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A REVIEW ON PRODUCTION OF EDIBLE MUSHROOMS AND THEIR APPLICATIONS

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ABSTRACT
Mushrooms have been consumed by humans as nutritious and delicious food since ancient times. The Greeks, the Romans and the Chinese regarded them as valuable healthy food. Recently there is an increased demand for edible mushrooms globally as they are low in calories, carbohydrates, fat and sodium and rich in proteins, minerals and vitamins and are free from cholesterol. Mushrooms are reported to be useful in preventing and treating Parkinson's disease, Alzheimer's disease, diabetes, hypertension and high risk of stroke. Antitumor property of mushrooms makes them valuable in reducing cancer invasion and metastasis. Mushrooms are antibacterial, immune boosters, cholesterol lowering agents and source of by products such as cellulase, β-glucosidase, dextranase, amylase and lactase. The ingredients of mushrooms such as phenols, polyphenols, terpenoids, selenium, polysaccharides, vitamins, and volatile organic compounds are known to be beneficial to the skin and hair. Mushrooms are used as potential ingredients in the cosmetics because of their antioxidant, anti-aging, anti-wrinkle, skin whitening, and moisturizing effects. This review critically focuses on the production, composition, nutritional, therapeutic, cosmetic and other applications of Agaricus bisporus, calocybe indica and Pleurotus ostretus. Regular consumption of mushrooms in diet helps in preventing nutritional deficiency and helps in maintaining good health. There is good scope for research in exploring the healing capacities of bioactive compounds of these mushrooms as nutraceuticals, pharmaceuticals and cosmeceuticals.

KEY WORDS
Agaricus bisporus, calocybe indica and Pleurotus ostretus

INTRODUCTION
Mushrooms are a group of live macro fungus with a distinctive fruiting body without chlorophyll and are reproduced by spores. Mankind considered fungi as good source of drugs and health food[1]. Mushrooms have been considered as a delicacy with high nutritional and functional value in food across the globe for their unique flavor and have been treated as a wonder food. More than 2,000 species of edible mushrooms exist in nature, but around 25 species are well known as edible and few are commercially cultivated. Cultivation of edible mushrooms with minimizing environmental pollution is an upcoming area[1].Recently mushrooms have drawn worldwide attention as the most interesting natural sources with diverse and unique bioactivities, including immunomodulatory, antioxidant, anti-inflammatory, antidiabetic, antibacterial, antifungal, antiviral, antitumor, hepatoprotective, antidiabetic and hypolipidemic activities[2]. Mushrooms have been valued as a traditional source of natural bioactive compounds for nutrition and health benefits and are recently been used in the cosmetic industry[3].Mushrooms convert the huge lignocelluloses biomass waste into human food, and also produce notable myco pharmaceuticals, myco nutraceuticals and myocosmeceuticals[4]. There are several reports on therapeutic, nutritional and cosmetic

applications of most widely used *Agaricus bisporus, calocybe indica* and *Pleurotus ostretus*. This review discusses on types of spawn, substrates, supplements, casing requirements for the production of Button, Milky white and Oyster mushrooms and also compares the nutritional, therapeutic, cosmetic and other benefits of these three types of most widely cultivated edible mushrooms.

OYSTER MUSHROOM CULTIVATION

Oyster mushroom growing on straw can be fragmented into 4 segments: Each step is important to the next and impact the overall yield. The step-by-step operation of growing oyster mushrooms on substrate is outlined below.

The series of steps for oyster mushroom raising can be divided into succeeding four steps:

(i) Preparation or procurement of spawn
(ii) Substrate preparation
(iii) Spawning of substrate
(iv) Crop management

1. Spawn Preparation

A pure culture of *Pleurotus* sp. is required for inoculation on decontaminate substrate. It utilizes 10-15 days for mycelial growth on cereal grains. It has been reported that jowar and bajra grains are superior over wheat grains[5].

2.Substrate Preparation

a. Substrates for oyster mushroom and their nutrition quality

Oyster mushroom can be raised on a large number of agricultural-remains having cellulose and lignin which assists in more enzyme growth of cellulose that is correspond with more yield. These include straw of wheat, ragi and paddy, leaves and stalk of maize, cotton and millets used citronella leaf, saw dust, cotton waste, jute and sugarcane bagasse, discarded waste paper, used tea leaf waste, sunflower stalks, dried grasses, dehulled corncobs, pea nut shells, and synthetic compost of button mushrooms etc. It can also be produced by using industrial remains like coffee by products, tobacco waste, apple pomace and paper mill sludge's etc[6].

b. Methods of substrate preparation

The mycelium of Pleurotus is saprophytic in nature and it does not require selective substrate for its growth. The mycelial growth can take place on a simple water treated straw but there are number of other cellulolytic moulds already present on straw, which compete with Pleurotus mycelium during spawn run and also secrete toxic metabolites hampering its growth. There are various methods to kill undesirable microorganisms present in the straw to favour the growth of Pleurotus mycelium. The popular methods of substrate preparation are as follows.

The accepted practices of substrate preparation are:

- Steam Pasteurization;
- Hot Water Treatment;
- Chemical Sterilization
- Sterile Technique (Till method) and

i. Steam pasteurization

In this method previously, socked substrate is loaded in wooden boxes or trays and then kept in a pasteurization room at 58-62°C for 4 hours. Temperature of the pasteurization room is changed by means of the steam through a boiler. straw after cooling at room temperature is loaded with spawn. The entire process takes about 3-5 days. This method is adopted on a commercial scale by Zadrazil and Schneidereit in Germany. There are various small changes of this method adopted in Europe[7].

ii. Hot water treatment

The substrate (wheat straw) after cutting (3-5 cm) is wetted in hot water (65 to 70°C) for 1 to 2 hours at 80°C or in case of paddy straw at 85°C for 30- 45 minutes. After draining surplus water and after bringing to room temperature, spawn is added. Hot water treatment makes the hard substrate like maize cobs, stems, etc. soft because of that the mycelial growth takes place easily. This method is not suitable for large-scale commercial cultivation.

iii. Chemical sterilization technique

Various species of Gliocladium, Penicillium, Doratomycs, Aspergillus and Trichoderma, spp. are the common reval fungi on the substrate during oyster mushroom production. The presence of the fungi does not allow the mycelium to grow on the substrate. In order to kill or suppressed for 25-40 days after spawning avoid the mould growth the substrate is treated with steeping in a chemical solution of carbendazim 50% WP (37.5 ppm) and formaldehyde (500 ppm) for a period of 16-18 h.

