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Nutritional security through front line demonstration for value added mushroom products

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Abstract
Mushroom (Pleurotus florida) have a short shelflife of about 24 hour at the ambient temperature due to high moisture, delicate texture and unique physiology (blackening) and autolysis) (Saxena and Rai, 1990) [12, 25]. The shelf -life of horticulture produce can be extended by simply harvesting them before ripening which is not applicable to the mushrooms. Even after harvesting mushrooms continue to respire, grow, mature and thus results in veil opening, weight loss, browning and microbial spoilage. In India, the fresh mushroom market is largely a contribution of marginal and small farmers who have limited resources and, therefore, are dependent on the local market for sale of their produce. The growers face consequences of oversaturated market and distress sale at highly non remunerative prices. The retention of fresh mushroom at the level of growers, whole seller, retailer and consumer further results in deterioration in the quality of the produce and deterioration in the quality of the produce and economical loss. In the peak periods of harvesting, gluts in the market can be checked by adopting appropriate postharvest technology to process surplus mushrooms into novel value-added products rather going only for canning or pickling. These value added products are the need of the hour for the mushroom growers not only to reduce the losses but also to enhance the income by value-addition provide Neutra ceuticals low fat, protein rich food to the consumers (Arumuganathan *et al*., 2003 and 2005) [3, 4] and the boost the consumption of this important horticulture crop. The studies were conducted to develop some novel value-added products namely mushroom murraba, mushroom ketchup, mushroom candy and mushroom chips from fresh button mushrooms.

Keywords: Value added, post-harvest, mushroom, Neutra ceuticals

Introduction
Oyster mushroom (Pleurotus florida) is highly perishable poses serious marketing problems in the peak seasonal period as well as commercial production resulting in gluts and distress sales. With a view to ameliorate the problem, processing of mushroom to develop some novel value-added products was undertaken from the fresh oyster mushrooms. Very good quality of oyster mushroom preserves (murraba) was successfully prepared. Besides, the pickle preparation from the fresh mushroom through the traditional technique, success was achieved in making products like mushroom ketch-up, mushroom candy and mushroom chips. All the value added products were found to be organeptically acceptable for their colour, appearance, flavour, taste, texture and overall acceptability on the 9 point Hedonic scale by a panel of ten judges. The evaluation of the products was done every month for the period of six months for the above said quality characters. Value added product named mushroom preserve was rated with the highest sensory score followed by mushroom chips. Preparation of these products will not only reduces losses but will also enhance the income by value- addition and better marketing of this horticulture crop in the peak period of harvesting, glut in the market can be checked by adopting appropriate post-harvest technology to process surplus mushroom into novel value-added products. 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. Mushrooms can be used as a supplementary food item to the growing population of the developing countries where the population mainly depends on cereal based foods. Due to high quality nutrients and their medical and therapeutic properties, mushrooms have become popular worldwide. During peak harvest season, market gets saturated quickly and growers resort to distress sale. Consequently, unsold mushrooms become a total loss. Hence, methods need to develop for the production of processed products from mushrooms.

Methodology
The present study was carried out at fresh oyster mushrooms:

Mushroom murraba (Preserve)
Freshly harvested mushroom were graded, washed, pricked and blanched in 0.05 per cent potassium meta bisulphite (KMS) for 5 minutes. It was treated with 40 per cent of its weight of sugar daily for 3 days. On the third day, mushrooms were taken out from the syrup and 0.1 per cent citric acid and remaining 40 per cent of sugar were mixed in the syrup. After making its concentration to 65 0Brix, mushrooms were added in the syrup and thus the good quality murraba (preserve) was prepared. The prepared murraba was packed in plastic jar and kept for further quality analysis.

Mushroom ketchup

Freshly harvested oyster mushroom were washed in 0.05 per cent KMS solution, sliced and cooked in 50 per cent of water for 20 minutes. Mushroom paste was prepared using a mixer grinder 0.2 per cent arrarote, 1.5 per cent acetic acid and other ingredients were mixed in the paste and cooked to bring to its TSS to 35 0Brix. Then the ketchup was filled in the sterilized bottles and kept for further analysis. The ingredients used in the ketchup were salt 10 per cent, sugar 25 per cent, acetic acid 1.5 per cent, sodium benzoate 0.065 per cent, onion 10 per cent, garlic 0.5 per cent, ginger 3 per cent, cumin 1 per cent, black pepper 0.1per cent, red chilly powder 1 per cent, arrarote 0.2 per cent. Thus, the ketchup of good flavour, taste and appearance was prepared. Joshi *et al*. (1991) [6] developed sweet chutney from oyster mushroom and the storage life of the product was more than a year.

