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# Total soluble protein, phenols and nitrogen contents of *Pleurotus djamor* (Fr.) Boedijn

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Analyses from different stages of white ecological variant of pan tropical mushroom *Pleurotus djamor* (Fr.) Boedijn procured from northern tropical moist deciduous forests of Tripura (India) revealed that it contained 0.12%-0.27% of total phenols, 1.88 – 2.96% of total soluble protein and 0.10-0.44% total nitrogen on the fresh weight basis. Both total soluble protein and total nitrogen parameters were found to be highest in juvenile bud stage and gradually decreased in consecutive other stages i.e., pre-mature (two days old), mature (three days old) and post-mature (four days old) stages. Besides, quantitative estimation of total phenols revealed that the species showed highest amount of phenols in juvenile bud stage (one day stage) and gradually decreased, but at post-mature (four days old) condition, amount of total phenol again increased. From these studies, it was concluded that the consumption of this edible mushroom would be better at 2-3 days mature stage but not at juvenile stage or post-mature (four days old) stage.

**Key words** : *Pleurotus djamor* (Fr.) Boedijn., soluble protein, total nitrogen, total phenols

## INTRODUCTION

Perhaps no subject is of more interest to the people in the day-to-day life than the search for palatable foodstuffs and determination of their dietary constituents. Everyone needs to secure one's life with foodstuffs which should be contributed with better flavour and taste, better source of protein, having acceptable biting properties, low calorie as well as cost effective, easily digestible and should be nontoxic (Alvarez-Parrilla *et al.,* 2007). Mushrooms represent one of the world's greatest untapped resources of nutritious and palatable foods. Mushrooms have been used as traditional foods and medicines in different parts of the world, including Asia, Africa and America (Alvarez-Parrilla *et al.,* 2007). As in America and other corners of the world, wild edible mushrooms have been a part of the diet, especially among ethnic groups (Alvarez-Parrilla *et al.,* 2007). They have nutritional relevance due to their high fiber, minerals and protein content, as well as low fat content (León-Guzman *et al.,* 1997). Several studies analyzing the total soluble proteins, total phenols, total amino acid compositions and antioxidant activity of fresh and cooked wild and commercial mushrooms have been published (Mau *et al.,* 2001, Lakshmi *et al.,* 2004; Lo and Cheung, 2005, Choi *et al.,* 2006, Ferreira *et al.,* 2007, Alvarez-Parrilla *et al.,* 2007). Among the antioxidant compounds, polyphenols have gained importance due to their large array of biological actions that include free radical scavenging, metal chelation and enzyme modulation activities, inhibition of low density lipoprotein (LDL) oxidation. (Rodrigo and Bosco, 2006; Alvarex-Parrilla *et al.,* 2007). The term 'polyphenol' refers to a complex group of compounds that includes in their structure an aromatic ring bearing one or more hydroxyl groups. They include simple phenols such as phenolic acids and derivatives, as well as complex structures such as flavones, flavonoids, anthocyanins, among others (Alvarez-Parrilla *et al.,* 2007). The objective of this study has been to analyze the differences among various stages of

wild *Pleurotus djamor* mushroom in accordance with their level of total soluble protein, total nitrogen and total phenols collected from the mixed type of forest of Tripura.

## MATERIALS AND METHODS

### *Collection of samples*

Wild mushrooms of various stages were collected at the end of the rainy season from northern tropical moist deciduous forests of Tripura (20°51´-24°32´ N latitude and 90°10´-92°21´ E longitude) during July-Ausust, 2010. Ten to twenty mushrooms of each stages (10 g) were collected and kept on ice 4-6 h for transportation to the laboratory. Mushrooms were classified up to species level, using morphological and anatomical characteristics. Mushrooms samples were sent to Mycological Research Laboratory of ICAR, Lembucherra, for identification and were identified as *Pleurotus djamor* (Fr.) Boedijn. (white ecological variety). Wild mushrooms were cut, weighted and frozen at –10°C for 1 day, lyophilized for 48 h (Labconco Freeze dry/shell freeze system), milled and stored at –10°C. In order to minimize variability between individuals from the same species, all mushrooms from the same specie were homogenized according to the modified method of Alvarez-Parrilla *et al.* (2007). Different stages of mushroom were expressed in the following terms juvenile (one day old), pre-mature (two days old), mature (three days old) and post-mature (four days old)