The technique, which was standardized at DMR, Solan by Vijay and Sohi in 1987, is as follows: galvanized drum with 90 liters of water was taken or tub of 200 liters capacity. Approximately about 10 to 12 kgs of substrate is soked in water .In another plastic container, Bavistin 7.5 g and 125 ml formaldehyde (37-40%) is dissolved in water and slowly added to the drum which contains the substrate. Straw is balled and coated with a polythene sheet. After completion of 15 to 18 h the substrate is removed from drum and surplus water is drained. The chemical containing water can be used once again for pasteurization of the substrate.

iv. Sterile technique

It is also known as Till method. The substrate was cut into small pieces which was soaked into water and after removing of excess water, the straw is placed in the polythene cover which is heat resistant and sterilized in an autoclave at 20 p.s.i. for 1-2 hours followed by addition of spawn under sterile conditions. This method is more suitable for research work rather than on large-scale commercial production[8].

c. Substrate supplementation

The content of nitrogen in all most all the substrates ranges between 0.5 to 0.8% and hence addition of organic nitrogen in the straw helps in getting better yields. Some of the mostly used supplements are soybean cake, rice bran, wheat bran, cottonseed meal, etc.they should be added to the substrate for Wheat bran and rice bran @ 10% while groundnut cake, cottonseed meal, soybean cake should be tried @ 3-6% on dry weight basis of the substrate[9]. The supplements also treated with 25 ppm carbendazim (250 mg in 10 lit. water) for 14- 16 h. All these Supplements added with straw before spawning. Addition of supplements increases substrate temperature by 2-3°C or even more and hence supplementation during summer season is not advisable. However, during winter months through increased temperature is observed, which helps in quick spawn run. Excess nitrogen can attract mould infestation, which should be taken care during cultivation[10].

3. Spawning of substrate

Freshly prepared (20-30 days old) grain spawn is best for spawning. The complete procedure is done in the sterile conditions which is previously treated with 2%farmaldehyde before 48 hours. The spawn @ 2 to 3% of the wet wt. of the substrate spawn is required[11]. 300gm of spawn is required for about 8-12 kg of wet substrate or 2 to 3 kg of dry substrate. Spawn can be mixed thoroughly or mixed in layers. Spawing is done in polythene bags (60 x 45 cm) of 125-150 gauze thickness. Small holes are done in all the sides of the cover including bottom so that the excess water for draining. Punchered bags give more and fast crop (4-6 days) than non-punchered bags because of accumulation of high CO_2, which reduces fruiting[12].

4. Crop Management

(A) Incubation

The polythene bags which are spawed are moved to dark room mycelium growth, the growth of the mycelium takes place between 10 to 33°C, but it grows maximum at 22 to 26°C.

(B) Fruiting

The last stage of mushroom cultivation is fruiting, this happened after the fully growth of mycelium on the substrate, if any contaminated bags are observed should be removed and the half-colonized bags kept for more days for complete growth.

The size of the fruit depends on the humidity of the substrate, the fruits are bigger in size with more humidity (85-90%) and the fruits are smaller in size at the humidity (65-70%) and we get the good results by spraying the water as required depending on the atmospheric humidity.

The concentration of CO_2 during harvesting should be less than 600 ppm. Or 0.6%. Proper ventilation has to be provided during fruiting[5].

Cultivation of Milky mushroom (*Calocybe indica*)

Milky mushrooms are the mostly eaten mushrooms by tropical and subtropical regions of the country. this is the new type of mushroom originated in India, it is primarily cultivated in south India, but from few years it also became popular in other parts of India mainly Haryana. The popularity of the mushroom is because of its white color, good quality and simple cultivation techniques.

Cultivation

1. **Substrate and substrate preparation Milky mushroom (*Calocybe indica*)**

As the oyster mushrooms, these also grown in wide variety of substrates like Wheat, Paddy, Maize, Ragi, Cotton, Bajra leaves and stalks, jute and cotton wastes, sugarcane bagasse, coffee/tea waste etc. Mostly use substrate which is abundantly available cereal substrate(paddy/wheat)[13]. It is grown on substrate which contains cellulose, hemicelluloses and lignin. As the substrate is exposed to atmospheric conditions like rain and fog, so there is chance of growing moulds which does not allow the mushroom fungus to grow. The available straw is broken into pieces (3-5 cm) and wetted in the cool water for about 8-16 hours. The soaking is to saturate the substrate in water, the easy technique is to keep the straw in gunny bags and placed in water[14].

The substrate can be treated in the following ways

a. Hot water treatment

This technique is mostly followed by the small growers, the straw pieces are filled in the gunny bags and place in the hot water at 80 to 90°C for 40 minutes for better pasteurization.

b. Steam pasteurization

The constant steam is passed under pressure into a room which contains the wet substrate placed in a shelfs and trays at a temperature 65°C for 5-6 hours. The air in the room is circulated at constant temperature.

c. Chemical sterilization technique

The chemical sterilization of milky mushroom is same as the procedure for the oyster mushrooms.

d. Sterilization / Autoclaving

This is most easy and popular technique which is done in the lab autoclave or house hold pressure cooker, the straw pieces are placed in the polythene bags that should be resistant to heat, which is placed in the autoclave, the Substrate is sterilized at 15 lb psi for 1 hour. After autoclaving is completed substrate is cooled and the spawing is done.

2. Spawning and spawn run

The spawn rate is more as compared to oyester at 4-5% of wet substrate, the preferred type of spawing is layer spawing, the room is maintained at temperature 25-35°C, which is dark, and the relative humidity of the room is 80%, the bags which are in the rooms will be colonized in 20 days[15,16].

3. Casing

Casing is an important managing practice in the production of any land mushroom (that grow on soil) and *Calocybe indica* is not an exception. Casing initiates the change from vegetative to reproductive phase. Dense casing interfaces delay the diffusion of harmful metabolic gases on mushroom bed surface. Thus, gathering of high concentrations of carbon dioxide in the soil during reproduction usually results in yield recession [17]. Smerdon defined that the quality of the soil used for casing should have good water holding capacity and better air space for gaseous exchange [18]. And the pH of the soil should be neutral to alkaline. the most suitable method for sterilization of soil is steam sterilization.it is the necessary step for production of mushrooms [19]. Mostly used the combination of loamy soil or garden soil and sand (1: 1) which is thoroughly mixed with calcium carbonate at 12% level (pH 7) on *Calocybe indica* mushroom beds[20]. They have wind up that partially steamed clay loam soil (pH 8.4) produces high productivity and more buttons compared to farm yard manure, coir pith compost, biogas slurry, sand and peat soil [21]. In clay soil and peat, the appearance of buttons in two days, where In sandy soil and farm yard manure, the growth of the fungus took more than 10 days for the production of pinheads and attained harvesting maturity after 10.6 and 9.2 days, respectively [22]. The main important quality of the clay loam soil is to absorb moisture quickly and release it slowly. Because of more absorbing capacity and slow releasing capacity the substrate will not dry faster [23].

