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Chemical profile and amino acids composition of edible mushroom

Neerja Rana[1], Devina Vaidya[2], Surabhi Sharma[3*] and Nilakshi Chauhan[2]

[1]Department of Basic Sciences, Dr YS Parmar University of Horticulture and Forestry, Nauni-173230, Solan, HP, India
[2]Department of Food Science and Technology, Dr YS Parmar University of Horticulture and Forestry, Nauni-173230, Solan, HP, India
[3]Institute of Food Science and Technology, Majrigrant, Dehradun, VCSG Uttarakand University of Horticulture and Forestry, Uttarakhand, India

*Corresponding author: surbhisml@gmail.com

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ABSTRACT

Study was conducted to evaluate the functional properties of popularly cultivated mushrooms viz., white button mushrooms *(Agaricus bisporus)* and oyster mushrooms *(Pleurotus pulmonarius*. Both types of mushroom exhibited high moisture, crude protein and amino acid content. The *Pleurotus* and *Agaricus* mushrooms contained 3.26% and 1.78% soluble protein, respectively. Further, the qualitative amino acid analysis revealed these proteins to be rich source of essential amino acids. A total of 17 amino acids were qualitatively identified in the fresh samples of both types of mushrooms. The Thin Layer Chromatography separation of amino acids showed that all the nine essential amino acid were present in *Agaricus bisporus* whereas, only five are present in *Pleurotus pulmonarius*. Hence, the supplementation of these mushrooms with cereal diet can help to overcome essential amino acids deficiency and reduce the post-harvest losses of this high value perishable crop.

Highlights

- The two species of mushrooms i.e. *Agaricus bisporus* and *Pleurotus pulmonarius*are rich source of essential amino acids
- Thin Layer Chromatography separation of amino acids showed nine essential amino acid in *Agaricus bisporus* and five in *Pleurotus pulmonarius*
- The conversion of fresh mushroom into dried powder can increase the shelf life and retains the amino acids present

Keywords: *Pleurotus pulmonarius*, *Agaricus bisporus,* Mushroom, protein, amino acid profile, protein content

Mushrooms are popularly known as functional foods (Liu and Wang 2009). The production of mushrooms is continuously increasing globally and China is the biggest producer in the present context. Diversified agro-climatic conditions in India offer vast potential for growing different types of mushrooms. There are about 20 varieties of mushrooms being cultivated throughout the world. In India, only white button mushroom (*Agaricus bisporus*), oyster mushroom (*Pleurotus* spp.) and paddy straw mushroom (*Volvariella volvacea*) are grown commercially. Out of these, white button mushroom contributes ~90% of the total production. These species require shorter growth time as compared to other edible mushrooms, and demand few environmental control. Their cultivation is simple and can be grown on agro-wastes.

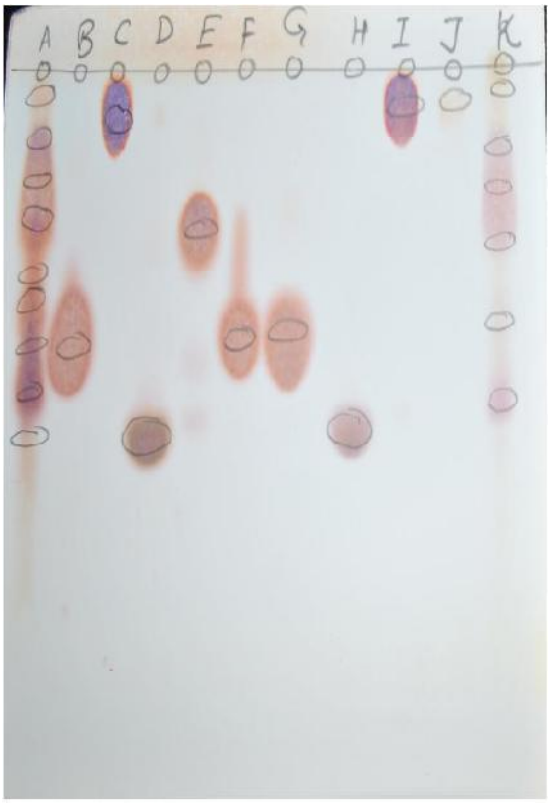

Plate 1: The Schematic representation of the amino acids (TLC plate) of the mushroom with standards A), *Agaricus bisporus* B) Methionine,C) Arginine D) Tryptophan E) Threionine F) Valine G) Isoleucine H) Phenylalanine I) Lysine J) Histidine K) *Pleurotus pulmonarius*

