



A REVIEW

Cultivation and processing of edible mushrooms

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Abstract : This is a review paper of some writings or literatures which presents the edible mushroom cultivation and processing including types, production and its scenario. Mushroom is a fungus considered to be edible due to its high nutrition facts. It is a great source of vitamin D, some minerals and protein. In addition, due to short or quick growing, good prices and health benefits, it is popular amongst farmers and new entrepreneurs. Their spawns are produced carefully in healthy conditions and sown on a well prepared compost bed containing required nutrition for spawn. Harvesting starts 50 to 55 days after sowing and mushrooms are twisted in opposite directions for harvest. Their fleshy nature leads to deterioration if not consumed within some hours or refrigerated or not utilized for canning, pickling, drying etc. which are post harvesting processes.

Key Words : Mushroom, Nutrition, Production, Harvesting, Processing

View Point Article : Sharma, Ajay, Singh, Shivam, Kuiry, Braj Mohan, Himanshu, Singh, Kulveer and Shivani (2021). Cultivation and processing of edible mushrooms. *Internat. J. agric. Sci.*, 17 (2) : 745-750, DOI:10.15740/HAS/IJAS/17.2/745-750. Copyright@2021: Hind Agri-Horticultural Society.

Article History : Received : 04.03.2021; Accepted : 20.03.2021

INTRODUCTION

A fruiting structure of a fungi, possess fleshy nature, having some spores and visible above ground/ soil surface/ growing media is called mushroom and have stem, cap and gills. In edible mushroom this fruiting body which is fleshy is edible. *Agaricus* spp. is scientific name of mushroom, Phylum Basidiomycota and Ascomycota, Agaricaceae family and order Agaricales. It reproduces through spores which produced in gills which are present under the cap. It falls under the Plant kingdom even these don't have a root system and chlorophyll is also absent in them. A network of mycelium is the source to draw the required nutrients from the mixture on which it is grown. Mushroom counts their life on Organic matter

as a saprophyte, parasite or as a mycorrhizal association with other plants.

It is widely consumed as fresh vegetable, pickle for storage, canned, and in powder form also. It is one of the most loved and attractive food by humans due to its high nutritional values (Gbolagade *et al.*, 2006) and having a lot of medicinal uses. In India medicinal use of mushroom in Ayurveda is common (Adhikari, 1981; Jitendra and Vaidya, 2000). Mushrooms are edible, medicinal for pharmaceutical uses and poisonous. Edible and medicinal mushrooms are cultivated throughout the year. According to USDA nutrition database it is having low calorie food (27Kcal/100 gm) which is a good choice for weight management. In addition, it has approximately

2.5% protein, 0.1% fats, 4.1% carbs, 92% water and Vitamin B₁, B₂, B₆, vitamin C and vitamin D due to presence of its precursor ergosterol, healthy amounts of Calcium, Potassium, Zinc and it is low in sodium (Jolly, 2017) and a big group of essential amino acids (Sanhez, 2004). So, it consists of dry matter (10%) and water (approximately 90%) (Morais *et al.*, 2000; Sanchez, 2004). It may be compared to milk and non-veg food like eggs and meat also in case of nutrition facts (Oei, 2003).

Table 1: Nutritional facts of edible mushroom

Energy	27 Kcal or 113 kJ
Protein	2.5 g
Carbohydrates	4.1 g
Fat	0.1 g
Vitamin B1	0.1 mg
Vitamin B2	0.5 mg
Vitamin B3	3.8 mg
Vitamin B5	1.5 mg
P	120 mg
Zinc	1.1 mg
Calcium	18 mg
Sodium	6 mg
Potassium	448 mg

Source: USDA Nutrition Database

Mushroom farmers also called as entrepreneurs. Landless farmer can take mushroom under cultivation as it doesn't require a big farm or land and can grow on different organic wastes (Ambili and Nitiya, 2014). The process of cultivation may be only process that is eco-friendly and produce protein rich food material (Beetz and Kustudia, 2004). After yeast, Mushroom cultivation may be count as the microbial technology on commercial bases (Pathak *et al.*, 2009). Traditional medicines were made from approximately 200 wild species of mushroom for different treatments (Sanchez, 2004).