4. Crop management

a. During bag filing, spawning and Spawn running stage

i. The room where the bags are placed should be cleaned and sprayed with formaldehyde (1%) two times per week. The room should not be much air movement. For commercial scale cultivation it is suggestible to have HEPA filtered air circulation. Spawn running rooms should be sprayed as given below:

ii. Formaldehyde 0.5% (5ml/litre of water) once in a week.

iii. Malathion 0.1% (1 ml/liter of water) once in a week.

Room should be protected from the rates and files by providing iron frame and nylon net on windows.

b. At the time of casing of the bags are opened top surface and spray with carbendazim (1 gm) + formaldehyde (5ml) in 1 liter of water the same is sprayed in the room after a week but the mushrooms should not be affected with this spraying chemical. [6] Malathion (0.1%) should be sprayed in evening or next dayafter the formaldehyde is sprayed to protect from files. If any spots are observed (it may be green/blue/brown) is treated with formaldehyde (4%, 40 ml/litre) by wet cotton touching it on and around the spot. This helps to kill the mould. After the complete production the bags are disposed by spraying with formaldehyde (2%) [24.]

d. Water management

This is one of most important for a better and healthy crop. Depending on the weather conditions the water spraying is done like in winter it requires twice in a day,in rainy once spraying is enough but in summer season care should be taken not to dry the substrate. This will be done by placing the sand on the floor and use mist sprayer 3-4 times and frequently check the moisture of the casing by touching. Watering should also be adjusted to maintain RH (80-85%) inside cropping room[25].

Cultivation of button (*Agaricus bisporus*) mushrooms

Button mushrooms are the most popular mushrooms all over the world and it is cultivated commercially in the valley as the environmental conditions are suitable for the production of mushrooms.

For cultivation of white button mushroom following steps are required:

(i) Compost preparation
(ii) Spawn-run
(iii) Casing
(v) Cropping and harvest

(i) Compost preparation

Compost is a very important for the production of button mushrooms and it is a particular detoriate substrate. Composting causes to indefinite microbial mortification of organic wastes. This process involves microbial putrifaction of organic material, synthesis of compost to absorb and hold moisture. The microbial action changes physical, chemical and inhibit the microbes .

The quality of mushroom compost depends on:

- Nature and quality of basic material
- Organic and in organic supplements
- Management of compost during composting [26]

Out of several formulations of compost, the most frequently used are:

- Long method compost (unpasteurized)
- Short Method Compost (Pasteurized) [27]

The phase-I composting

This phase is done outdoor; the wet substrate is mixed with required amounts of Brewers grains and chicken manure as the layers, which is added with more water, the mixing of the compost up and down for the proper mixing after 2-3 days. It is finally added with urea, for the completion of outdoor process.

The phase-II composting

This phase-II composting is done indoors either in a bulk chamber/ pasteurization tunnel/ pasteurization room. These chambers are specially manufactured for phase-II composting and are fitted with boiler-fed steam-pipes and a blower. The phase-I compost is filled into the chamber up to a height of 6–7 feet, or if it is filled in trays or shelves to a depth of 15–20 cm for spawning in a pasteurization room. In either case, the temperature is rise first to 48°–50°C for 6-8hrs and then it is raised by steam injection to strictly 57°C–59°C for effective pasteurization of the compost. This temperature of air and compost is maintained at this range for 4–6hr, and allowed to fresh filtered air introduction slowly to lower down the compost temperature to 50°C–52°C for conditioning, which takes 3–4 days when the compost gets free of ammonia further air is introduced for bringing down the temperature of compost to 25°C–28°C. After cooling down, it is ready for seeding [26].

Spawning and Spawn Run

The spawn and compost are mixed @ 0.5%-0.75% which is filled in shelves, trays or polythene bags to 15-20 cm. the mouth of the bag is closed with 2% formalin dipped unprinted paper or with polythene. The temperature of the room is maintained at 24°C with a relative humidity 80-85%, mycelia growth started in 2 days after spawn is added and complete mycelia growth is obtained within 2 weeks, lower the temperature takes more time for spawn run.

Casing and Case Run

Casing is layer used to cover the top layer of spawn which is necessary for fruiting of mushrooms in the absence of casing gives the low yield, it does not contain any nutrients but used to hold the water and for good aeration and pH is maintained at 7-7.5.the commonly used casing is peat-moss which is added with chalk or lime for adjusting the pH. Due to lack of availability of peet-moss in india, it is replaced with other manures

- 1–2 years rotten cow dung + clay loam soil + 2 years old spent compost (1:1:2).
- 1–2 years old cow manure + clay loam soil (1:1).
- Garden loam soil + sand (4:1)
- Fired Brick Chips
- 2 years old spent compost + sand (4:1)
- 1-2 years old cow manure + Ashes (1:4)[26]

One important thing DO NOT mix different kinds of casing on the same bed. It is a good idea, to try several kinds on different beds in the same room.

Sterilization of casing soil

Micro-organisms permeant home land is the soil, as we are using soil as the casing material it is very much necessary to sterilize the soil, it is done by heat /chemicals, for effective sterilization the soil temperature is raised to 60°C for 5hrs.

Chemical sterilization

Soil is made ready for casing material by treating with 2%farmaldehyde (formalin), it is mixed as 500ml formalin in 10lts of water for 1 cubic meter of soil. The soil is placed on the plastic sheet and formalin is sprayed and closed with another sheet and frequently the cover is removed and mix the soil in order to free the soil form fumes of formalin, it is continued for 48hrs, then the casing material is used after one week, as it is completely free from formalin.

Soil solarization

This step reduces the parasitic moulds to maximum extent, the casing material is placed on the plastic sheet evenly and kept for 30 days with frequent watering, and by coving with the other sheet [27].

Influence of Casing Soil on Mushrooms

The casing soil will help in the weight of the individual mushrooms, the casing and the weight is directly proportional as the casing is heavy, the weight of mushroom is heavy, the pin heads should be minimum at a time as the number of pin heads increase there is a compition in the mycelia and the structure of the mushroom is bad.

Cropping and harvest

The mycelia reached to the top of the casing soil, the temperature of the room should be around 24°C for 7-10 days, as the mycelia is completely spred with mushrooms the temperature is further reduced to14°C–18°C and proper ventilation is providing to remove/reduce the CO2 level, below 1000 ppm and humidity is between 85-90%. These all requirements help to fast the fruiting of mushrooms [26].

