RESEARCH ARTICLE

PHYSICOCHEMICAL COMPOSITION, NUTRITIVE VALUE, AND FUNCTIONAL ATTRIBUTES OF COMMERCIALLY CULTIVATED MUSHROOMS IN SRI LANKA

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ABSTRACT

Edible mushrooms are nutrient-rich functional foods, popular in both modern and traditional Sri Lankan cuisine. However, limited studies have assessed the nutritional profile and functional qualities of commercially grown mushroom species in Sri Lanka. Therefore, this research seeks to analyse the physicochemical profile, nutritional quality, and functional properties of five edible mushroom species cultivated on a commercial scale in Sri Lanka, namely, American Oyster (*Pleurotus ostreatus*), Black Oyster (*Pleurotus* sp.), Abalone (*Pleurotus cystidiosus*), Button mushroom (*Agaricus bisporus*) and Chinese mushroom (*Pleurotus* sp.). In this study, one-way ANOVA and Tukey's post hoc multiple test have been used to analysed the above properties. In terms of physicochemical characteristics, Abalone exhibited the highest pH (6.53 ± 0.06). At the same time, Button mushroom had the highest titratable acidity (0.62 ± 0.00 g/ 100 mL), and the Black Oyster recorded the maximum total soluble solids value compared to other varieties (5.8 ± 0.1 Bx). In terms of nutritional properties, moisture, ash, total lipid, crude protein, carbohydrates, and crude fiber fractions of the analyzed mushroom species exhibited values ranging from 0.72-3.23 %, 22.45-31.51 %, 58.75-65.07 % and 7.89-11.88 %, respectively. The highest moisture content was observed in Chinese Oyster mushrooms (93.45 ± 0.70 %), and the highest carbohydrate content was observed in American Oyster mushrooms (65.07 ± 0.95 %). The lowest fat content (P<0.05) (3.23 ± 0.34 %), and the highest protein content (P<0.05) (31.51 ± 0.87 %) were found in Button mushrooms. In terms of functional properties, Button mushroom showed the significantly (P<0.05) highest values for flavonoids (45.56 ± 1.33 mg QE/100 g DW) and antioxidant activity (86.38 ± 0.63 mM Trolox/g). In contrast, the Black oyster mushroom obtained the highest phenol content (515.33 ± 1.53 mg GAE/100 g). Based on findings of this study, the variety Button mushroom was highly nutritious and provided functional qualities compared to the other four varieties. Moreover, this study provides valuable insights into the comprehensive properties of these selected mushroom species, which could support the pharmaceutical and biomedical industries due to their bioactive properties, while also promoting consumer nutritional well-being.

Keywords: Edible mushrooms, Functional attributes, Nutritional profile, Physicochemical properties

INTRODUCTION

With modernization, people are increasingly concerned about their health and are trying to incorporate more nutritious, healthy food into their regular diets. Notably, dietary mushrooms play an important role, especially among consumers with vegetarian preferences. A mushroom is a macro fungus with different forms of fruiting bodies. It consists mainly of two major components: the aerial and subterranean parts. The aboveground portion, which is the edible part of the mushroom, primarily consists of a cap and a stalk. The belowground portion forms a white, thread-like mycelial network of hyphae. Although global fungal diversity is now estimated at 2.2 –3.8 million species, about 14,000 described species produce visible, mushroom-sized fruiting bodies (Jo *et al*., 2023).

Due to their unique nutrient composition and therapeutic potential, mushrooms have gained significant attention worldwide as a valuable functional food. As a result of that, most of the Asian, African, and Middle Eastern

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countries have used mushrooms for their medical applications. Specifically, it has been used to treat asthma, cancers, bronchitis, arthritis, gastric ulcers, hepatitis, hyperlipidemia, and diabetes due to its antimicrobial, anti-inflammatory, antioxidant, and anti-cancer properties (Gunawardena *et al*., 2014). In addition to those bioactive compounds, mushrooms are rich in carbohydrates, dietary fiber, protein, moisture, fat, vitamins, and minerals (Dimopoulu *et al*., 2022). Therefore, mushrooms are the best viable, healthy alternative for ensuring adequate nutrition among people.

