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Nutritional and health importance of fresh and dehydrated oyster Mushroom (*Pleurotus Florida)*

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Abstract
Mushrooms are popular food and commercially available in India. The food experts have also realized and increasingly appreciated the food value of mushroom because of the low calorific value and very high content of protein vitamins and minerals. These are very low calorie food suited to those interested in cutting down the calorie intake, like obese persons. Being low in fat, devoid of cholesterol, these make an ideal diet for the heart patients. With very high fibre and alkaline elements, mushrooms are suited to those suffering from hyperacidity and constipation, consumption of fiber has gained importance in general health maintenance. It has been reported that daily intake of 100-200 g (dry weight) of mushroom can provide nutritional balance in a normal human being.

Keywords: Micronutrients, health, value addition, post-harvest

Introduction
Mushroom is a macroscopic fungus having various shapes, sizes, appearance and edibility. They are used as a food since time immemorial due to their taste and other health beneficial functions. The word 'mushroom' is believed to be derived from the French word 'Mouse'or 'Moss' , while in India it is known as 'Ksumpa' in Sanskrit and 'Khumbi' or 'Kukurmutta' in hindi. Reference about their occurrence and utilization as a food and medicine are found in classical religious writings like Vedas, Bible.

Some reports indicate their potential as lifesaving drugs, antibiotic and biologically active substance. Mushroom is a fleshy sponge umbrella shaped form belonging to kingdom *Mycota*. It lacks the usual green chlorophyll and therefore cannot synthesize its own food photo synthetically therefore needs a substrate for their own absorptive nutrition. They produce enzymes that degrade complex organic substances. The nutrients absorbed by the mycelium out of decaying matter accumulate and get transferred into various constituents of fruiting body. Mushrooms are known as wonder vegetable as they have unique growth pattern and quick multiplication. The significant feature of mushrooms is that they are cultivated entirely on waste products and convert a wide spectrum of agriculture and industrial waste into substance on which growth is supported. So mushroom cultivation is emerging as a promising agro based and land independent enterprise, having capacity to convert nutritionally valueless substance into high protein food.

There are about 20 species of mushroom being cultivated throughout the world as food. Diversified agro climatic conditions in India offer vast potential for growing different types of mushrooms. In India only four species Viz White button (*Agaricus bisporus*), Oyster mushroom (*Pleurotus spp*), White milky mushroom (*Calocybe Indica*) and Paddy straw mushroom (*Volvariella volvacea*) are grown commercially (Tiwari, 2004). Amongst the varieties of cultivated edible mushroom, oyster mushroom (*Pleur*otus *species*) popularly known as *dhingri* in north India has its origin from Greek word 'Pleuro' which means formed laterally or in a sideway position.

Oyster refers to shell like appearance of fruiting bodies. These are lignocellulosic fungi having capabilities to fight against hunger, malnutrition prevalent among vulnerable group by producing protein rich food. At present, thirty nine *Pleurotus* species have been reported throughout world and in India, twenty two species have been identified, out of which species namely *Pleurotus Sajor-caju*, *Pleurotus eryingii*, *Pleurotus flabellatus*, *Pleurotus ostreatus* and *Pleurotus sapidus* etc. are cultivated. These can be grown on various materials like paddy straw, wheat straw, maize stalks etc. as a substrate with no added nitrogen for commercial production (Das, 2006) [5].

World production of mushrooms is estimated to be about 12 million tonnes and the annual growth rate is still above 8%, India too, though late starter is fast catching up current production with annual growth rate of above15%. The venture is no more confined to the seasonal growing in the northern region, it has spread far and wide in the country. Besides the seasonal farmers, many big environmentally controlled units have also come up as export-oriented units.

The Indian mushroom industry comprises mainly of small seasonal growers and few export oriented commercial farms having highly technical and environmental control facilities. The mushroom production in India is mainly confined to Himachal Pradesh, Kashmir, Uttar Pradesh, Tamil Nadu and some parts of Haryana, Punjab, Orissa, Karnataka and Delhi. Production of mushroom is increasing at a faster rate from 4000 tonnes in 1985-86 to 60,000 tonnes in 2000 and to 70,000 tonnes in 2006. In India, Haryana is the leading mushroom growing state with approx production of 7000 tonnes per annum. Majority of mushroom growers cultivate white button mushroom (93%) and very few oyster mushrooms (7%) of total mushroom production in Haryana state. Oyster mushroom is the third largest cultivated mushroom in the world and contributes approximately 16 per cent to the total world production. It is gaining popularity due to its diverse ability of growth at a wide range of temperature at a nominal capital investment and recycles the agro and industrial wastes. Production of oyster mushroom or dingri (*Pleurotus spp.)* is less in Haryana due to its poor market as a fresh commodity because of characteristic flavour, meaty texture and general suspicious of some of them being poisonous.