Mushroom candy

Fresh mushroom after harvesting were subjected to washing and halved into two pieces. Halved pieces were blanched for 5 minutes in 0.05 per cent KMS solution. After draining for half an hour they were treated with sugar. Sugar treatment was given at the rate of 1.5 kg sugar per kg of blanched mushroom. Initially sugar was divided into three equal parts. On the 1st day, blanched mushroom were covered with one part of sugar and kept for 24 hours. Next day, the same mushrooms were covered with 2 nd part of sugar and again kept overnight and on the third day mushrooms were removed from the sugar syrup. This sugar syrup was boiled with 3rd part of sugar and 0.1 per cent citric acid to bring its concentration upto 700Brix. Blanched mushrooms were mixed with this syrup and again the contents were boiled for 5 minutes to bring its concentration upto brix 72 0Brix. After cooling, mushrooms were removed from the syrup and drained for half an hour. The drained mushrooms were placed on the sorting tables to separate only defective and unwanted pieces. Finally mushroom pieces were dried in a cabinet dryer at 60°C for about 10 hours. As soon as these became crispy, all mushrooms were packed in polypropylene bags and stored in a cool and dry place for further analysis.

Mushroom chips

Study was conducted to prepare ready to eat mushroom chips. The freshly harvested oyster mushrooms were washed, sliced and blanched in 2 per cent brine solution. The mushrooms were dipped overnight in a solution of 0.1 per cent of citric acid +1.5 per cent of NaCl+0.3 per cent of red chilly powder. After draining off the solution, the mushrooms were dried in cabinet dryer at 60° C for 8 hours. Then it was fried using the refined oil and good quality chips were prepared. Garam masala and other spices can be spread over the chips to enhance the taste. After spices mixing, the chips were packed in polypropylene packets and sealed after proper labelling. These packets were kept at room temperature for further analysis.

Observations and assessment

All the value-added products were evaluated for their colour, appearance, flavour, taste, texture and overall Table 1: Organoleptic evaluation of value-added products prepared from fresh oyster mushroom Name of product Colour Appearance Flavour Taste Texture Overall acceptability through

Table 1: Organoleptic evaluation of Oyster mushroom Value and products

Name of the Product	Colour	Appearance	Flavour	Taste	Texture	Overall Acceptability	Mean	Storage Life(Months
Mushroom Murraba	8.2	7.9	7.9	8.4	8.6	8.4	8.23	12
Mushroom Ketchup	7.5	7.2	8.0	8.2	8.2	8.0	7.85	12
Mushroom Candy	7.8	7.8	7.8	8.4	8.5	8.0	8.05	12
Mushroom Chips	8.0	7.6	8.2	8.4	8.3	8.1	8.05	3
Mushroom Biscuits	8.2	7.7	8.2	8.6	8.4	8.7	8.3	12
Mushroom Soup	6.9	6.2	7.7	7.6	6.9	7.8	7.2	--
Mushroom Jam	8.7	7.8	8.0	8.4	7.9	7.8	8.2	8.06
Mushroom Pickle	8.6	8.3	8.2	8.1	8.1	8.4	8.3	12
Mushroom Patties	7.9	7.7	7.5	8.1	8.3	8.0	7.9	--
Mushroom Pakoda	8.4	8.2	8.5	8.6	7.5	8.1	8.2	--

Organoleptic evaluation on the 9 point Hedonic scale by a panel of ten judges (Rangana, 1994) [11]. The evaluation of the products was conducted every month for the above said quality characters. It is seen from the Table 1 that the value added product named mushroom murraba (preserve) was rated with the highest sensory score by the taste panel. The mushroom murabba (preserve) was very good in taste, quality and appearance like amla murraba. As far as the shelf -life of the product is concerned, mushroom murraba could be stored for six months without any change in its keeping quality in general and texture in particular. The colour of the murraba also did not change during the course of study. It was totally accepted in the organoleptic evaluation. The mushroom ketchup up was also liked by the panel of judges and the products had storage life of six months. The oyster mushroom candy, the novel product also had excellent taste and keeping quality even six months. The colour also remained light brown which is similar to the colour of the candy. In case of mushroom chips, the keeping quality was excellent upto 3 months in polypropylene packets. The flavour of the mushroom chips was highly acceptable in the organoleptic evaluation. Taste wise the chips were very tasty and giving good aroma of mushrooms but they had become little bit softer after 3 months. The texture of the product, which is a deciding factor of the product's acceptability, was good in general and it ranged from 8.2 to 8.6. With regard to taste, the products named mushroom murraba, mushroom candy and mushroom chips scored equal and the maximum point in evaluation. As far as the overall acceptability is concerned, mushroom murabba topped the list and it was followed by mushroom chips, mushroom candy and mushroom ketchup in that order. Similar findings were made by Chandrasekhar *et al*. (2002) [5]; Lal, and Sharma (1995) [8]; Anu (2007) [2]; Mane *et al*.,

2003 [9]; Rai *et al*. (2003) [10] and Adule *et al*. (1981) worked on simple preservation of oyster mushroom and the results coineide with the present results.