In Sri Lanka, both commercial and wild edible mushroom species contribute to the local cuisine. *Lena hathu*, *Mahaweli hathu, Heen weli hathu*, Wood ear mushroom, *Idalolu* are some common examples of wild edible mushrooms that appeared in Sri Lanka. Those wild edible mushrooms are seasonal and mainly occur during the rainy season. Sri Lankan commercial mushroom production was first initiated in 1989 by the United Nations Development Programme (UNDP). Later, the Sri Lankan Export Development Board established mushroom houses and spawn laboratories for spawn mushroom production (Karunarathna *et al.*, 2017). Paddy straw mushroom (*Volvariella volvacea*), American oyster mushroom (*Pleurotus ostreatus*), Button mushroom (*Agaricus bisporus*), Shiitake mushroom (*Lentinus edodes*) and Abaloni mushroom (*Pleurotus cystidiosus*) are some examples of commercially grown edible mushrooms in Sri Lanka.

Compared with other crop species, research on the nutritional and functional traits of commercially cultivated mushrooms in Sri Lanka remains scarce. Furthermore, there are no reported studies on a comprehensive analysis of the properties of commercial edible mushrooms in Sri Lanka. As a result, most of the local people have a limited understanding of Sri Lankan mushroom varieties and their nutritional and medicinal value. Therefore, it is essential to analyze the comprehensive characteristics of edible mushrooms produced on a commercial scale in Sri Lanka within a single study. Although Sri Lanka possesses several nutritionally rich local mushroom cultivars, their commercial-scale promotion remains limited. Major constraints include the absence of standardized high-quality spawn, limited research on yield stability across regions, and inconsistent production technologies. Additionally, low consumer awareness, weak market linkages, and inadequate post-harvest handling facilities hinder commercialization. Investments in research, training, and market development are essential to establish local cultivars as viable commercial products (Thilakarathne *et al*., 2018).

Thus, this research aims to determine the physicochemical composition, nutritive value, and functional properties of five commercially produced edible mushrooms in Sri Lanka, namely American oyster mushroom (*Pleurotus ostreatus*), Black oyster mushroom (*Pleurotus* spp.), Abalone mushroom (*Pleurotus cystidiosus*), Button mushroom (*Agaricus bisporus*), and Chinese oyster mushroom (*Pleurotus spp*.). These mushroom varieties are the most widely cultivated commercial scale mushroom varieties in Sri Lanka and most of the Sri Lankan people highly preferred to incorporate these mushroom varieties into their regular diet. The findings of this research will help determine the nutritional composition of different mushroom varieties and provide information on the potential health benefits and dietary values of each variety. Further, the findings of the current study will help develop new mushroom-based products with superior characteristics and expand the mushroom market in Sri Lanka. Not only that, but it will also be helpful to develop different pharmaceutical drugs with higher functional properties.

METHODOLOGY

Sample collection and preparation

Five selected mushroom varieties, namely Abalone, Chinese oyster, American oyster, Button, and Black oyster mushrooms, were obtained from supermarkets in the Matara district, and a composite sample of each mushroom type was prepared.

The collected samples were packed in separate polyethene bags and properly labelled. In the laboratory, mushroom powder was prepared separately for each mushroom variety as follows. First, the collected mushroom samples were sorted and cleaned. Then, they were cut into small slices and dehydrated at 50 °C for seven hours until the weight remained constant. Finally, the dried samples were processed into fine powder to obtain the mushroom powder. Prepared mushroom powders were placed in high-density polyethene (HDPE) bags and stored at refrigeration temperatures until further analysis.

Physicochemical properties

pH value

The pH of each sample was determined using a pH meter (AD 132, made in Romania manufactured by ADWA instrument suppliers), and the homogenate was prepared by mixing 5 g of each mushroom powder with 20 mL of distilled water.