Mushroom can serve as one of the most important sources of vegetable protein combating the growing shortage of protein especially in vegetarian population. FAO has recommended it as a supplementary food item in context of world protein shortage for the growing populations of the developing countries. The protein content of fresh mushroom is higher than most of vegetable with the exception of green peas and pulses. Mushrooms are almost equal to meat and milk in nutritional value. Essential amino acids index, amino acids score and nutritional index lies intermediate between low grade vegetable and high grade meats and values are close to that of milk.

Mushroom contains about 90 per cent moisture and cannot be stored more than 24 hours at ambient temperature due to its highly perishable nature. Development of brown color is the first sign of deterioration of mushroom. Mushroom do not bear any outer protecting covering therefore rate of respiration from surface is very high. These conditions make them highly perishable in nature and hence they can be stored only for few hours under ambient conditions of tropics and subtropics. Surface browning, severe desiccation, texture loss is some of the symptoms associated with their spoilage

In India, these are seasonally available as most of the cultivation is seasonal using low-cost technology. Fresh mushroom market is largely catered by the seasonal growers who do not have cool-chain storage and transport facilities and all the produce in highly localized markets needless to mention that such seasonal players at times face the consequences of over-saturated market and understandably resort to distress sales at un remunerative prices. Post-harvest losses are very high in most of the horticultural commodities and it may be one of the highest in mushrooms. Mushrooms even after harvesting continue to grow, respire, mature and senesce resulting in weight loss, veil-opening, browning, wilting and finally in spoilage. Drying is one of the oldest techniques of food preservation known to man. It is essential that the moisture content is reduced to a level (< 5 %) as microorganism cannot grow at this level (Rama and Jacob, 2002) [9].

During peak period of harvesting glut in market can be checked by adopting appropriate post-harvest techniques and to process surplus mushroom. The shelf life of mushroom is around 24 hour at ambient temperature, dehydration appears to be a promising cost effective method of preservation for Indian condition since the mushroom is not available throughout the year. Thus there is need for processing the mushroom to increase their off season availability export potential.

Mushroom production and substrate for cultivation

Oyster mushroom is an ideal income generating activity for the landless women and unemployed rural youth. Being labour intensive, significant value addition, dependence on locally available abundant and cheap raw material, low initial investment, simple technology and limited space requirement, it is worthwhile proposition. Mushroom production has been assuming great importance in Haryana, particularly in districts like Sonepat, Gurgaon, Rohtak and Hisar. The cultivation of this crop might be very remunerative and, therefore, the net return would be better than other crop.

Due to several advantages of mushroom cultivation such as its nutritional value, taste and low production cost, it has been accepted by rural people. The oyster mushroom cultivation could very well supplement the income of rural household; thus, it is a useful alternative vocation in rural development. Nutritional value of mushroom largely depends on chemical composition of the compost which is a mixture of straw or hay, corn cobs, water, cottonseed meal and nitrogen supplemented. Seven substrates Viz. paddy straw, wheat straw, black gram waste, mustard waste, sugarcane baggage, tea waste and banana pseudostem for the cultivation of *Pleurotus sajor-caju.* Among the various substrates, paddy straw produced significantly higher yield followed by black gram waste than the other substrate. A huge agro waste available and if mushrooms are grown on the agriculture waste, this would not only reduce environmental hazard by helping in disposal of these waste but also help us to produce useful protein rich food. Mushroom cultivation does not require fertile land and do not increase pressure on already overburdened cultivation land. Suman and Gupta (2000) [10] reported that economic analysis of *dhingri* (oyster mushroom) cultivation is an economically alternative enterprise for the small and marginal farmers in lower areas of Himanchal Pradesh. Its cultivation technique is simple, requires less space and remains profitable even under the adverse market and production situations. Many biological wastes that are available in plenty in the rural areas can be used for its production. According to Upadhyay and Verma (2000) [11] oyster mushroom (*Pleurotus spp*) is the third largest cultivation mushroom in the world and contributed 16.3 per cent to the total world mushroom production. India is blessed with varied agro-climatic from temperature, subtropical to tropical, which is suitable for the cultivation of different type of mushrooms. Several factors like strains,