Mushroom production in India:

Three hundred species of mushroom is edible from which only 10 are commercially grown (Barny, 2009). Around 1.5 million tons of mushroom species produced every year globally. In India, mushrooms cultivated commercially are paddy straw mushroom, milky mushroom, Reishi mushroom as medicinal and edible, button mushroom and oyster mushroom and out of which button mushroom is most popular and alone covers 95% of production and export. Mushroom export is gaining

high numbers every year in fresh and preserved forms both and major countries where Indian mushrooms are exported include Mexico, US, Israel etc.

First ever cultivated mushroom which was put out for public in year 1943 was done at Agricultural College, Coimbatore and mushroom was paddy straw mushroom after which cultivation methods spread all over India (Prakasam, 2012).

In 1961, ICAR has started Button mushroom cultivation in Solan (called as 'Mushroom city of India') and then funds were provided by ICAR for research in some different started. Sharma *et al.* (2017) reported that button mushroom produced most commonly contributes 73% alone in production, Oyster mushroom is on 2nd number with 16%. Karthick and Hamsalakshami (2017) reported that India will produce more than 6,00,000 tons of mushroom per year in 2020 AD. During cultivation of these edible mushrooms, agro wastes can be recycled easily and the gap of nutrition lacking in population can be filled by mushroom, also, the drained substrate after harvesting can be used directly as fertilizer, animal food if upgraded (Zadrazil *et al.*, 1992) and also as a slurry for biogas production (Bisaria *et al.* 1990).

Table 2 : Different mushrooms grown in India:

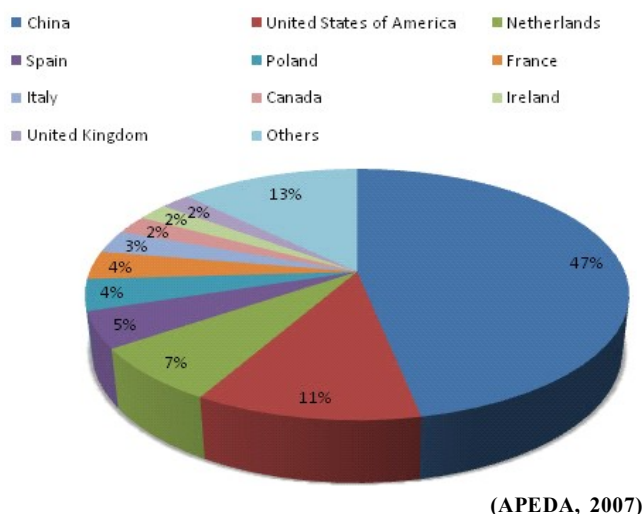
Edible Mushrooms	Medicinal Mushrooms
<i>Volvariella volvacea</i> , <i>Pleurotus djamor</i> , <i>Pleurotus sajor-caju</i> , <i>Calocybe indica</i> , <i>Pleurotus ostreatus</i> , <i>Auricularia polytricha</i> , <i>Pleurotus florida</i> , <i>Lentinula edodes</i> , <i>Pleurotus eryngii</i> , <i>Hypsizygus tessulatus</i> , etc. (Dhar <i>et al.</i> , 2011)	<i>Pleurotus</i> spp, <i>Phellinus rimosus</i> , <i>Ganoderma lucidum</i> . (Ajith and Janardhanan, 2007; Jose <i>et al.</i> , 2002).