Color

Colour parameters (L*, a*, b*) were measured using a colourimeter, BCM-200 (China).

Titratable acidity

Titratable acidity was measured following the procedure outlined by Anyasi *et al* (2015). Water extracts from each mushroom sample were prepared by mixing 5 g of mushroom powder with 20 mL of distilled water, then centrifuged at 3000 rpm at room temperature for 10 minutes. After that, 1 mL of each prepared water extract sample was titrated against 0.8 N NaOH using phenolphthalein as the indicator, and the endpoint was recorded upon observing the colour change. Titratable acidity was determined using the following equation and expressed as a percentage of citric acid.

$$\text{Titratable acidity} = \frac{N \times V_{NaOH} \times W}{V_{Sample}}$$

Where; N: Concentration of NaOH, V_{NaOH}: NaOH volume spent for titration, W: Equivalent weight of citric acid, and V_{sample}: Volume of sample used for titration

Proximate analysis

The moisture content, crude protein, crude fat, crude fibre and ash content were determined according to the AOAC (2000) methods. Carbohydrate content was calculated by using the difference. All values were expressed as dry weight, with moisture content reported on a fresh-weight basis.

Functional properties

Sample preparation

One gram of each mushroom powder was thoroughly mixed with 10.5 mL of methanol and 4.5 mL of distilled water. After that, the mixture was vortexed and then placed in a mechanical shaker for 1 hour. Then, the content was centrifuged at 5000 rpm for 15 minutes. The same procedure was repeated three times to prepare the samples for determining the total flavonoid, total phenolic, and total antioxidant activity. Finally, the resulting supernatants were pooled and used as samples to assess the mushroom's flavonoid, phenolic, and antioxidant content.

Total phenolic content

Total phenolic content was measured following the Folin–Ciocalteu method as reported by Chandra *et al.* (2014). One millilitre of 10% Folin-Ciocalteu was mixed with 200 µL of the extracted sample, then mixed well. The mixture was then kept for two minutes, 1 mL of 7.5% sodium carbonate solution was added, the volume was adjusted to 5 mL, and the mixture was thoroughly mixed using a vortex mixer. The resulting solution was incubated in the dark for 30 minutes, after which absorbance was measured at 765 nm using a UV–visible spectrophotometer (HACH DR3900, Germany). The results were expressed as milligrams of gallic acid equivalent per 100 g of dry weight (mg GAE/100 g DW).

Total flavonoid content

Total flavonoid content was determined by using an alkaline reagent test described by Chandra *et al.* (2014). One millilitre of the extracted sample was transferred to a 10 mL

volumetric flask and combined with 4 mL of distilled water. Then, 0.3 mL of 5% sodium nitrate was added, and the mixture was allowed to stand at room temperature for 5 minutes. Following this, 0.3 mL of 10% aluminium chloride ($AlCl_3$) solution was added. At the sixth minute, 2 mL of sodium hydroxide were added, and the volume was adjusted to 10 mL with distilled water. The mixture was thoroughly vortexed and incubated in the dark at room temperature for 15 minutes. The absorbance of the solution was then measured at 510 nm using a UV–visible spectrophotometer. The results were expressed as mg quercetin equivalent per 100 g on a dry weight basis (mg QE/100 g DW).

Total antioxidant activity

Total antioxidant activity was determined by using the DPPH method described by Cuvelier and Berset (1995). One hundred microliters of the prepared sample was taken, and 1 mL of DPPH solution was added. The solution was incubated in the dark for 30 minutes, and absorbance was measured at 517 nm using a spectrophotometer. The results were expressed as millimoles of Trolox equivalent per gram of dry weight (mM Trolox/g DW).

Statistical analysis

All measurements were performed in triplicate, and the obtained values were expressed as mean ± Standard Deviation (SD). Statistical analyses were conducted using the MiniTab 17 software version. Mean comparisons were conducted using one-way analysis of variance (ANOVA) followed by Tukey's post-hoc multiple comparison test.