PRODUCTION AND CULTIVATION OF OYSTER MUSHROOMS:

Oyster mushroom (Pleurotus spp.), commonly known as "Dhingri" in India, The oyster mushroom is one of the most suitable fungal organism for producing protein rich food from various agrowastes without composting. Oyster mushroom (*Pleurotus* spp.*)* cultivation has increased tremendously throughout the world during the last few decades [28, 29]. Oyster mushroom accounted for 14.2 % of the total world production of edible mushroom in 1997[28]. Oyster mushroom cultivation can play an important role in managing organic wastes whose disposal has become a problem [30]. Oyster mushroom can be cultivated in any type of ligno cellulose material like straw, sawdust, rice hull, etc This mushroom is cultivated in about 25 countries of far-east Asia, Europe and America. It is the 3rd largest cultivated mushroom in the world. China alone contributes 88% of the total world production. The other major oyster producing countries are South Korea, Japan, Italy, Taiwan, Thailand and Philippines. At present India produces annually 10,000 tons of this mushroom. It is popularly grown in the states of Orissa, Karnataka, Maharashtra, Andhra Pradesh, Madhya Pradesh, West Bengal and in the North-Eastern States of Meghalaya, Tripura Manipur, Mizoram and Assam.

The oyster mushrooms have three distinct parts- a fleshy shell or spatula shaped cap (*pileus*), a short or long lateral or central stalk called *stipe* and long ridges and furrows underneath the pileus called gills or *lamellae*. The gills stretch from the edge of the cap down to the stalk and bear the spores. The spores are smooth, cylindrical and germinate very easily on any kind of mycological media within 48-96 hrs. The mycelium of *Pleurotus* is pure white in colour. Cultivation technology of oyster mushroom is very simple which does not require costly infrastructure facilities. The cultivation of oyster mushroom in India is mainly done in seasonal low cost growing rooms with very less expenditure on infrastructure. Theoretically each crop takes 45 days and under controlled conditions and hence there can be 8 crops per year [31].

Oyster mushrooms are 100% vegetarian and the nutritive value of oyster mushroom is as good as other edible mushrooms like white button mushroom (A. bisporus), shiitake (Lentinula edodes) or paddy straw mushroom (Volvariella spp.). They are rich in vitamin C and B complex. Protein content varies between 1.6 to 2.5% on fresh weight basis. It has most of the mineral salts required by the human body such as potassium, sodium, phosphorus, iron and calcium. The niacin content is about ten times higher than any other vegetables. A polycyclic aromatic compound pleurotin has been isolated from P. griseus, which possess antibiotic properties [32].

PRODUCTION AND CULTIVATION OF MILKY MUSHROOMS:

Mushroom farming today is being practiced in more than 100 countries and its production is increasing at an annual rate of 6 to7 per cent. Mushroom production is an eco- friendly activity where agricultural or industrial wastes are utilized and recycled. During the last four decades, mushrooms have attained the status of commercial crop [33]. milky mushroom (Calocybe indica) has become the third commercially grown mushroom in India after Button and Oyster mushroom [34]. In modern mushroom production panorama, button mushroom (Agaricus bisporus) ranks first, (Calocybe indica) is popular in US and Europe thus milky mushroom cultivation in India has increased [35].

Calocybe indica (Milky Mushroom) are white in color, gills and stalks white. Mushrooms large with long, thick fibrous stalk. It can be grown on 2 cm 2 cm 11 substrates containing lignin, cellulose and hemicelluloses, straw of paddy, wheat, ragi, maize, bajra, cotton stalks, sugarcane bagasse, wastes, dehulled wastes etc. Calocybe indica is of Indian origin and has become the third commercially grown mushroom in India, after button and oyster mushrooms.C. indica a tropical edible mushroom, is popular because it has good nutritive value and it can be cultivated commercially on a large scale. Paddy straw used as a substrate in milky mushroom. Paddy straw mushroom is a popular variety among people because of its distinct flavour. Pleasant tastes, higher protein content and shorter cropping duration compared to other cultivated mushrooms [36]. It is becoming more popular, due to its robust size, attractive color, sustainable yield, delicious taste, and unique texture [37].

Small scale mushroom growers prefer to grow this tropical mushroom due to the following reasons: [38]

(1) Ideally suited to warm humid climate (30~38°C; 80% to 85% humidity).

(2) Its longer shelf life without any refrigeration (can be stored up to 7 days at room temperature).

(3) Retains fresh look and does not turn brown or dark black like that of button mushrooms.

(4) Lesser contamination due to competitor molds and insects during crop production under controlled conditions.

(5) Infrastructure needed to grow this mushroom is very much affordable and cost of production is comparatively low, which means industrial production could be attractive and

(6) Has a short crop cycle (7~8 wk) and good biological efficiency of 140% (140 kg fresh mushroom/100 kg dry substrate).

PRODUCTION AND CULTIVATION OF BUTTON MUSHROOMS:

The white button mushroom (*Agaricusbisporus*) is very popular as table mushroom, cultivated mushroom which is edible basidiomycete fungus, throughout the world and is the most important mushroom of commercial significance in India. The original wild form bears a brownish cap and dark brown gills but more familiar is the current variant with a white form, having white cap, stalk and flesh and brown gills [39]. *Agaricus* is the most cultivated mushroom and accounts for the 38% of worlds cultivated mushrooms [40].

For successful growth the environmental conditions are very much important ,as it requires less temperature, the north india in winter take the advantage of growing the mushrooms and the temperature for mycelium growth is 22°C -25°C and at the time of fruiting the temperature is14°C -18°C the humidity required is high, the compost is the most important thing for cultivation of mushrooms, for increasing the area of cultivation mostly shelves or trays system is adopted and required measurements should be taken to avoid the moulds and pests attack [26].

Nutritional, therapeutic and other uses of Oyster mushrooms:

Pleurotus ostreatus is an edible species, commonly known as the oyster mushroom [41]. Pleurotus is an efficient lignin- degrading mushroom and can grow well on different types of lignocellulolosic material. Edible mushrooms can be easily grown on a variety of lignocellulosic substrates of agricultural, forest, and food processing industries. P. ostreatus requires a shorter growth time compared to other edible mushrooms. The substrate does not require sterilization, only pasteurization is enough thus their cultivation is less expensive. oyster mushrooms convert a high percentage of the substrate to fruiting bodies, increasing profitability. P. ostreatus needs few environmental controls, and their fruiting bodies are not often attacked by diseases and pests, and they can be cultivated in a simple and cheap way. P. ostreatus cultivation is an excellent alternative for production of mushrooms when compared to other mushrooms [42]. Milky white mushrooms contain eighteen amino acids including eight essential amino acids. These are popular and most versatile commercially cultivated and consumer preferred.