substrates, spawing media and rate are responsible for nutritional composition and yield of oyster mushroom, but substrate played a major role in variation of nutritional composition and yield among these factors. Lakshmi *et al*. (2005) observed that oyster mushrooms (*Pleurotus. spp*) are widespread through-out the hardwood forest of the world. They are edible, nutritious and secure third rank among the cultivated mushrooms in the world.

Nutritional Composition of Mushroom

Mushrooms are edible fungi which need organic matter to grow. Mushroom secretes enzymes to digest surroundings foodstuff and to get nutrients from organic matter, which is called compost. Nutritional value of mushroom as a result largely depend on chemical composition of the compost (substrate) which is a mixture of straw or hay, corn cobs, water, cotton seed meal and nitrogen supplement. Thus, there are wide variations in the nutritional composition reported for the same species by different workers. Besides, the differences due to variation in the genetic make-up of the species, cultivation technology and the condition at the stage of harvest as well as post-harvest are reported to affect the composition (Rai and Saxena, 1998).

Proximate composition

Mushrooms are richer source of protein as compared to cereals, pulses, fruits and vegetables on dry weight basis. Besides protein (3.15%), it also contains 2.4% carbohydrates, 0.4% fat, 1.0% fiber, and 91% moisture on fresh weight basis. Four species of *Pleurotus* mushrooms i.e. *Pleurotus Florida, Pleurotus sajor-caju* and two hybrids of *Pleurotus ostratus* and *Pleurotus florida* were analysed for amino acids and protein contents. Amino acid contents ranged from 21.7 to 27.7 per cent depending on the varieties. Essential amino acids, total protein nitrogen and non-ammonia nitrogen contents were 51.0 to 53.2 per cent, 3.3 to 3.5 per cent and 46.5 per cent, respectively.

According to FAO, mushrooms can serve as an alternative source of proteins in developing countries, where the population mainly depends on cereal based foods, the efficiency with which the mushrooms convert carbohydrates into protein is about 65 per cent in comparison to 20 per cent for pork, 15 per cent for poultry and 45 per cent for beef. The oyster mushroom cultivated on paddy straw, banana leaves, sugarcane baggage, water hyacinth and beetle nut husk contain moisture content 88.15 to 91.64 per cent, crude fibre contents ranged from 1.49 to 1.90 per cent, whereas, energy value of fruit bodies was between 310.00 and 352.32 Kcal/100g of fruit body weight.

Mushrooms are rich sources of many things that are important to our health. They are a good source of proteins that are important to all body functions. Their proteins are of very high quality and are rich in the most important protein building blocks, the essential amino acids. They are an excellent source of most B vitamins and the primary natural source of ergo sterol or pro-vitamin D. While many people who eat balanced diets receive all of the needed minerals, some get more sodium than they need. Mushrooms have the double benefit of low sodium and more potassium and iron than most foods. *Pleurotus sajor-caju* and *Pleurotus florida* species of mushroom, variation in protein in oyster mushroom cultivated on substrate which ranged 24 to 26 per cent, respectively and crude fat ranged from 1.88 to 1.98 per cent, respectively.

Fat content in oyster mushroom ranged from 1.1 to 8.3 per cent on dry weight basis. Seventy two percent of total fatty acids were found to be unsaturated. Fresh mushroom contain moisture (85-95%), protein (3.0%), carbohydrates (4.0%), fat (0.3-4.0%) and mineral/ vitamins (10%). Milky mushroom contain 17.5 g/100g ash, 32 g/100g protein, 0.75 g/100g fat, 95 mg/100g calcium, 8.5 mg/100g iron, 14.6 g/100g fibre and 2.1 g/100g moisture on dry weight basis as compared to oyster mushroom which contained 14.5 g/100g ash, 27 g/100g protein, 0.65 g/100g fat, 12.3 g/100g fibre and 2.3 g/100g moisture.