RESULTS AND DISCUSSION

Physicochemical properties of selected mushroom varieties

To assess the physicochemical properties, the pH, colour, titratable acidity, and total soluble solids of the powdered mushroom samples were measured, and the results are summarized in Table 1.

Table 1: Physicochemical properties of selected powdered mushroom varietiess

Property		Abalone	American Oyster	Black Oyster	Button Mushroom	Chinese Oyster
pH		6.53 ± 0.06 ^{a}	6.23 ± 0.06 ^{c}	6.30 ± 0.10 ^{bc}	6.50 ± 0.10 ^{a}	6.30 ± 0.10 ^{bc}
Titratable Acidity (g/ 100 mL)		0.41 ± 0.00 ^{b}	0.58 ± 0.06 ^{a}	0.41 ± 0.00 ^{b}	0.62 ± 0.00 ^{a}	0.48 ± 0.06 ^{b}
Total Soluble Solid (˚Bx)		4.9 ± 0.10 ^{c}	5.53 ± 0.15 ^{ab}	5.8 ± 0.10 ^{a}	5.3 ± 0.10 ^{b}	5.27 ± 0.06 ^{b}
Colour	**L***	37.66 ± 0.50^{d}	43.04 ± 0.19^{c}	44.25 ± 0.96 ^{c}	57.63 ± 0.96 ^{a}	47.87 ± 1.10^{b}
	a*	4.72 ± 0.09 ^{bc}	6.12 ± 0.10 ^{a}	3.63 ± 0.10 ^{c}	5.22 ± 0.80 ^{ab}	6.39 ± 0.64 ^{a}
	b*	9.83 ± 0.65 ^{c}	15.73 ± 0.16^{a}	13.36 ± 0.75^{b}	14.72 ± 0.94^{ab}	15.22 ± 0.7 ^{ab}

Data are presented as mean ± standard deviation (SD) for three independent experiments (n = 3). Means sharing the same letter within a row are not significantly different ($P < 0.05$).

As presented in Table 1, the powdered mushroom samples exhibited significantly higher ($P \leq 0.05$) pH, titratable acidity, and total soluble solids in the variety Abalone (6.53±0.06), Button mushroom (0.62±0.00 g/ 100 mL), and Black Oyster mushroom (5.8±0.010 ˚Bx), respectively. According to the study by Adedayo *et al.* (2010), the pH values of four mushroom varieties in Nigeria, namely Lentinus subnudus, Chlorophyllum molybditis, Marasmus spp., and Pleurotus tuberegium, ranged from 6.1 to 7.2, and the results of the current study are also consistent with this. Moreover, as stated by Kuka *et al.* (2011), the titratable acidity of two different wild edible Latvian mushroom varieties, namely *Boletus edulis beticola* and *Boletus edulis pinicola,* ranged between 0.22±0.01 g/ 100 mL and 0.26±0.01 g/ 100 mL, respectively, where the reported values are slightly less than those of the current study. The discrepancies in titratable acidity across studies may be due to variations in the varieties used, established environmental conditions, farming techniques, the age of mushrooms at harvest, the area and climatic factors, and the maturity stage used in different studies.

The color of powdered mushrooms was determined by using the CIE color system, which is denoted by using L*, a*, and b* values, where L* means the lightness index of the sample, and a* means the redness (+) to greenness (-), while b* values describe the blueness (-) to yellowness (+) (Kic., 2018). According to the results for powdered mushrooms shown in Table 1, the Button Mushroom exhibited the highest ($P \leq 0.05$) L* value (57.63 ± 0.96)^{a}, indicating it is the lightest/brightest powder among all varieties. Also, the Chinese Oyster variety exhibits the highest ($P < 0.05$) a* value (6.39 ± 0.64), indicating the strongest red hue. Furthermore, the American Oyster array exhibited the highest ($P \leq 0.05$) b* value (15.73 ± 0.16)^{a}, reflecting a more intense yellow colouration among the tested varieties. According to the Kic *et al.* (2018), the colour values reported for fresh American oyster mushroom (L*=75.94±2.71, a*=0.21±0.52, b*=12.29±1.41) and fresh Button mushroom (L*=86.63±7.07, a*=1.81±1.39, b*=12.77±1.39) were relatively higher than the values observed in the present study. Differences in environmental conditions, harvest time, storage conditions, and maturity stage can cause such deviations.