There are several reported nutritional and medicinal benefits of oyster mushroom. The composition of Oyster mushrooms includes 29% protein, 13% dietary fiber, vitamins and minerals, and are free from cholesterol [43]. The protein component is rich source of essential amino acids such as leucine, glutamine and valine [44]. Some chemical compounds derived from *Pleurotus* spp. show antitumor and antibacterial properties. An acid extract containing cationic protein from two spp. of *Pleurotus* (*P. nebrodensis* and *P. eryngii*) inhibited the growth of *Staphylococcus epidermidis* at minimum inhibitory concentration of ≤0.025% v/v [45]. The compounds derived from *Pleurotus* spp. are cardioprotective [46]. The substrate from which mushrooms have been cultivated and harvested is called spent mushroom compost (SMC). Many studies indicated the potential of SMC as a source for fuel, animal feed and soil fertilizer [47]. Biotechnological applications have led to new SMC products for pesticide degradation [48] and heavy metal filtration [49].SMC for successful commercial growth of lettuce [50]. Active enzymes such as total cellulase, β-glucosidase, dextranase, amylase and lactase recovered from SMC of several mushrooms including *P. eryngii* and *P. ostreatus*. Dextranase is used to prevent caries by inhibiting dental biofilm formation [51]. lactase useful in wastewater treatment [52].

Malnutrition is a problem in developing third world countries. Mushrooms with their flavour, texture, nutritional value and high productivity per unit area have been identified as an excellent food source to alleviate malnutrition in developing countries [53]. Among the reasons for the quick acceptance of mushroom is its nutritive content. Mushrooms are eaten as meat substitutes and flavouring. In general, edible mushrooms are low in fat and calories, rich in vitamin B and C, contain more protein than any other food of plant origin and are also a good source of mineral nutrients [54].

Currently, high biofuel prices have caused an increase in food prices and food scarcity in many countries (World Bank, 2008). To alleviate hunger and malnutrition in a world of rising food prices, cultivation of mushrooms is a very reliable and profitable option.

The oyster mushroom cultivation on sawdust of different woods and found that *P.ostreatus* gave the maximum yield. Presently sawdust is commonly used and is the preferred medium at commercial scale. *P.ostreatus* gave maximum biological efficiency on sawdust. Of the sawdust types, softwood sawdust like mango and cashew are known to be more suitable than hardwood sawdust [55]. Few of the reported pharmacological actions with their chemical constituents are reported in the Table 1.

Table.1 Pharmacological effects and chemical constituents of *Pleurotus ostreatus (Oyster)* mushroom

Pharmacological effect	Chemical constituents	References
Anticancer	Water soluble protein (or) polysaccharides	Jedinak A et al (2010) Wu et al (2011) De Silva DD et al (2012) [56,57,58]
Antioxidant	β-D Glucan (pleuran) Lectin	Bokek P & Galbavy S (2001) Wang H &Ng TB (2000) Zhang YX et al (2012) Mitra P et al (2013) [59,60,61,62]
Antitumor	β-D Glucan (pleuran) Glycopeptide s Proteoglycans	Bokek P & Galbavy S (2001) Li et al (1994) Sarangi I et al (2006) Silva S. et al (2012) Devi KSP et al (2013) [59,63,64,65,66]
Antiviral	Ubiquitin-like protein	Wang H &Ng TB (2000) Ei-Fakharany et al (2010) [60,67]
Antibacterial	β-D Glucan (pleuran), silver nanaoparticles(AgNPs)	Karacsonyi S & Kuniak L (1994) Mirunalini S et al (2012) Vamanu E et al (2012),[68,69,70]
Antidiabetic	Unspecified bioactive	Krishna S & Usha PTA (2009) Ghaly et al (2011) [71,72]
Antihypercholesterolic	Lovastatin	Bobek P et al (1995) Weng TC et al (2010) [73,74]
Eye health	Unspecified bioactive	Isai M et al (2009) [75]
Anti-arthritic	β-(1,3/1,6)Dglucan	Bauerova et al (2009) [76]

Nutritional, therapeutic and other uses of Milky White Mushrooms:

Among eighty edible mushrooms are considered for commercial exploitation, milky mushroom (Calocybe indica) has become the focal point of exploitation in India as it grows in hot humid climate and suitable for cultivation almost throughout the year. Milky mushroom is considered as a better proxy for oyster mushroom notably in tropical regions with longer shelf life of 3-4 days and offers wide export potential. Cultivation of milky mushroom has become popular in Tamilnadu, Kerala, Karnataka and Andhra pradesh. Pleurotus ostreatus is the second most cultivated edible mushroom worldwide after Agaricus bisporus.

Calocybe indica on different substrates shows the presence of altogether eighteen fatty acids especially eicosapentaenoic acid and docasohexaenoic acid. These two omega3 PUFAs known to decrease the incidence of coronary heart diseases, stroke and rheumatoid arthritis [77]. Milky mushroom known for its delicacy, flavor, and aroma. Calocybe indica is considered as a valuable vegetable, consisting of protein (10-40 per cent) carbohydrate (13-70 per cent) fat less than (1-8 per cent) 4 minerals and significant amount of essential amino acids [1]. Calocybe indica is rich in protein, lipids, fiber, carbohydrates, and vitamins and contain abundant amount of essential amino acids and low in fat [78]. When compared to oyster mushroom milky mushroom had more carbohydrate protein, and fat [79]. Mushrooms contain polysaccharides glycogen and chitin. Chitin is a water- insoluble structural N-containing polysaccharide accounting for up to 80-90 per cent of dry matter in mushroom cell walls [80]. Mushrooms are excellent source of high quality proteins as compared to most of the vegetables; they are in easily digestible form. Quality of protein is comparable with meat, egg and milk [81]. The protein value of mushrooms is twice as that of asparagus and potatoes four times as that of tomatoes and carrots, six times as that of oranges. Calocybe indica consists of about 15- 40 per cent protein [82]. Mushrooms are very useful for vegetarian because they contain some essential amino acids which are found in animal proteins [83]. Mushrooms contain all the essential amino acid required by an adult [84].

The mature fruit bodies of Calocybe indica contain more amounts of proteins than button mushroom [85]. The leucine, threonine, tyrosine and alanine are the amino acids predominant in Calocybe indica. Mushrooms are excellent source of vitamins especially B complex vitamins viz. thiamin, riboflavin, niacin, panthothenic acid, biotin, folic acid and vitamin B12, vitamin D and ascorbic acid. Mushrooms are excellent source thiamine riboflavin, nicotinic acid and ascorbic acid. Mushrooms also provide vitamin D which helps to keep bones stronger and healthy and helps to regulate the growth of the cells[86]. The vitamin B12 and folic acid, which are normally not found in vegetarian items are present in mushrooms and along with availability of iron and protein, are reported to maintain hemoglobin level as single source in diet [87].