### *Proximate analysis of total (phosphate buffer) soluble protein*

The total (phosphate buffer) soluble protein was estimated from the stipe connecting pileus of mushroom for different stages (24, 48, 72 and 96 h) after soaking treatment. The procedure of Lowry *et al.* (1951) was followed for estimation of total (phosphate buffer) soluble protein. The standard curve for protein was prepared using boving serum albumin (BSA) as standard protein. The unknown amount of protein in the sample was determined using a standard curve and also taking into account all the possible variables. Amount of total soluble protein was estimated as g per 100 g fresh weight (FW) basis.

### *Proximate analysis of total nitrogen*

The level of total nitrogen (soluble and insoluble) were estimated by the modified Micro-Kjeldahl method of Lang (1958). The ethanol soluble and insoluble nitrogen fractions were estimated at different stages in oven dried samples of stipe connecting pileus part of mushroom. Amount of total nitrogen was estimated as g per 100 g fresh weight (FW) basis.

### *Determination of total phenols*

Mushroom extracts were obtained according to the methodology proposed by Kähkönen *et al.* (1999) and Alvarez-Parrilla *et al.* (2007). Total phenols were determined according to the method reported by Georgé *et al.* (2005), with the Folin-Ciocalteu reagent, using tannic acid in ethanol (80%) as standard. Absorbance at 650 nm was determined by using Systronics UV-VIS Model-117 Spectrophotometer and results were expressed as mg of tannic acid (TNA) per 100 g fresh weight (FW) basis.

### *Statistical analysis*

Values are presented as the mean ± SEm of five replicates. For standard error of the mean (SEm), the obtained results (data) were statistically analyzed according to Steel and Torrie (1980). Two-way ANOVA analyses were performed in order to determine differences between various biochemical parameters and various stages of mushrooms at 5% significant level, using the commercial software SPSS 13.0 (SPSS Inc. Headquarters Chicago, Illinois, USA).

## RESULTS AND DISCUSSION

Mushrooms apart from being famous for their appetizing flavour, offer themselves as potential protein source. The great advantage is that mushrooms have the capacity to convert nutritionally valueless substances into high protein food (Chang and Hayes, 1978). The digestibility of mushroom protein was as high as 72-83% (Lintzel, 1941). Mushrooms are useful for diabetic and heart patients and an important source of nutritive proteins and minerals to the vegetarians (Bahl, 1994). Initially the