Nutritional properties of selected mushroom varieties

Proximate composition of the selected mushroom varieties was determined using the AOAC (2000) method, and the results are summarized in Table 2.

Table 2: **Nutritional properties of selected mushroom varieties on a dry weight basis**

Property	Abalone	American Oyster	Black Oyster	Button Mushroom	Chinese Oyster
Moisture % *	91.66±0.1^{ab}	92.14±0.88 ^{ab}	90.01±0.20 ^{b}	92.76±1.58 ^{a}	93.45±0.70 ^{a}
Ash %	9.83±0.57 ^{a}	8.26±0.39 ^{b}	6.82±0.50 ^{c}	9.03±0.12 ^{ab}	6.68 ±0.42 ^{c}
Protein %	22.45±0.94 ^{d}	24.29±0.74 ^{cd}	26.08±0.76 ^{bc}	31.51±0.87 ^{a}	28.02±0.71^{b}
Fat %	3.23±0.34 ^{a}	2.38±0.29 ^{b}	2.45±0.43 ^{ab}	0.72±0.22 ^{c}	3.13±0.27 ^{ab}
Fiber %	11.88 ±0.35 ^{a}	8.07±0.42 ^{b}	7.89±0.37 ^{b}	11.04±0.34 ^{a}	11.65±0.29 ^{a}
Carbohydrate %	52.61 ± 1.52 ^{b}	56.99 ± 1.36 ^{a}	56.76 ± 1.01 ^{a}	47.70 ± 1.13 ^{c}	50.52 ± 0.60 ^{bc}

Data are expressed as mean ± standard deviation from three independent experiments (n = 3). Means with different superscripts within a row are significantly different ($P < 0.05$). Moisture values are presented on a fresh weight basis.

Among the five tested varieties, Button mushroom had the lowest fat content among all the varieties (0.72±0.22 %). Significantly highest ash content (9.83±0.57 %) was reported in Abalone mushroom. Fibre content (11.88±0.35 %) was also highest in Abalone mushrooms. In contrast, protein and carbohydrate contents were significantly higher ($P \leq 0.05$) in the Button mushroom variety (31.51±0.87 %) and the American oyster variety (56.99 ± 1.36 %), respectively. Due to its higher protein content, Button mushrooms have the potential to promote themselves as a beneficial protein option for consumers. The moisture content was not significantly different ($P \leq 0.05$) among the tested varieties.

According to the study by Wickramasinghe *et al*. (2023), carbohydrate content, crude protein, crude fat, and ash content in the varieties, Button (*Agaricus bisporus*), oyster (*Pleurotus ostreatus*), *Makandura white* (*Calocybe sp.),* and *Reishi* (*Ganoderma lucidum*), ranged from 56.78–79.97%, 10.53–31.30%, 0.57–4.37%, and 2.80–11.00%, respectively. Thus, these results align with the observations reported in the present study. Moreover, the crude fibre values in the current study are similar to those reported by Ogbe and Obeka (2013). In contrast, the obtained value for protein content in American oyster mushrooms (24.29±0.74 %) is lower than that reported by Cohen *et al.* (2014). This deviation could have occurred due to changes in environmental conditions and in the maturity stage of the mushrooms.