The Calocybe indica consists of vitamin A, C, E and B complex vitamins viz. thiamin, riboflavin, niacin, panthothenic acid. The characteristic flavor of mushroom species, mainly, dried is highly valued by consumers [4]. Chemical structure flavor components in mushrooms are classified as derivatives of octane and octanes, lower terpenes, aldehydes, sulfur and heterocyclic compounds. Mineral content viz. calcium, phosphorous, sodium, potassium, magnesium, and other trace elements present in fresh mushroom is higher than many fresh fruits and vegetables [88]. Mushrooms are rich in copper, a mineral that has cardio-protective properties. A single serving of mushroom is said to provide 20-40 per cent of the daily needs of copper [89]. Mushrooms are also excellent source of selenium, an antioxidant that works with vitamin E to pro tect cells from the damaging effects of free radicals [90]. Calocybe indica have most of the mineral salts required by the human body such as potassium, sodium, phosphorus, iron, and calcium [91].

Tropical milky white mushroom (*Calocybe indica* P&C var. APK2) variety was first identified in the West Bengal and can be cultivated on a wide variety of substrates, at a high temperature range (30~38ºC). The commercial production techniques for the first time in the world. This edible mushroom has a long shelf life (5~7 days) compared to other commercially available mushrooms [25]. In the tropical region, the climate is suitable to grow milky white mushroom compared to button mushroom production. Milky white mushroom resembles button mushroom in several aspects, with higher shelf life, increased productivity, milky white color. The mushrooms are robust and flexible for production in varied sizes from a small button (average weight, 35~40 g) to large caps depending upon consumer demand, which is normally not possible with other cultivated mushrooms [92]. Milky white mushroom contains essential amino acids Argenine, Histidine, Lysine, Trptophan, Phenyl alanine, Leucine, Isoleucine, Threonine, Methionine and Valine [93].

Calocybe indica (Fam: *Tricholomataceae*,Ver: Milky mushroom) are abundant in India 5. Among the various edible mushroom *calocybe* genus consists of about 20 species of mushroom, including *calocybe indica*, which can be cultivated throughout the year in the entire of India even in hot humid climate. It is a fleshy, milky white, umbrella like mushroom [94, 95]. *C. indica* is an indigenous popular edible mushroom, possessing a variety of secondary metabolites such as phenolic compounds, terpenes and steroids possibly involved in their medicinal effects and nutritive values in range/100grams are energy - 27kcal, moisture - 90.67%, carbohydrate - 6.3~7.3 g, fat - 0.1g, protein - 2.6~2.9 g, lipids - 0.6~0.7g, fiber- 1.5~1.8 g, thiamine (vit B1) - 0.1mg(8%), Riboflavin (Vit B2) - 0.5 mg (33%), Niacin (Vit B3) - 3.8 mg (25%), Pantothenic acid (B5) - 1.5 mg (30%), Calcium - 18 mg (2%), Phosphorous - 448 mg (10%), Sodium -6 mg (0%), Zinc - 1.1 mg (11%) [96]. It is important to note that the accumulation of these compounds depends on management, processing and maturity at the time of harvest. Though a revolution in mushroom cultivation has been witnessed, serious effects are needed to perfect the production technologies of newer edible mushroom including *C. indica* [97]. Recently, *C. indica* have become an attractive functional food mainly because of their chemical composition, and this can be explained by the antioxidant capacity of mushrooms. As far as milky mushroom is concern there is a lack of scientific investigations. Therefore, we have carried out a preliminary study on the cultivation aspects and antioxidant activity of *C. indica* to establish their health promoting properties. Some of the reported pharmacological actions and chemical constituents are in the Table 2.

Table.2 Pharmacological effects and Chemical constituents of (*Calocybe Indica*) Milky white mushroom

Pharmacological effect	Chemical constituents	References
Antioxidant	Vitamin E(tocopherol)	Mattila P et al 2000 [98]
Anticancer	Water soluble protein (or) polysaccharides	Jedinak A et al (2010) Wu et al (2011) De Silva DD et al (2012) [56,57,58]
Antihypercholesterolic	Lovastatin	Bobek P et al (2001) Weng TC et al (2010) [73,74]

Nutritional, therapeutic and other uses of Button mushrooms:

Agaricus bisporus is the most widely consumed mushroom in the world, with a high nutritional value and many bioactive compounds, including L-ergothioneine (2-mercaptohistidine trimethylbetaine, ERGO), polysaccharides, amino acids, phenolics, dietary fiber, ergosterol, vitamins, and minerals. Phytochemicals play an important role in preventing oxidative stress, which contributes to cataracts, cardiovascular disease, atherosclerosis, chronic in flammation, and neurodegenerative diseases such as Alzheimer’s and Parkinson’s disease. Fungi are an important source of antioxidant and other medicinal compounds. Recently, research is being conducted on the use of mushrooms to reduce damage caused by oxidizing agents [99].

The most important qualities of *A. bisporus* are its dietetic and medicinal properties derived from its rich composition of metabolites and biologically-active elements. *A. bisporus* is a rich source of dietary fi ber (chitin), essential and semi- -essential amino acids, and antioxidant substances (sterols, phenolic and indole compounds, ergothioneine, vitamins, selenium) [100.101] *A. bisporus* grows in Poland between May and September. Usually, it occurs in places fertilized with cow dung, compost piles, parks and forests. Its growth on open spaces is rare [101]. More frequently, it can be cultivated on special culturing substrates

A. bisporus plays an important part in the decomposition of leaves and needles in parks and forests. Apart from its ecological function, it is one of the most frequently cultivated mushrooms worldwide [102]. The fi rst known information about *A. bisporus* culturing comes from France in 1707 [100,101,103] and for this reason, the species is also widely known as the Paris champignon. The reported pharmacological and chemical constituents of *Agaricus biosporus* are given in Table 3.

Table.3 Pharmacological effects and Chemical constituents of *Agaricus biosporus* (Button) mushroom

Pharmacological effect	Chemical constituents	References
Brest cancer	Arginine, Lovastatin	Kanaya *et al*. 2011, Chen *et al*., 2012. Yang *et al*. 2016 [104,105,106]
Anticancer	polysaccharides α- glucan, β-glucan and galactomannan	(Smiderie *et al*., 2011) [107]
Antioxidant	phenolic compounds like gallic acid, protocatechuic acid, catechin, caffeic acid, ferulic acid and myricetin, serotonin	Liu *et al* 2013, Sarikaya and Gulcin, 2013 [108]
Antibacterial	silver nanoparticles (AgNPs)	Owaid *et al*., 2017 [109]
Antidiabetic	alpha-glucans	Volman *et al*. 2010 [110]
Antihypercholeste rolic	Lovastatin	Xu *et al*., 2013, Yang *et al*. 2016 [111,106]
Cardiovascular	Lovastatin	Xu *et al*., 2013, Yang *et al*. 2016 [111,106]
Wound healing activity	chitin and chitosan	Rajewska & Bałasinska, 2004 [112]
Anti-inflammatory	Fucogalactan	Ruthes *et al*., 2013 [113]