Nutraceuticals

In addition to the nutritional components found in edible mushrooms, some have been found to comprise important amounts of bioactive component. The content and type of biologically active substances may vary considerably in edible mushrooms, their concentrations of these substances are affected by difference in strain, substrate, cultivation, developmental stage, age, storage age, storage conditions, processing & cooking practices. (P. Mattila, L. Barros, *et al*.) ~ 396 ~ The Pharma Innovation Journal http://www.thepharmajournal.com The bioactive substances found in mushrooms can be divided into secondary metabolites (acids, terpenoids, polyphenols, sesquiterpenes, alkaloids, lactones, sterols, metal chelating agents, nucleotide analogs and vitamins), glycoprotein and polysaccharides, mainly B-glucans. New proteins with biological activities have also been found, which can be used in biotechnological processes and for development of new drugs including lignocellulose – degrading enzymes, lectins, protease and protease inhibitors, ribosomes – inactivating proteins, hydrophobins. (J. Erjavec, *et al*., 2012) [18].

Carbohydrates

Polysaccharides are best known and most potent mushroom derived substances with anti-tumor and immunomodulating properties. Data on mushroom polysaccharides have been collected from hundreds of different species of β-glucans are well known for their biological activity, specifically related to immune system. Hence activating and reinforcing the host immune system seen to be the best strategy for inhibiting growth of cancer cells. Dried mushrooms are rich in carbohydrates. (https://nbd.nal.usda.gov) Mushroom carbohydrates have been found in many cases to have anti cancer properties (Kalac, 2012). Carbohydrates, calculated by difference were also an abundant macronutrient that ranged from 52.90g / 100 g in Lentinus edodus, 69.74g/100g in Boletus sp., 78.24g /100g. Flammulina ventutipes and 57.88g /100g in Agaricus bisporous. And the highest levels of carbohydrates were also found in Pleurotus eryngiii (king oyster) (77.79g/100g) Although an extraordinarily high or appreciable level of total fiber was reported for A.bisporous, P.Seryngii and P.Ostreatus (Manzi *et al*., 2004) Furthermore when comparing dried mushroom to fresh or frozen mushrooms, beta-glucan content of fresh mushrooms were higher than dried mushrooms.

Proteins

Total protein content in mushrooms varying between 21-50%. The highest protein content was found for Agaricus bisporous (58.05%) and lowest was found for (23.55%). After drying, the protein content was increased significantly. (Tsungai Reid *et al*.,) Edible mushrooms are good source of protein, 200-250 g/kg of dry matter, leucine,valine, glutamine, glutamic and asparatic acids are the most abundant. (E. Guiltamon *et al*.,) Protein is an important constituent of dry matter of mushrooms. (Aletor, 1995, Zrodlowski, 1995) [14] Protein content of mushrooms depends on the composition of the substratum,size of pileus, harvest time and species of mushrooms.(Bano and Rajratnam 1982) [15]. Mushrooms are very useful for vegetarian because they contain some essential amino acids which are found in animal proteins. (Verma *et al*., 1987) A need for food protein compels one to explore unconventional protein sources is the single cell protein. Mushrooms are the oldest single cell protein food for man. (Sawaya *et al*., 1985) [24] The protein content of mushrooms are affected by number of mushrooms namely the type of mushrooms, the stage of development, the sampled level of nitrogen available and the location. (Flegg *et al*., 1977) [20].

Fats

In mushrooms, the fat content is very low as compared to carbohydrates and proteins. The fats present in mushroom fruiting bodies are dominated by unsaturated fatty acids. (Singer, 1961) [26] In general, mushrooms are low calorie foods since they provide low amount of fat (Diez and Alvarez, 2001). Mushrooms have 4.48% fats on dry weight basis. (Ogundana and Fagade, 1981) Total fat content in A.bisporous was reported to be 1.66 to 2.2/100gm on dry weight basis. (Kanwar *et al*., 1990) [21] Polyunsaturated fatty acids are mostly contained in edible mushrooms; thus they may contribute to the reduction of serum cholesterol. It is noteworthy that transisomers of unsaturated fatty acids have not been detected in mushrooms. The major sterol produced by edible mushrooms is ergosterol, which shows antoxidant properties. (E. Guiltman, A. Garcia- Lafuente, M. Lozano, L.Barros, Baptista). It has been observed that a diet rich in sterols is important in prevention of cardiovascular diseases. (P. Kalac).