Typically, mushrooms contain 35%-70% carbohydrates, composed of several monosaccharides, disaccharides, polysaccharides, sugar alcohols (such as

mannitol and inositol), and sugar acids (such as glucoronic and galacturonic acids). Most of the carbohydrates in mushrooms are structural polysaccharides that resist human digestive enzymes (Wannet *et al*., 2000).

Crude fibre is another important nutritional component that determines the degree of digestibility in mushrooms. Generally, crude fibre content is increased with the maturity stage of the mushroom. Crude fibre content of the tested varieties ranged between 7.89±0.37 % and 11.65±0.29 % and the obtained values for crude fibre content for Button and American oyster mushroom (Table 2) fell in line with the findings of Bano and Rajaratnam (1982), given as 7.5±0.35 % for American oyster and 10.4±0.23 % for the variety Button mushroom. Usually, the protein content of the mushroom is moderately higher (19.5 %) than that of most vegetables and fruits. According to Cohen *et al.* (2014), the protein level in Button mushrooms ranges from 22.7 g/100 g of dry weight to 40.8 g/100 g of dry weight, and these findings are also in accordance with the results of the current study.

Functional properties of selected mushrooms

To evaluate the functional properties, total flavonoid content, total phenol content, and total antioxidant activity were analyzed, and the obtained results were summarized in Table 3.

Table 3: Functional properties of selected mushroom types

Mushroom type	Flavonoid (mg QE/100 g DW)	Phenol (mg GAE/100 g W)	Antioxidants (mM Trolox/g)
Abalone	35.94 ± 0.44 ^{c}	510.44 ± 0.77 ^{a}	24.27 ±0.79 ^{b}
American Oyster	36.88 ± 0.88 ^{bc}	504.46 ± 1.53 ^{b}	19.21 ± 0.55 ^{d}
Black Oyster	39.69± 0.44 ^{b}	515.33 ± 1.53 ^{a}	20.94 ± 0.63 ^{cd}
Button	46.56 ± 1.33 ^{a}	402.28 ± 1.53 ^{d}	86.38 ± 0.63 ^{a}
Chinese Oyster	33.75 ± 0.88 ^{c}	488.70 ± 0.77 ^{c}	22.49± 0.47 ^{bc}

Total flavonoid content, total phenol content and antioxidant content of five selected mushroom species were analyzed using their 70% methanolic extract. Statistical significance at $P < 0.05$ is indicated by different letters within a column

Flavonoids, a class of health-beneficial bioactive compounds, exhibit anti-inflammatory, cardioprotective, neuroprotective, and anticancer properties (Ullah *et al.,* 2020). Therefore, it is important to incorporate flavonoid-rich foods into our regular diet to reduce the risk of life-threatening diseases. Among the tested mushroom species, Button mushrooms (46.56±1.33 mg QE/100 g DW) have the highest ($P<0.05$) flavonoid content, and incorporating them into our regular diet can help reduce the risk of life-threatening diseases.

According to Table 3, significant differences can be observed among the studied mushroom varieties regarding the phenol content of the mushroom is higher than the total flavonoid content. Mushrooms contain several phenolic compounds such as salicylic, myricetin, gentisic acid, 4-hydroxybenzoic acid, homogentisic acid, *etc.* (Gasecka *et al*., 2018). In this study, Abalone (510.44 ± 0.77 mg GAE/100 g DW) and Black Oyster mushroom (515.33 ± 1.53 mg GAE/100 g DW) exhibited a higher phenol content compared to other varieties. However, when considering the antioxidant potential, Button mushroom exhibited the highest antioxidant activity (86.38±0.63 mM Trolox/g). Thus, Button mushrooms are highly susceptible to oxidative stress and produce comparatively larger amounts of antioxidant compounds than the other four varieties to help prevent it (Dawood *et al*., 2020).