Plate 2: The Schematic representation of the amino acids (TLC plate of the mushroom A) Fresh B) & C) Dry powdered Mushroom of *Agaricus bisporus*

Mushrooms have a great nutritional value since they are quite rich in protein, with an important content of essential amino acids, fiber and poor in fat. Edible mushrooms also provide a nutritionally significant content of vitamins (B1, B2, B12, C, D and E) (Heleno *et al.* 2010; Mat ila *et al.* 2001). Edible mushrooms could be a source of many different nutraceuticals such as unsaturated fat y acids, phenolic compounds, tocopherols, ascorbic acid and carotenoids. Babu and Rao (2013) and Ghahremani-Majd and Dashti (2015) found that *Agaricus bisporus* was high in antioxidants. The global economic value of these mushrooms is now increasing and a prime reason for the rise in consumption is food value coupled with their medicinal and neutraceutical constituents. Thus, they might be used directly in diet and promote health, taking advantage of the additive and synergistic effects of all the bioactive compounds present (Barros *et al.* 2007; Barros *et al.* 2008a; Barros *et al.* 2008b; Ferreira *et al.* 2009; Pereira *et al.* 2012; Vaz *et al.* 2010). However, these are perishable species and maximum storage life is 15 days under refrigerated conditions. Thus, despite of their neutraceutical value, the commercial cultivation of these mushrooms is limited in our country but some non profit organizations are encouraging the farmers to take up mushroom cultivation as it is potential crop with high nutritional benefits (Singh and Singh 2014). Therefore, the present study was undertaken to characterise the protein and amino acid profile in fresh and dry powder of two popular mushroom types namely *Agaricus bisporus* and *Pleurotus pulmonarius.*

Table 1. Nutritional value of mushrooms (mean ± SD)

Characteristics	White button mushroom (Fresh)	White button mushroom (Dry)	Oyster mushroom (Fresh)	Oyster mushroom (Dry)
Moisture (g/100 g)	91.02 ± 0.04[b]	4.38+0.04[a]	89.17 ± 0.08[b]	4.88+0.02[a]
Ash (g/100 g)	0.78 ± 0.01[a]	6.98+0.01[b]	0.62 ± 0.03[a]	13.21+0.02[a]
Proteins (g/100 g)	3.26± 0.08[b]	33.25+0.08[d]	1.78 ± 0.04[a]	30.30+0.04[b]
Total Free Amino acids (mg/g)	30.12±1.2		25.52±2.2	
Fat (g/100 g)	0.19± 0.01[b]	1.92[d]	0.15± 0.02[a]	1.10+0.03[e]
Carbohydrates (g/100 g)	6.46± 0.03[a]	64.21[a]	9.02± 0.02b	76.11+0.02[d]
Energy(kcal/100 g)	29.55 ± 0.32[a]	300.62[a]	37.24± 0.14[b]	384+0.11[d]

*All data are the mean ± SD of the three replications. Mean followed by different letters in the same column differs significantly(p 0.05)

Table 2. Colour test for presence of different amino acids

Test/ reaction	Specificity of test	Colour obtained	Remarks
Nin hydrin test	amino acid present	Purple colour	All amino acid may present
Xanthoproctic test	All aromatic amino acids are present	Orange yellow	All aromatic amino acid present
Million's Test	tyrosine	Brick red	tyrosine
Pauly;s test	Tyrosine, Trptophan, Histidine	red	Histidine present
Hopkin-Cole Test	tryptophan	Violet ring	Tryptophan present
Sakaguch's test	Arginine	red	Arginine present
Sodium nitroprosside Test	Cysteine and methionine	Red	Cysteine and methionine present

Table 3. Qualitative Analysis of Amino acid using thin layer chromatography

Distance travelled by Solvent (cm)	Distance at which spot appeared (cm)		Colour of the spot	RF Value of standard 0.40	Calculated RF value		Amino acid
	Agaricus bisporus	Pleurotus pulmonarius			Agaricus bisporus	Pleurotus pulmonarius	
8.8	4.5	4.9	Pink	0.59	0.51	0.55	Methionine
8.8	1.5	1.8	Blue	0.16	0.17	0.20	Arginine
8.8	5.8	---	Brown	0.65	0.65	----	Tryptophan
8.8	2.1	2.3	Pink	0.25	0.23	0.26	Threonine
8.8	3.5	---	Pink	0.35	0.39	----	Valine
8.8	3.0	3.2	Pink	0.33	0.34	0.36	Isoleucine
8.8	4.7	---	Brown pink	0.50	0.53	----	Phenylanine
8.8	1.9	1.7	Yellow	0.19	0.21	0.19	Lysine
8.8	2.1	2.0	Orange	0.22	0.23	0.22	Histidine