Carbohydrates

The carbohydrates constitute the greatest fraction of the mushroom dry matter. Total carbohydrate content of *A. bisporus* was 60 per cent and about 50 per cent was N-free carbohydrate. Carbohydrate content was recorded in the range of 46.6 to 81.8 per cent in *Pleurotus* species, 50 percent in *Volvariella volvacea* and 67.5 per cent in *Lentinus edodes.* Total carbohydrate content on a fresh weight basis ranged between 2.98 to 6.04 per cent in seven *Pleurotus* species and the lowest carbohydrate content was in *Pleurotus eryngii* while *Pleurotus membrannceus* had the highest carbohydrate content.

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Dietary fibre

The fibre content in *Pleurotus* species ranged from 0.7 to 1.3 per cent on fresh weight basis. On dry weight basis, *Pleurotus* species had 7.5 to 27.6 percent fibre, whereas *Agaricus bisporus* had 10.4 per cent. Neutral detergent fibre and acid detergent fibre were 43.52 and 17.20 g/100g in *dhingri* mushroom (*Pleurotus sajor-caju*) and 41.19 and 15.72 g/100g on dry weight basis in white button mushroom (*Agaricus bisporus*). Hemicellulose content determined by subtracting ADF and NDF was 26.32 and 25.47 g/100g. Total dietary fibre content was 43.73 percent in dhingri mushroom and 40.52 per cent in white button mushroom on dry matter basis

Minerals

Mushrooms were reported to be rich in minerals as evident from their ash content which was 8-10 per cent in *Agaricus bisporus*, 5-15 per cent in *Pleurotus* species and 11.5 per cent in *Volvariella volvacea*. Amongst the mineral, highest content is of K (45% of total ash content), followed by P, Na, Mg and Ca which together constitute about 56 to 70 per cent of total ash content. In cap and stipe of straw cultivated *Agaricus bisporus*, Ca content was 2377 and 1228, Cu 37.46 and 25.67, Fe 128 and 100.2, K 47370 and 45657, Mn 8.44 and 6.09, P 18810 and 12782 and Zn 70.1 and 50.1 ppm on dry matter basis . Inorganic P, K, Ca, Fe, Mn were found to be higher in pileus (50, 1030, 1280 and 270 and 390 mg/100g) than in the stalk of mushroom. The copper content in *Pleurotus* mushroom was found higher (12.2 to 21.9 ppm) as compared to other mushroom. Mineral composition of oyster mushroom is biologically highly valuable because of its content of microelements, but especially because of numerous microelements. Mushroom has a wide spectrum of mineral substance it represent a good source of biologically valuable substances for human nutrition.

Mushrooms were found to contain 61 mg/100g of iron, 156 mg/100g of calcium and a number of other dietary minerals (Nabubuya *et al*., 2010).

Post-Harvest Storage of Fresh Mushroom

To ensure high quality mushrooms in the market place with enhanced shelf-life, these must be cooled as quickly as possible after picking and kept cool throughout the cold chain (Rai and Arumuganathan, 2003) [2]. Blanching for a short period is absolutely essential for producing good quality frozen mushrooms. Steam blanching for three minutes prior to freezing recorded retention of qualities of oyster mushroom (Das and Pathanayak, 2003). Another researcher Arumuganathan and Rai (2004) [1] conducted studies to identify the suitable packaging materials for the mushroom products. The different packaging materials used were, polythene, polypropylene, lug bottles, laminated pouches, PVC wrapped trays, plastic jars and tin cans.

Processing of Mushroom

Steeping water blanched mushrooms in 0.5 per cent citric acid and 500 ppm SO_2 kept for 8-10 days without losing much flavour and texture. To maintain whiteness, dipping in diluted solution of H_2O_2, 30 volume (1:3) for half an hour and then steeped in 0.25 per cent citric acid and 500 ppm SO_2 had significant effect. Dehydrated mushrooms in friction top tins kept well for about 9 months while in polythene bags for 5-6 months at room temperature. Mushrooms contain large quantities of water. Therefore, suffer considerable weight loss during transportation and storage, which cause serious economic losses. High moisture content and very fast respiration rate cause loss in texture, development of off flavour and discoloration due to increased proteolytic activity during post-harvest stag. It occur due to the active O-diphenol (polyphenol) oxidase, tyrosinase and peroxidase activities on phenolic compounds which reduces the market quality of mushroom.