CHEMICAL COMPOSITION AND NUTRITIONAL VALUE OF BUTTON, OYSTER AND MILKY MUSHROOMS

The six major constituents of mushrooms are water, proteins, carbohydrates, dietary fiber, fat, and ash. The moisture content of mushrooms is usually determined by drying at 105° C in a hot air oven overnight to a constant weight. The difference in weight before and after drying is expressed in terms of percentage. The protein content is determined by Kjeldahl method and the lipids are estimated by Twisselman method using extractive solvent like diethyl ether. The lipids in mushrooms include free fatty acids, mono-, di-, and triglycerides, sterols, sterol esters and phospholipids. The sporophore samples are incubated in a muffle furnace at 500°C to estimate the ash content which normally contains potassium and phosphorous. Total carbohydrate content in a given mushroom sample is calculated using the formula, 100 − moisture (%) − protein (%) − crude fat (%) − ash (%) and expressed as g/100 g of fresh or dry sample [114]. The energy content in mushrooms is influenced by the composition of crude protein, fat and carbohydrates whose conversion factors are 2.62, 8.37, and 3.50 kcal/g of the individual components, respectively. These conversion factors are slightly lower than the actual conversion factors used for other food ingredients because they are estimated as crude components. These differences could be due to variations in mushroom culture conditions, time of sampling and substrates used. have reported that the type of substrates and supplements used for mushroom cultivation had greatly influenced the proximate composition (carbohydrate, protein, fat, fiber, ash content, and moisture content) including antioxidants. Based on the availability of soluble sugars are given in table 4. Mushrooms are good sources of minerals (Ca, K, Mg, Na, and P), trace elements (Cu, Fe, Mn, and Zn) and sometimes, toxic heavy metals (Cd and Pb) as compared to vegetables. The mineral components of milky white mushrooms as reported [115,116,117] in the literature are given in Table 5.

Table 4. Composition of Button, Oyster and Milky mushrooms

	Domestically cultivated mushrooms		
	Button [114]	Oyster [118]	Milky white [118]
Growth temperature (°C)	13~19	20~30	30~38
Moisture	92.3	88.40 ± 0.23	85.95 ± 1.05
Total solids	7.7	11.60 ± 0.23	14.05 ± 1.05
Crude protein (g/100 g)	2.09	04.83 ± 0.04	03.22 ± 0.17
Total lipids (g/100 g)	0.33	00.46 ± 0.01	01.05 ± 0.03
Available CHO	ND	4.28	6.38
Ash (g/100g)	0.78	01.41 ± 0.03	02.30 ± 0.73
Total carbohydrate (g/100 g)	4.5	05.10 ± 0.25	6.80 ± 0.5
Calorie (kcals/100 g)	27.0	41.8	50.03
Dietary fiber (g/100 g)	1.5	00.63 ± 0.02	01.11 ± 0.02

Table 5. Comparison of mineral and antioxidant composition of Oyster, Milky white and Button mushrooms both in fresh and dry form (/100 g)

Component	Oyster mushrooms [115] (*Pleurotus ostreatus*)		Milky white mushrooms [118,119,120] (*Calocybe indica*)		Button mushrooms [114] (*Agaricus bisporus*)	
Form	Wet	Dry	Wet	Dry	Wet	Dry
Calcium (Ca, g)	0.001	0.01	0.01	0.21	0.02	0.25
Copper (Cu, mg)	0.67	8.4	0.9	ND	2.2	29.0
Iron (Fe, mg)	4.30	54.0	1.8	56.25	56.25	48.0
Zinc (Zn, mg)	6.60	83.0	8.0	12.87	5.1	66.0
Magnesium (Mg, g)	0.16	2.0	0.51	0.13	0.1	1.3
Manganese (Mn, mg)	0.89	11.0	0.53	1.64	0.42	5.5
Cadmium (Cd, µg)	30.0	380.0	ND	ND	2.8	36.0
Phosphorus (P, g)	1.11	13.9	0.62	ND	0.98	12.7
Lead (Pb, µg) 14.0	1.6	20.0	ND	ND	14.0	180.0
Selenium (Se, µg)	12.00	150.0	ND	13.20	110.0	1400.0
Sodium (Na, g)	0.01	0.13	0.37	ND	0.03	0.42
Potassium (K, g)	2.98	37.3	1.97	ND	3.64	47.3
Vitamin A (mg/g)	0.35	0.28	0.32	0.22	-	-
Vitamin C (mg/g)	0.36	0.27	1.03	0.40	-	-
Vitamin E (mg/g)	7.28	5.15	2.93	0.80	-	-
Reduced Gluathione (nmole/g)	0.18	0.12	0.16	0.12	-	-

Table:6 Microchemicals and their activities in *Agaricus bisporus*, *Pleurotus ostreatus*

Mshroom Species	Mycochemicals	Activities	References
Agaricus bisporus, *Pleurotus ostreatus*	Alkaloids	Antimicrobial, antioxidant anti-inflammatory	Mattila,et al., 2001 [121]
	Carbohydrate	Antimicrobial	De Silva et al., 2012 [122]
	Phenols and Polyphenols	Antimicrobial, antioxidant anti-inflammatory	Badalyan, S.M. 2001 [123], Mattila,et al., 2001 [121]
	Proteins and Amino acids	Antimicrobial, anti-inflammatory	Choi,et al., 2014 [124]
	Saponins	Anti-cancer, Antioxidant	Lee et al., 2013 [125]
Agaricus bisporus,	Tannins	Antimicrobial, antioxidant	Mortimer,et al., 2012 [126]

Mushrooms in Cosmetics:

Many mushrooms and their ingredients have been reported to be beneficial to the skin and hair. The ingredients are phenolics, polyphenolics, terpenoids, selenium, polysaccharides, vitamins, and volatile organic compounds. These compounds show excellent antioxidant, anti-aging, anti-wrinkle, skin whitening, and moisturizing effects, which make them ideal candidates for cosmetic products [3]. Mushrooms are rich in protein, vitamins, minerals, and excellent sources of β-glucan, selenium, thiamine, riboflavin, niacin, pantothenic acid, and folic acid [127,128]. It has reported that mushrooms favor longevity and avoid premature aging [129,130]. Recently consumers started preferring cosmetics containing natural ingredients being safe and environment friendly. Thus, ingredients extracted from mushrooms, are now getting their way into cosmetics, such as ceramides, lentinan, schizophyllan, omega 3, 6, and 9 fatty acids, carotenoids, resveratrol, and others [131,132].

