optimal growth of mushrooms. Moreover, it is also justifiable with respect to the elected sampling area which is the Medicinal lab linked to a well-reputed research university. Hence, controlled environment availability to the specimen could also be inferred to be one of the main factors responsible for the absence of lead in any of the samples.

In case of other essential trace minerals which are fundamentally required by humans for proper functioning, mushroom samples were found to be sufficiently enriched in that regard too. The recorded ranges for under-study mushrooms were recognized to be 0.90-1.90mg/g, 0.40-1.31mg/g, 2.20-7.75mg/g and 6.90-17.70mg/g for the respective minerals of Cu, Mn, Zn and Fe. The samples of *G. lucidum* were found to be containing the highest concentrations of Cu, Zn and Fe while *P. ostreatus* had the maximum content of Mn. The observations assimilated in this work are further supported by the works of (Falandysz *et al*., 2001; Mallikarjuna *et al*., 2012) [12, 21]. The mineral profiling of the Pakistani strains of mushroom further reveals that *P. ostreatus* emerged to be a rich source of Ca, Na, Fe, Mg, K and P and *V. volvacea* turned out to be generally wealthier in convergence of K, P, Mg, Fe and Zn.

Mineral content present in the flesh of mushrooms is directly influenced by various factors too such as under-study specimen of mushrooms, sampling site conditions and the quality (polluted/unpolluted) of growing environment (Kalač and Stašková, 1991) [16]. Moreover, the minerals uptake is also affected by the amount and nature (acidic/basic) of organic matter in the soil along with the current stage of matter decomposition. Mushrooms have also been regarded as quite appreciated mineral source owing to the presence of efficient, effective and complicated uptake mechanisms happening between soil and fruiting body of mushroom (Lepšová and Mejstřík, 1988) [19]. This study clearly elucidate the fact these edible mushrooms can be employed as a good quality source for minerals as lot of minerals are involved in carrying out various metabolic reactions, nerve impulse transmission mechanisms, enhancement in rigidity of bones and maintaining water-salt balance in the body of human beings (Okoro and Achuba, 2012) [24].

4. Conclusion

This research work covers the proximity analysis along with mineral profiling carried out on five elected commercial and edible mushrooms (*Lentinus edodes, Pleurotus ostreatus, Volvariella volvacea, Pleurotus eryngii* and *Ganoderma lucidum*) for investigating their usability as a good quality diet. Proximity analysis revealed these mushroom to be highly enriched with crude fibers, crude protein and carbohydrate content which hints at their potential application as a dietary supplement for treating malnutrition ailments. Particularly, specimens of *V. volvacea* and *L. edodes* possessed 23% dry weight content of protein which was comparable with amount provided by various currently used protein supplements. Furthermore, the lower fats concentration in fruiting bodies of mushrooms further approves off their use as low-calorie food add-on for people with cholesterol issues. Mineral profiling of investigated specimens also provides the valuable input for

estimating their nutrition value. These commercial mushrooms, particularly *P. ostreatus* and *G. lucidum*, were established to be highly enriched with essential macro as well as micronutrients. Henceforth, it could be proven these mushrooms holds exceptional nutrition potential and incessant efforts are required for the documentation and cultivation of these specimens for fully benefiting from their nourishment prospective.

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Table 1: Operational conditions employed in the metal quantization performed through Atomic Absorption Spectrophotometer

Elements	Wavelength (nm)	Slit width (nm)	Lamp current (mA)	Burner head	Flame specification	Burner height (mm)	Oxidant gas pressure (flow rate) (kPa)	Fuel gas pressure (Flow rate) (kPa)
Calcium	422.7	0.4	7.5	Standard type	Air-C_2H_2	7.5	160	6
Copper	324.8	1.3	7.5	Standard type	Air-C_2H_2	7.5	160	7
Iron	248.3	0.2	10	Standard type	Air-C_2H_2	7.5	160	6
Lead	283.3	1.3	7.5	Standard type	Air-C_2H_2	7.5	160	7
Magnesium	285.2	1.3	7.5	Standard type	Air-C_2H_2	7.5	160	7
Manganese	279.6	0.4	7.5	Standard type	Air-C_2H_2	7.5	160	7
Zinc	213.9	1.3	10.0	Standard type	Air-C_2H_2	7.5	160	6

Table 2: Proximate composition of selected mushrooms (% dry weight)