Mushroom production in world:

Wakchaure (2011) stated that according to latest data of FAO mushroom production is increased from 2.18 to 3.41 Million Tons from 1997 to 2007 *i.e.*, in 10 years. According to reports, 2015 (publically available) says that, there is a worth 35 Billion dollars market of mushroom in world which is expected to increase by 9.2% till 2021 which in turn will increase the worth to 60 Billion dollars. According To FAO (April, 2014), most grown countries in mushroom production are China, U.S., India, Vietnam, Netherland. Button mushroom alone contribute a worth 15% of share in production globally and export a total of 105.4 tons of Button mushroomis

exported by India to other countries (Singh *et al.*, 2017). US produce a total of 4,61,000 tons of *Agaricus* mushroom and their MNCs also owns canning firms in India and China. Jos, 2017 reported that a total of 120 farms of mushroom produce a worth 260 million kg of mushroom in 2015.

Share of countries in production:



Cultivation of mushroom:

Yield content and quality totally depends upon the cultivation practices including methods, strategies, integrated management approach, harvesting time and post-harvest management.

Prime aemperature:

A range between 24 to 28°C is required for the mycelium to spread at an excellent rate, which is for the first two weeks. During vegetative phase/ fruiting body formation phase, a range between 16 to 18°C is must for good produce *i.e.* after two weeks. At low temperature growth may be retarded and at High, crop may not grow properly. Paddy Straw Mushroom can be grow at 35°C easily.

Relative humidity:

With a good ventilation, a good range of humidity falling between 85-90% must be there.

CO₂ Concentration:

Carbon dioxide concentration must be in between 9 to 15.

With these maintained climatic conditions, one can

see the pin heads coming out of substrate within some days. Some Fertilizers, water, insecticides are also required for a healthy production. The following steps are must in production of mushrooms:

Preparation of Compost Substrate:

Compost may be synthetic or natural mainly constitute of straw (wheat/rice), horse and poultry excreta, Gypsum, DAP, Urea, Potash, sunflower Oilcake (FICCI, 2010).

Mycelium/Spawn propagation:

As mushroom also produce spores which are material for again propagation but commonly not used so, because of unsettled sprouting (Anonymous, 2013). These spawns are thoroughly mixed well with the bedding material and spread with a good amount of water to retain moisture. Sometimes, it may be covered with newspaper or some other material to hold maximum moisture content in bedding material. After 15 days white mycelial growth appears above the bedding material (Anonymous, 2013) commonly known as “Jaala” in Haryana.

Manure Casing:

Casing is a method or procedure called so because of addition of a sterilized/microbes free media/soil having manure of cow (commonly known as “Kurdi khaad” in Haryana) on the compost bed having propagated spawn mycelium. It is properly spread on the compost after the 15 days of mycelium propagation when mycelial threads/ pin heads/jaala appears on the compost bed. In button mushroom it may be applied twice *i.e.* one more time (light manuring) which may be approximately 12-14 days of first casing.

Harvesting:

Mushroom is commonly a short duration crop which can be ready to harvest within 50-60 days and it is harvested in several pickings. It must be harvested in closed-cap stage for better price. Harvesting is done either by hands or knife. With hands, after holding of cap it is twisted gently clockwise and anti-clockwise to break off from its root net/mycelium and taken out from bed. After harvesting, processing of mushroom starts.

Processing of mushroom:

Mushroom has very short keeping life if not

consumed fresh. Their color and attraction may be lost in a day if not refrigerated as more temperature results in browning. Its high rate of respiration requires immediate focus. Tyrosinase compound in them leads to browning due to formation of melanin pigment (Ahlawat *et al.*, 2008). Processing is a process which increase the life of food by some methods like freezing, drying, sterilization, canning, pickle making etc. All these process can make possible a long-term preservation. Kubiak (2003) reported that mushrooms after processing are exported to other countries from pollen on a large scale. Also, frozen button mushroom is gaining popularity from some last years and their export increased to twice the previous amount within 4 years from 1998 to 2002 (Smolenski, 2004).