Moreover, based on the findings of Fogarasi *et al.,* (2020), range of the total phenol content (113.06 ± 0.02 to 408.57 ± 0.02 mg GAE/100 g DW), total flavonoid content (12.52 ± 0.03 to 40.56 ± 0.05 mg QE/100 g DW) and total antioxidant content (11.15 ± 0.00 to 18.38 ± 0.01µM Trolox/g DW) of the selected mushroom varieties (*Agaricus bisporus, Pleurotus ostreatus, Cantharellus cibarius,*

Boletus edulis, and Lactarius piperatus), and the findings supported the results obtained in this study. The nutritional profile and functional properties observed in the studied mushroom varieties indicate strong potential for developing a range of value-added products. These include mushroom-based meat analogues, high-protein snacks, fortified soups and broths, mushroom powders for bakery applications, functional beverages, and ready-to-cook dehydrated mushroom mixes. The antioxidant and dietary fiber content further support their incorporation into health-oriented food formulations. (González *et al*., 2020).

CONCLUSION

This study evaluated the physicochemical, nutritional, and functional characteristics of five selected commercially grown edible mushroom varieties in Sri Lanka. Based on its findings, all the tested edible mushroom varieties are rich in nutritional value. However, among them, Button mushroom is found to be more nutritious than the other tested varieties, due to its higher protein content, antioxidant properties, and lower fat content compared to the other four varieties. When considering the protein content, not only Button mushroom but also most of the other tested varieties are helpful to satisfy the protein requirements of vegan diets. In addition, it also holds potential for application in the development of medicines within the pharmaceutical industry.

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AUTHOR CONTRIBUTION

GTS conducted the research, summarizing initial draft; PABNP conceptualization, supervision and editing the manuscript; KLWK supervision and editing the manuscript; SMAR summarizing the draft manuscript.

REFERENCES

Adedayo, B.C., Oboh, G. and Akindahunsi, A.A. (2010) 'Changes in the total phenol content and antioxidant properties of pepperfruit (Dennettia tripetala) with ripening', *African Journal of Food Science*, 4(6), pp.403–409. Available at: http:// www.academicjournals.org/AJFS.

Anyasi, T.A., Jideani, A.I.O. and Mchau, G.A. (2015) 'Morphological, physicochemical, and antioxidant profile of noncommercial banana cultivars', *Food Science and Nutrition*, 3(3), pp. 221–232. Available at: https://doi.org/10.1002/fsn3.208.

AOAC (2000) Official Methods of Analysis. 17th Edition, The Association of Official analytical Chemists, Gaithersburg, MD, USA. Methods 925.10,65.17, 974.24, 992.16.

Bano, Z. and Rajaratnam, S. (1982) In: tropical mushroom biological nature cultivation methods. *The Chinese University Press, Hongkong*, p. 382.

Chandra, S. *et al.* (2014) 'Assessment of total phenolic and flavonoid content, antioxidant properties, and yield of aeroponically and conventionally grown leafy vegetables and fruit crops: A comparative study', *Evidence-based Complementary and Alternative Medicine*, 2014. doi: https:// doi.org/10.1155/2014/253875.

Cohen, N., Cohen, J., Asatiani, M.D., Varshney, V.K., Yu, H.T., Yang, Y.C., Li, Y.H., Mau, J.L. and Wasser, S.P., 2014. Chemical composition and nutritional and medicinal value of fruit bodies and submerged cultured mycelia of culinary-medicinal higher Basidiomycetes mushrooms. *International journal of medicinal mushrooms*, *16*(3).

Cuvelier, M.E. and Berset, C., 1995. 4A Standard Calibration Techniques. *The Micro flown E-Book*, 28, pp. 25-30.

Dawood, M.A., Eweedah, N.M., El-Sharawy, M.E., Awad, S.S., Van Doan, H. and Paray, B.A., 2020. Dietary white button mushroom improved the growth, immunity, antioxidative status

and resistance against heat stress in Nile tilapia (Oreochromis niloticus). Aquaculture, 523, p.735229.