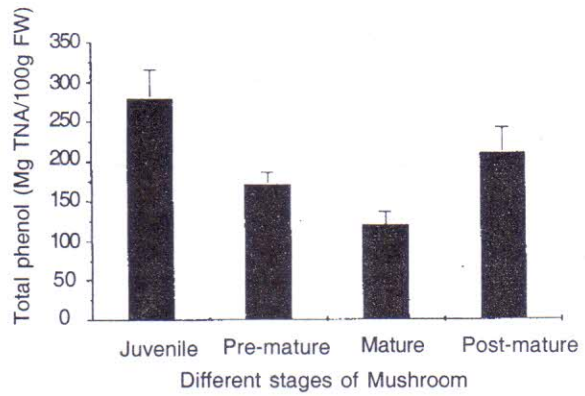


**Fig 1.** Amount of total phenols on stipe connecting pileus part in different stages of mushroom

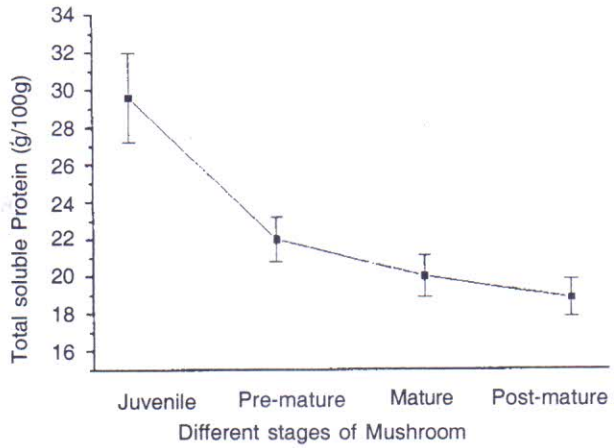


**Fig 2.** Amount of total soluble protein in different stages of mushroom

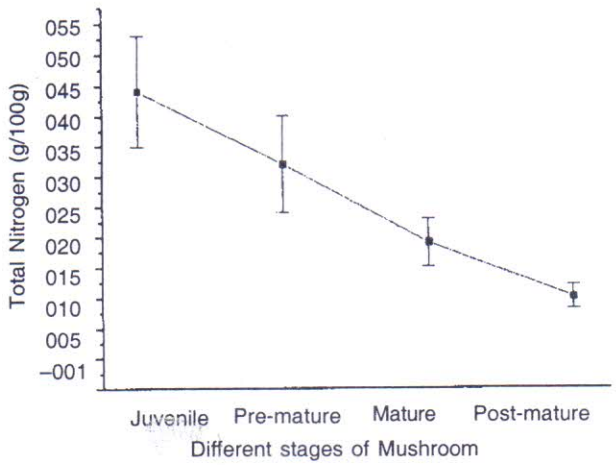


**Fig 3.** Amount of total nitrogen in different stages of mushroom

crude protein content of the common mushroom *Agaricus bisporus* has been reported to be 19-38% on a dry weight (DW) basis.

The present studied mushroom is under the genus *Pleurotus.* More than 100 strains of *Pleurotus* have been cultivated (Mata and Salmones, 2003), mainly strains of *P. ostreatus* (Jacq. : Fr.) Kumm., *P. columbinus* Bres., *P. pulmonarius* (Fr.) Quel., and *P. djamor* (Fr.) Boedijn (pink and white ecological varieties). The present mushroom under the investigation is a white ecological variety of *P. djamor* (Fr.) Boedijn. The data of Table 1 revealed that the total soluble protein content was highest (2.96 g/100 g fresh weight) at juvenile stage (1 day) and gradually decreased in pre-mature, mature and post mature stages (Fig. 2). Same trends were found for total nitrogen content which was found highest (0.44 g/100 g fresh weight) at juvenile stage (1 day) and gradually decreased in pre-mature, mature and post mature stages (Fig. 3).

In literature, protein analysis of *Pleurotus ostreatus* was found to be 15-35% and 4.6-33% on fresh and dry weight basis, respectively (Chang and Hayes, 1978; Hafiz *et al.,* 2003). Mushrooms, the fruiting bodies of fungi, are appreciated not only for their texture and flavour but also for their high protein and other nutritional characteristics (Manzi *et al.,* 1999). Nutritionally, mushrooms provide key nutrients and bioactive components such as high-quality proteins, vitamins, minerals, unsaturated fatty acids and fibers (Danell and Eaker, 1992; Buswell and Chang, 1993; Omarini *et al.,* 2010). *P. tuber-regium,* contained crude protein ranging from 4.1 to 13.8% with the highest concentration in the cap (13.8%) than other parts. In *P. eryngii,* the level of protein was reported to be 24.08% on fresh weight basis (Hassan *et al.,* 2010). But varying amount of protein contents in edible mushrooms from other parts of the world were also reported. For example, Adejumo and Awosanya (2005) reported protein contents of two mushrooms i.e., *Auricularia* sp. (with 4-9% protein) and *Agaricus* species (with 24-44% protein) from Africa, whereas Kalyoncu *et al.,* (2010) reported higher amount of protein in three edible mushrooms – *Sparassis crispa* (83.40%), *Armillaria mellea* (76.94%) and *Meripilus giganteus* (75.56%) from Antolia. *Pleurotus sajor-caju* fruit bodies when grown in three different substrates, showed varied level of proteins content – highest (16%) in wheat straw,