Materials and Methods

The two mushrooms species (*Agaricus bisporus* and *Pleurotus pulmonarius*) were purchased from the Department of Plant Pathology, Dr YS Parmar University of Horticulture and Forestry Nauni, India. However, the studies were carried out in the Departments of Basic Sciences and Food Science and Technology, Dr YS Parmar University of Horticulture & Forestry Nauni, India. Randomly three fruiting bodies per type were sampled. All the samples were reduced to a fine dried powder (20 mesh), homogenised and stored in a desiccators, protected from light, until further analysis.

The samples were analysed for different chemical constituents viz., moisture, proteins, fat, total free amino acids, carbohydrates and ash using the standard AOAC procedures (AOAC 1995). The crude protein content of the samples was estimated by the Macro-Kjeldahl method; the crude fat was determined by extracting a known weight of powdered sample with petroleum ether, using a Soxhlet apparatus. The ash content was determined by incineration at 600±15 ºC. Energy was calculated according to the following equation: Energy (kcal) = 4 × (g protein) + 3.75 × (g carbohydrate) + 9 × (g fat). The Amino acids were extracted using methanol on soxhlet and then concentrated using distillation. The extracted samples were run over thin layer chromatography (TLC) silica gel plate along with standard amino acids and were compared using RF value (Thimmaiah 2006)

Results and Discussion

The results on the nutritional value of the two mushrooms type are presented in table 1. Moisture content was 91.02% in white but on mushroom and in 89.17% in Oyster mushroom. The variation in percent moisture content of different types has also been reported by Guillamón *et al.* (2010) which have been related to harvest, growth, culinary and storage conditions. Agaricus and oyster mushrooms contain high content of protein, without significant statistical differences (3.26-1.78 g/100 g). Mushrooms are reported to be a good source of protein, and some investigators have even pointed out that the amino acid compositions of mushrooms are comparable to animal proteins (Longvah and Deosthale 1998; Mat ila *et al.* 2002). The fat content of both the species were found to be very low (0.19 and 0.15 g/100 g). In general, mushrooms are low calorie foods as they provide low amounts of fat (León-Guzmán *et al.* 1997). The ash content was found to be 0.78 percent and 0.62% in *Agaricus* and *Pleurotus* mushroom respectively. The main constituents in the ash are potassium and, depending on the mushroom, phosphorus (Mat ila *et al.* 2002) or magnesium. The higher protein content in both types was further confirmed by qualitative tests which indicated the presence of 17 amino acids (Table 2).

The Thin layer Chromatography of dried powdered mushrooms of both the type (TLC fingerprint) indicated the presence of all the nine tested essential amino acid in white but on mushroom having same RF value with that of standard and five were present were in Oyster mushrooms (Plate 1) . The comparison of fresh and dry mushrooms indicated the presence of all the essential amino acid in dried mushroom powder (Plate 2)

The rich nutritional composition of the two important mushroom types namely, *Agaricus bisporus* and *Pleurotus pulmonarius* grown in niche area of Solan Distrct of Himachal Pradesh, India recorded higher protein and carbohydrates, low contents of fat which make them excellent food with low caloric value. Both types of mushrooms contained comparable moisture, ash, carbohydrates and energy values. The protein content and free amino acids were high in *Agaricus biosporus* containing all the nine essential amino acid in fresh and dried mushroom powder whereas five were present in *Pleurotus pulmonarius* powder. Further, the mushrooms being a perishable commodity can also be consumed in dried form with all neutraceuticals and essential amino acids.

Conclusion

The rich nutritional composition of the two important mushroom types namely, *Agaricus bisporus and Pleurotus pulmonarius* grown in niche area of Solan

District of Himachal Pradesh, India recorded higher protein and carbohydrates, low contents of fat which make them excellent foods with low caloric value. Both types contained comparable moisture, ash, carbohydrates and energy values. The protein content and free amino acids were high in *Agaricus biosporus* containing all the nine essential amino acid in fresh and dried mushroom powder whereas five are present in fresh *Pleurotus pulmonarius* and dried powder. Further, the mushrooms being a perishable commodity can also be consumed in dried form with all neutraceuticals and essential amino acids.

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