Mushrooms	Crude Protein	Crude Fat	Ash	Fiber	Carbohydrate	Energy (kcal/100g)
Lentinus edodes	23.51±.03	0.88±.02	5.87±.03	8.48±.04	72.52±.04	342.20±.03
Ganoderma lucidum	16.07±.04	0.64±.04	2.1±.03	54.12±.03	82.47±.03	394.30±.04
Pleurotus eryngii	18.90±.04	2.11±.02	7.61±.03	6.20±.05	76.50±.03	385.20±.04
Volvariella volvacea	23.15±.04	1.75±.04	9.14±.05	7.43±.04	66.54±.04	354.80±.04
Pleurotus ostreatus	22.15±.05	2.02±.03	7.03±.05	6.21±.03	65.66±.03	368.41±.04

Values are mean ± SD of carefully conducted triplicate experiments. Furthermore, mean carrying different superscripted alphabets vary ($p<0.05$) with 95% confidence

Table 3: Mineral profiling of selected mushrooms

Mushrooms	Macronutrient minerals			Trace minerals				
	Calcium (Ca)	Magnesium (Mg)	Phosphorus (P)	Lead (Pb)	Copper (Cu)	Manganese (Mn)	Zinc (Zn)	Iron(Fe)
L. edodes	109.20±0.02	89.10±0.01	502.50±0.03	ND	1.20±0.00	1.10±0.00	2.20±0.01	12.10±0.01
G. lucidum	32.80±0.03	145.60±0.02	1221.01±0.20	ND	1.90±0.00	0.60±0.00	7.50±0.00	17.70±0.00
P. eryngii	11.00±0.02	75.81±0.00	779.80±1.02	ND	0.90±0.00	0.80±0.02	3.41±0.00	11.20±0.00
V. volvacea	61.33±0.00	125.40±0.00	833.00±0.20	ND	1.42±0.00	0.40±0.00	4.60±0.00	10.20±0.00
P. ostreatus	12.10±0.01	102.01±0.10	867.40±1.30	ND	1.10±0.00	1.31±0.07	6.71±0.00	6.90±0.03