Dimopoulou, M., Kolonas, A., Mourtakos, S., Androutsos, O., & Gortzi, O. (2022). Nutritional Composition and Biological Properties of Sixteen Edible Mushroom Species. *Applied Sciences (Switzerland)*, *12*(16). https:// doi.org/10. 3390/ app12 168074.

Fogarasi, M., Diaconeasa, Z.M., Pop, C.R., Fogarasi, S., Semeniuc, C.A., Fărcaş, A.C., Ţibulcă, D., Sălăgean, C.D., Tofană, M. And Socaci, S.A., 2020. Elemental composition, antioxidant and antibacterial properties of some wild edible mushrooms from Romania. *Agronomy, 10(12)*, p.1972

Gasecka, M., Siwulski, M., & Mleczek, M. (2018) Evaluation of bioactive compounds content and antioxidant properties of soil-growing and wood-growing edible mushrooms. *Journal of Food Processing and Preservation,* 42 (1), pp 1–10.

González, A., Cruz, M., Losoya, C., Nobre, C., Loredo, A., Rodríguez, R., Contreras, J. and Belmares, R., 2020. Edible mushrooms as a novel protein source for functional foods. Food & function, 11(9), pp.7400-7414.

Gunawardena, D., Bennett, L., Shanmugam, K., King, K., Williams, R., Zabaras, D., Head, R., Ooi, L., Gyengesi, E. and Münch, G. (2014) Anti-inflammatory effects of five commercially available mushroom species determined in lipopolysaccharide and interferon-γ activated murine macrophages. *Food chemistry*, *148*, pp 92-96. doi: https:// doi.org/10.1016/ j.foodchem.2013.10.015

Jo, C., Zhang, J., Tam, J.M., Church, G.M., Khalil, A.S., Segre, D. and Tang, T.C. (2023) Unlocking the magic in mycelium: Using synthetic biology to optimize filamentous fungi for biomanufacturing and sustainability. *Materials Today Bio*, *19*, p.100560.

Karunarathna, S.C., Mortimer, P.E., Xu, J. and Hyde, K.D. (2017) Overview of research of mushrooms in Sri Lanka. *Revista Fitotecnia Mexicana*, *40*(4), pp.399-403.

Kic, P. (2018) 'Mushroom drying characteristics and changes of colour', *Engineering for Rural Development*, 17, pp. 432–438. Available at: https:// doi.org/10.22616/ ERDev2018.17.N009.

Kuka, M. and Cakste, I. (2011) 'Bioactive compounds in Latvian wild edible mushroom Boletus edulis', *6th Baltic Conference on Food Science and Technology: Innovations for Food Science and Production, FOODBALT-2011 - Conference Proceedings*, pp. 116–120.

Ogbe, A. O., & Obeka, A. D. (2013) Proximate, mineral and anti-nutrient composition of wild Ganoderma lucidum: Implication on its utilization in poultry production. *Iranian Journal of Applied Animal Science,* 1(3), pp 161–166.

Ullah, M.I., Ijaz, M.U., Hussain, G., Faisal, M.N., Rasul, A., Bukhari, S.A., Mustafa, I. and Anwar, H. (2020). Estimation of Protein and Productive Efficiency Profile of Locally Produced Oyster Mushroom (*Pleurotus Ostreatus*) in Broiler.

Wannet, W.J., Hermans, J.H., van der Drift, C. and Op den Camp, H.J. (2000) HPLC Detection of Soluble Carbohydrates Involved in Mannitol and Trehalose Metabolism in the Edible Mushroom Agaricus bisporus. *Journal of Agricultural and Food Chemistry*, 48(2), pp.287-291.

Wickramasinghe, M.A. *et al.* (2023) 'Comparison of nutritional composition, bioactivities, and FTIR-ATR microstructural properties of commercially grown four mushroom species in Sri Lanka; Agaricus bisporus, Pleurotus ostreatus, Calocybe sp. (MK-white), Ganoderma lucidum', *Food Production, Processing and Nutrition*, 5(1). Available at: https://doi.org/10.1186/ s43014-023-00158-9