Over blanching can cause poor quality of colour and texture with loss of free amino acids and sugars. Different blanching times should be used for the various sizes to prevent over blanching and shrinkage. A short spray of cold water should follow the blanching process to cool the mushrooms to 36^{O}C or lower. Rama and John (2000) [9] reported that when the temperature during sun-drying ranged from 21.6^{O}C to 35.7^{O}C, time taken was 14 hour for the pretreated oyster mushroom and 12 hour for the untreated oyster mushroom, to reach 5-6 per cent moisture level. They also reported that the dehydration ratio, shrinkage ratio and rehydration ratio of the sun dried product was 10.64, 0.19 and 2.21, respectively. The colour of the final product varied from brown to creamy white. Chandra and Samsher (2002) [3] studied the effect of various pretreatments and drying methods on the quality characteristics of oyster mushroom (*Pleurotus flabellatus*). They also evaluated the quality of dehydrated mushrooms after drying i.e. before and after storage of six months at room temperature. It was found that untreated (control) samples gave higher rehydration ratio in case of all the drying methods, followed by steeped and combination of blanched plus steeped samples before and after storage. Mushroom sample pretreated with combination of blanching plus steeping in KMS (5%) and citric acid (0.25%) solution dried in tray drier rated highest sensory score for colour, texture, flavour and overall quality followed by polyhouse, sun and vacuum drying. Button mushrooms (Agaricus *bisporus)* slices were dried by three methods i.e., sun drying, mechanical drying, and microwave oven drying after different pretreatments namely control (unblanched), blanching in hot water, blanching in hot water and steeping in 0.5% KMS solution, blanching in hot water and steeping in 0.5% KMS solution + 0.1% EDTA solution, blanching in hot water and steeping in 0.5% KMS solution + 0.2% citric acid solution. Dehydration characteristics were assessed during all these methods of drying. The microwave oven and hot air oven dried samples were better in quality than sun dried samples. The samples pretreated with 0.5% KMS +0.2% citric acid after blanching in water produced superior quality dried mushrooms in comparison to other pretreatments (Kumar and Barmanray, 2007) [7]. Kulshreshtha *et al.* (2009) [6] studied the drying characteristics and quality of the dried mushrooms. Drying was done at air temperatures of 50 to 90^{O}C and air velocities of 1.71 and 2.13 m/s. Two batch sizes, namely, 0.5 kg and one kg of sliced milky mushrooms were dried. Drying characteristics and the quality of dried mushrooms were analyzed. The results indicated that the drying time decreased only marginally with increase in air velocity. Drying air temperature of 50^{O}C was better as it resulted in a dried product having better rehydration characteristics, lesser shrinkage and lighter color and found to be acceptable in terms of taste and flavour.

Utilization of Mushroom for Development of Value-Added Products

Earlier people believed mushrooms to be wild food but now it has become very popular and valuable food items in the modern dietary regimes because of its nutritional value. Mushrooms are consumed in a variety of ways because of their delicious flavour. Diversification of mushroom to various products for mass consumption can be met through the preparation of recipes like pickles, chutney, ketchup, soups, chips, toasts, sweet meat, snack, pizza etc Lal Kaushal and Sharma (1998) [8] reported that mushroom can be supplemented in various preparation like weaning foods, biscuits and soup powders. Chandrasekar *et al*. (2001) [4] studied the shelf life of mushroom curry which was packed and stored in retort able pouches. The sensory evaluation of mushroom curry showed that overall acceptability was very good initially (8.25) which reduced slightly (8.25 to 7.68) during the storage at ambient temperature for 12 months.

Conclusion

The oyster mushroom is widely cultivated in many mushroom areas of the world. *Pleurotus* mushroom which were thought to be “Food delicacies”, are now confirmed to have a definite role in human nutrition and health. Their carbohydrates are non-starchy, protein is made up of most of the essential amino acids in fairly high concentration and fat is dominated by unsaturated fatty acids. Mushrooms are good source of B-complex and folic acids, which counteract pernicious anaemia. Calcium, copper, phosphorous, manganese and available iron are the main minerals. Mushrooms are good for diabetics and gastro-intestinal ulcers. They display hypocholestrolemic, hypolipidic, antibacterial and antiviral activities. Being low calorie food, they serve to reduce obesity. Mushroom protein is intermediate in quality between vegetable and animal proteins and the supplementary value of mushroom protein in vegetarian diet is of considerable significance. Mushroom do not contain any cholesterol, rather they contains ergo sterol, which is converted into vitamin D in the human body.

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