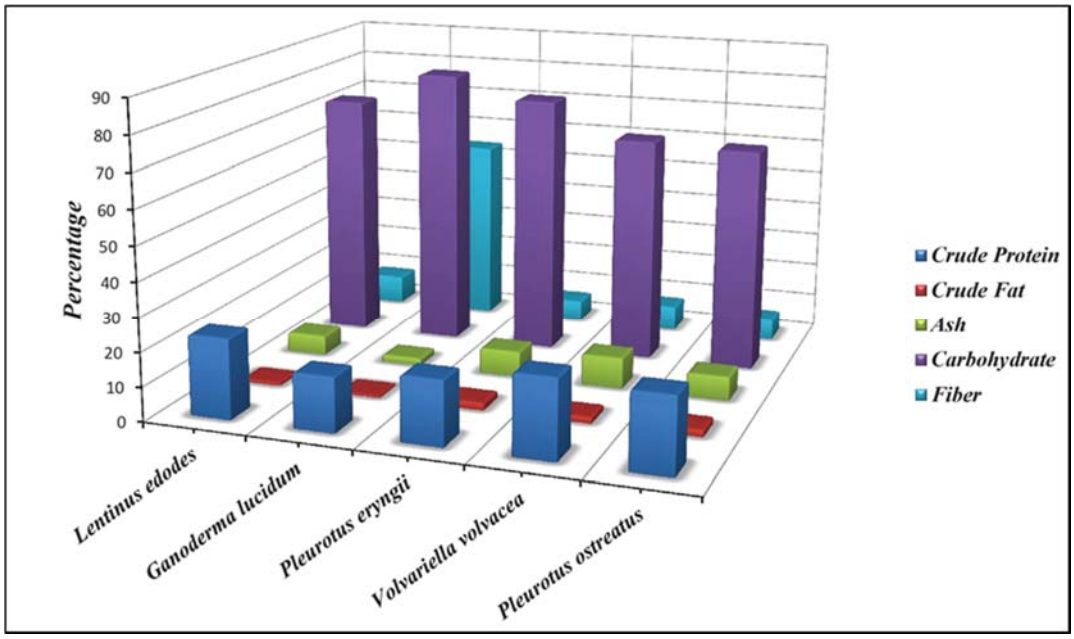

Fig 1: Proximate nutrient quantization of collected mushroom samples

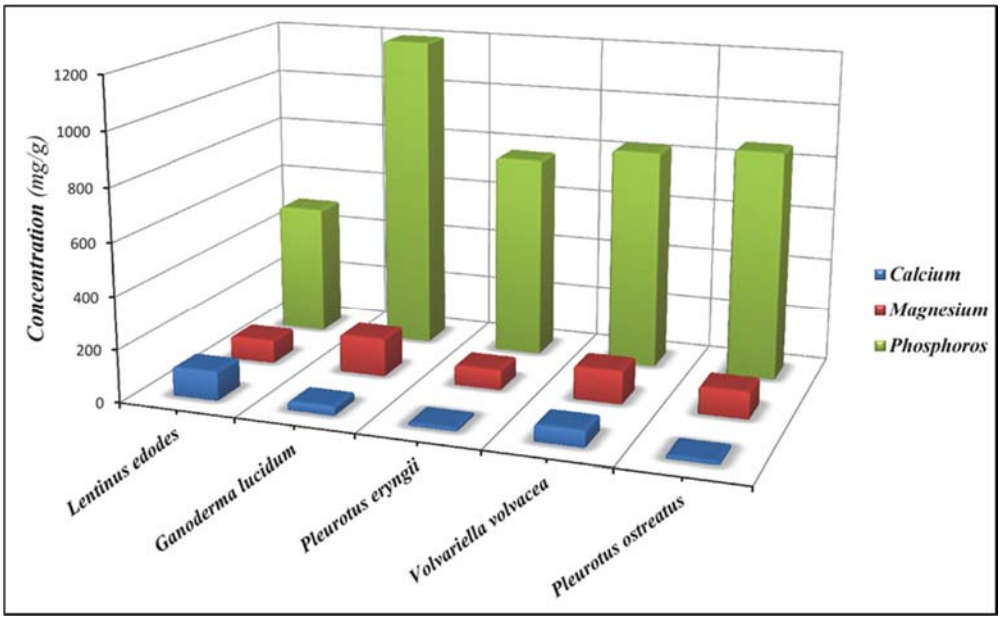

Fig 2: Comparative macronutrient mineral analysis of elected mushroom

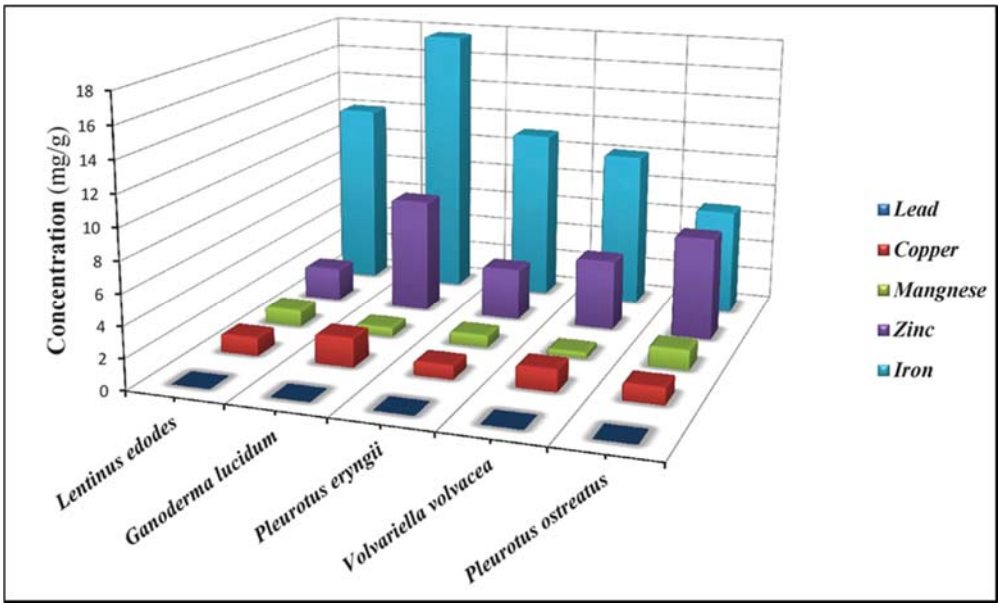

Fig 3: Comparative micronutrient trace mineral analysis of elected mushrooms

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