Mushrooms are a good source of vitamin D, antioxidants and minerals like iron, selenium, and copper, which are all useful in both promoting healthy and strong hair and preventing hair loss and dandruff. The inclusion of mushroom extracts into haircare cosmetics is of great potential in the cosmetic industry. Nowadays several types of mushrooms are incorporated in topical creams, lotions, ointments, serums, and facial preparations as antiaging ingredients [3]. Both fruiting bodies and mycelia of wild and cultivatable mushrooms represent ample sources of active components. The compounds so obtained from mushrooms are relatively complex mixtures of metabolites, in liquid or semisolid states, or in dry powder form, and are intended for external or oral use for cosmeceuticals or nutricosmetics. Nutricosmetics are also known as beauty pills or oral cosmetics which are taken orally for reducing wrinkles on the skin and for anti- aging effects [133]. The compounds like carotenoids, polyphenols, vitamins, mushroom extracts, micronutrients, glycopolyglycans, amino acids, other mushroom-based elements, and polyunsaturated fatty acids are used as nutricosmetics [134].

Mushroom polysaccharides act as effective moisturizing agents in cosmetics. l-ergothioneine, a thiourea derivative of histidine which could reduce the oxidation to mitochondrial membrane, was discovered in high concentrations in Pleurotus *ostreatus*, and in Agaricus *bisporus* [135]. The glucan isolated from an alkaline extract from a somatic hybrid mushroom of *Calocybe indica* var. APK2 and *Pleurotus florida* showed antioxidant properties with immune activation of macrophage, splenocyte, and thymocyte [136]. Tyrosinase inhibition is the most common approach to achieve skin whitening [137].Many mushrooms have tyrosinase inhibition activity including *Agaricus bisporus*, *Agaricus hortensis*, *Ganoderma* spp., and *Phellinus baumii*. The methanol extract from fruiting bodies of *Phellinus baumii* showed inhibitory activities of tyrosinase and melanin synthesis by dose dependent manner in B16/F10 melanoma cells [125].

Mushroom chitosan is also widely used in cosmetology as an emulgatory, gel-forming, protective, and anti-bacterial agent [138]. Chitin-glucan is a copolymer found in the cell wall of several mushrooms with good moisturizing properties, has potential for use in skin moisturizing and anti-aging formulations[139.] Some mushrooms are also used in biotransformation and the products such as lactic acid and ceramides could potentially be used in cosmetics [140]. Lactic acid is an alpha hydroxy acid used in cosmetic preparations in dermatology to hydrate and smooth dry, flaking skin. Ceramides are also used in cosmetics as epidermal hydrating agents [141].

Kojic acid a phenol is commonly found in several mushrooms is used as a natural skin lightener in creams, lotions, and serums and also as a remedy for age spots and pigmentation [142]. Kojic acid inhibits melanin production on the surface of treated skin, thereby lightens the new skin cells that form after the dead cells are exfoliated.Xanthophylls and Carotenes are the terpenoids widely used in sun screen lotions, which are organic pigments found in many mushrooms [143]. Selenium (Se) is an ultra-trace essential element for mammals and essential in different selenoproteins and/or selenoenzymes. *Agaricus bisporus* and *Lentinus edodes* are edible mushrooms that accumulate Se in their bodies [144,145]. Selenium can benefit bone health and strengthen the teeth, hair, and nails, which is widely used in shampoos.

DISCUSSION:

Several mushroom species have been pointed out as sources of bioactive compounds, in addition to their important nutritional value. The inclusion of whole mushrooms into the diet may have efficacy as potential dietary supplements. In the present study we have discussed about the three mainly edible mushrooms, all the three are rich in nutrients and good for health, when we compare the production of the three mushrooms there are some advantages and disadvantages to the three mushrooms, when compared the spawn rate is less (2-3%) to oyster mushroom than the milky (4-5%) but more than the Button (0.5-0.75%) mushroom ,but the preparation of compost in the button is complicated and lengthy about 28days preparation which is not required for milky and oyster mushrooms. one more important in button and milky is casing which is difficult to prepare for button than milky and casing is not required in oyster. Moreover, the button mushroom requires highly stable infrastructure for different operations like composting, spawn making, cropping and post-harvest practices requires great efficiency and the temperature maintaince is not possible in all regions it requires less temperature about 20^{o}C where the oyster (20-30^{o}C) and milky (30-38 ^{o}C). there are differences in the composition of three mushrooms as told in the table4 and 5. These differences could be due to variations in mushroom culture conditions, time of sampling and substrates used. the type of substrates and supplements used for mushroom cultivation had greatly influenced the proximate composition (carbohydrate, protein, fat, fiber, ash content, and moisture content) including antioxidants. Based on the availability of soluble sugars. .for the production of mushrooms in the home the most suitable mushrooms are the oyster mushrooms which is very easy to maintain and produce very large amount of mushrooms in less days compared to milky and button.

For centuries people across the world have been using wild mushrooms for food, medicine and cosmetics, as well as for other economic and cultural purposes. Many mushroom ingredients possess potent antioxidant, as well as anti-inflammatory, properties, which are useful in treating fine lines, wrinkles, uneven tone, and texture of skin[2].Worldwide mushroom production has been gaining popularity as a multibillion dollar business. Milky white mushroom is an important edible mushroom is native to India and can be cultivated throughout the year in the entire parts of India even in hot humid climate [146]. Milky white mushrooms and oyster are highly suitable for commercial production in humid tropical and subtropical regions where temperature is in between 25ºC and 35ºC throughout the year. In the tropical region, milky white and oyster mushrooms can be cultivated with less cost compared to button mushroom production. There is a 3~5% increase in world mushroom consumption every year. US and Europe are the markets for mushrooms [92].

CONCLUSION:

People prefer mushrooms not only for their flavor and delicacy but also for their nutraceutical, pharmaceutical and cosmeceutical benefits. Mushrooms are largely unexplored source of potential novel pharmaceuticals and cosmeceuticals. Several mushroom species have been identified as sources of bioactive compounds. In addition to their nutritional value mushrooms contain components useful to prevent or treat different types of diseases. Processing of mushrooms improves their shelf life and marketability. Powder formulations of some species have revealed the presence of essential nutrients which could be developed in to nutraceutical formulations useful to prevent oxidative stress and associated health problems. As a natural source of bioactive compounds, mushrooms are now preferred ingredients in the cosmetic industry for their antioxidant, anti-aging, anti-wrinkle, skin whitening, and moisturizing effects. At present the research on bioactive principles of edible and wild mushrooms is limited. Further studies on mushroom extracts and phytochemicals will help us to understand the role of mushrooms and their phytochemicals as nutritional agents, therapeutic agents and cosmeceuticals.

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