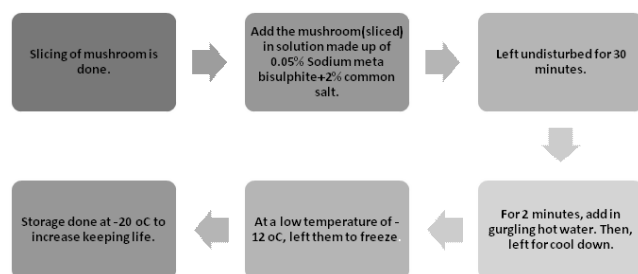
After harvesting, the very prior processing done is washing, to remove the soil/dirt attached to it. Then, it is added in salt/brine solution before drying or packaging. Processing methods are as follows:

Packing and Refrigeration:

To increase the keeping life from 3 to 6 days of fresh harvested mushrooms, it is ensured that they don't have any material on them, kept in polythene bags of 25 gauge and sealed carefully, immediately kept in refrigerator at 5°C results in cut down the rate of browning, water loss, respiration and any unwanted flavor buildout (Anonymous, 2014).

Freeze-drying:

It is followed so to expand the keeping life for around 4 months. This is done by a process as followed:



Blast freezing done at -25 to -30°C temperature. (Sobkowska and Wozniak, 1974; Czapski and Szudyga, 2000). Kondratowicz and Kowalko (2000) reported the cryogenic freezing effects on mushrooms and stated that if mushrooms are stored at a T of -80 to -100 °C for just 5 to 6 minutes, it will leads to a gain of almost 1 year of

shelf life.

Drying/Dehydration:

Moisture leads to excess microbial activity, so, removing moisture will in turn smash down the microbial activity levels or it may completely stop it. But before drying some other treatments done like cleaning of mushrooms followed by immersing in hot water and suddenly in cold water for 2 minutes each, followed by adding in solution of water having 1% citric acid+0.2% potassium meta bi-sulphite. After these pre-treatments, mushrooms are processed for drying which may be done by sun drying, flow drier drying, vacuum drying and among these methods, the cheapest one is sun drying (Anonymous, 2014), and the costly one is vacuum drying but it leads to a good quality dried mushroom. These dried mushrooms are generally used in pickles, stews and also in soups after their rehydration.

Sterilization:

It is a process of elimination of any microorganisms attached to avoid any kind of spoilage and commonly done by some sort of chemicals, irradiation and steam also. 1-3 kGy amount of radiation will leads to increase in keeping phase of mushrooms (Akram and Joong-Ho Kwon, 2010).

Canning:

This post-harvest process is commonly followed in case of button mushroom and adopted widely on a big scale. Fresh mushrooms harvested at an early stage, stalks are removed and used for canning in oil/marinades, brine and vinegar also.

Pickle making:

It is the oldest method to preserve edible fruits, vegetables in houses using natural spices (Turmeric/red-chilli/clove/garlic/ajwain/anise), oils, salt, sugar etc. as preservatives (Anonymous, 2013). Fermentation occurs in pickle making leads to a light flavour also.

Conclusion:

Mushroom falls in the list of a healthy eating options and used in almost every house as a vegetable and medicine in some. It is an adaptable/flexible crop grown all over the places. It is consumed fresh with some other vegetables. In addition, is available in every market/city/village in form of fresh harvested, pickle, canned, frozen

and also used in medicines, cosmetics, supplements, seasoning etc. These are also grown to utilize the agriculture and farm waste to save environment from pollution. Its market is emerging every year due to monetary potential and its constituents and demand. It is also a crop known for landless farmer as it doesn't require much space. These are quick growing, ever in demand crop and didn't produce any waste, pollution as its bedding material after harvesting utilized as a manure and applied in fields. Hence, it provide income from harvest and additional benefits of manuring, animal feed etc. It is a great source of protein and minerals and it is much filling that commonly used in diet for weight loss and better physical health. Due to these nutritional facts, future prospects of this crop is higher or it hold a bright future of production and consumption.

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