Vitamins and minerals

Mushrooms are one of the best sources of vitamins especially vitamin B (Breene 1990, Mattila *et al*., 2002) [17] Mushrooms contain appreciable amount of niacin, pantothenic acid and biotin. In addition, mushroom also contain folic acid and vitamin B12 which are absent in most of the vegetables. (ude and Ezenwugo, 2001) [29] Mushrooms are good sources of some B vitamins like Riboflavin (vitamin B2), Pantothenic acid (vitamin B5) and Niacin (vitamin B3). These B vitamin play an essential role in the nervous system and provide energy by breaking down carbohydrates, fats and protein. (Barbara *et al*., 2008) [16] Mushrooms naturally produce vit. D when they see sunlight (or other source of UV light). Through the action of sunlight, they convet their abundant ergosterol to ergocalciferol (vit D2). Wild mushrooms in Europe commonly have 2-40 mcg vit D/100g. (Mattila 1994; Mattila 2002; Teichman 2007) [22, 23]. Store bought mushrooms are able to generate over 20 mcg vitamin per 100g that after being placed in sunlight for a couple of hours in the midday sun (Phillips, 2013) The vitamin D in mushrooms is easy to absorb and effective in improving Vit.D status (Urbain, 2011) [30] The fruiting bodies of mushrooms are charecterized by a high level of well assimilated mineral elements. Major mineral constituents in mushrooms are K, P, Na, Ca, Mg and elements like Cu, Zn, Fe, Mo, Cd form minor constituents. (Bano and Rajarathnum, 1982, Bano *et al*., 1981; Chang 1982) [15] K, P, Na and Mg constitute about 56 to 70% of the total ash content of the mushrooms. (Li and Chang, 1982) While potassium alone forms 45% of the total ash. The content of potassium and sodium in A. bisporous was 300 and 28.2 ppm resp. A. bisporous ash analysis showed high amount of

K, P, Cu and Fe.(Abou and Helilah *et al*., 1987) [13] A.bisporous contains Ca (0.04 g), Mg (0.16g), P(0.75g), Fe (7.8g), Cu(9.4 mg), Mn (0.833mg) and Zn (8.6mg) per kilogram fresh weight.

Utilization

Mushrooms may be baked, fried, boiled, creamed, roasted, pickled and Stuffed. In India it is mostly consumed fresh. However, where mushrooms can be grown at ambient temperatures (i.e. hilly areas) but cannot be transported quickly to the consumption places, the only way to its utilization is its processing. They can be processed as canned, dried or frozen mushrooms. The vitamins in mushrooms are well retained during cooking, canning, dehydration. The moisture content in dried mushrooms should be between 5 and 8%. Drying of mushrooms is done to remove free water to such a level that the biochemical and microbial activity are ~ 397 ~ The Pharma Innovation Journal http://www.thepharmajournal.com checked due to reduced water activity. (Sugana S. *et al*., 1995; Lidhoo C.K. and Agrawal Y. C., 2006) [28] Dried mushrooms rich in calories (300%), protein (10%), carbohydrates (80%) and total dietary fiber (10%) (https://nbd.nalusda.gov) Further their high lysine, leucine, valine, and tryptophan content make them good supplement to cereal based Indian diets.(Bano and Rajarathnam, 1988 and http://nbd.usda.gov.) These characteristics have made them a very valuable food. Mushroom powder have been used by many researchers for development of variety of food products like mathri and rava idli. (Singh V., and Verma A., 2013) [27] Besan laddoo (Verma A. and Singh V., 2014) [31], Jam and Squash (Lakshmipathy G. *et al*., 2013) and Biscuits (Wakchaure, G.C. *et al*., 2010) [32] Regula J. and Michalowska, G. (2010) successfully prepared cookies and breads with 10 and 20% dried mushroom powder added to the flour and they recommended it as a good quality dietary supplement. A large section of population consumes papads. Papad is one of the many preserved dehydrated form of foods. Since centuries, papad has been a popular snack item of India and many varieties are available commercially (Saxena *et al*., 1989) Mushroom papads prepared can serve a very good source of protein, dietary fiber, calcium and phosphorous be increased with increased level of mushroom powder. Mushroom soup powder is prepared by mixing powder of dried slices of white button mushroom or oyster mushroom with milk powder, corn flour and other ingredients. Delicious and crunchy mushroom biscuits were prepared by using the button / oyster mushroom powder and various ingredients *viz*., maida, sugar, ghee (bakery fats), mushroom powder, coconut powder, baking soda, ammonium bichromate and milk powder. Also it is used in the preparation of Mushroom nuggets, Mushroom ketchup, Mushroom candy and Mushroom preserve (Murabba) (G. C. Wakchaure, 2011)

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