**Table 1 :** Estimation of total protein, phenols and nitrogen in stipe connecting pileus part of *Pleurotus djamor*

| Mushroom sample | Amount of biochemical parameters | | |
|---|---|---|---|
| | Total phenol (mg/100g) | Total protein (g/100 g) | Total nitrogen (g/100 g) |
| Juvenile (1 day stage) | 279.119 ± 0.042* | 2.960 ± 0.031 | 0.440 ± 0.061 |
| Pre-mature (2 days stage) | 144.754 ± 0.065 | 2.211 ± 0.021 | 0.334 ± 0.054 |
| Mature (3 days stage) | 127.105 ± 0.018 | 1.986 ± 0.032 | 0.210 ± 0.010 |
| Post-mature (4 days stage) | 208.544 ± 0.021 | 1.880 ± 0.051 | 0.100 ± 0.007 |

*All the readings are based on 5 replicates ± SEM

**Table 2 :** Two-Way ANOVA analyses of the data

| Sources of variation | df | SS | MS | F | F(0.05) |
|---|---|---|---|---|---|
| Row | 4 | 0.02251 | 0.00752 | 4.268 | 3.0069 |
| Column | 4 | 0.96582 | 0.04112 | 26.635 | 3.0069 |
| Error | 16 | 0.01478 | 0.00215 | | |
| Total | 24 | 1.00311 | | | |

medium (13.4%) in water hyacinth and lowest (10.8%) in corn cobs substrate (Kihumbu *et al.,* 2008).

Though available literature of biochemical parameters for *P. djamor* is very meager, the present result is in accordance with the previous results for edible pileus parts of the different species of *Pleurotus* as well as for other genera also and agreed the significant level of protein and nitrogen contents (Petrovska. 2001; Oyetayo and Oyetayo, 2005; Khan *et al.,* 2009; Manjunathan and Kaviyarasan, 2010; Cuptapun *et al.,* 2010). The variation may be due to the variation in species of mushrooms or due to the stages of development or due to variation in soil and location (Flegg and Maw, 1977).

The data from Table 1 revealed that the total phenol content was highest (279.119 mg/100 g fresh weight) at juvenile stage and gradually decreased in pre-mature and mature stage. But it increased up to 208.544 mg/100 g FW in post mature stage (Fig. 1). Mushroom contains various polyphenolic compounds recognized as an excellent antioxidant due to their ability to scavenge free radicals by single electron transfer (Hirano *et al.,* 2001). Some common edible mushrooms which are widely consumed in Asian countries, have currently been found to possess antioxidant activity which also correlated with their total phenolic content (Cheung and Cheung, 2005; Cheung *et al.,* 2003; Lo and Cheung, 2005; Mau *et al.,* 2004; Yang *et al.,* 2002; Yen and Hung, 2000).

High phenolic compounds might account for good antioxidant properties found in all species of *Leucopaxillus giganteus* (629 mg/100 g), *Sarcodon imbricatus* (376 mg/100 g) and *Agaricus arvensis* (283 mg/ 100 g) (Barros *et al.,* 2007). Among the antioxidant compounds, polyphenols have gained importance due to their large array of biological actions that include free radical scavenging, metal chelation, enzyme modulation activities and inhibition of LDL oxidation (Rodrigo and Bosco, 2006; Alvarez-Parrilla *et al.,* 2007).

Statistical analyses (Table 2) considering the amount of chemical constituents in each experimental set (two-way ANOVA) revealed that calculated F (26.635) for various amount of biochemical parameters in stipe connecting pileus part of the present studied mushroom was much

higher than tabulated F (3.0069) value and hence three different types of biochemical parameters exhibited highly significant effect on different stages of white coloured mushroom *P. djamor.* Again, amount of biochemical parameters from different stages of white coloured mushroom *P. djamor* revealed that calculated F (4.268) was found to be slightly higher than tabulated F (3.0069) and hence amount of biochemical parameters from different stages of white coloured mushroom *P. djamor* was also found significant (Table 2). It can be concluded that the investigated wild edible white coloured mushroom *P. djamor* is a good source of food in terms of protein and may be cultivated and can be easily consume.

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