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RECYCLING OF AGRICULTURE WASTES THROUGH OYSTER MUSHROOM CULTIVATION TO MITIGATE STUBBLE BURNING PROBLEM AND EMPOWER RURAL PEOPLES

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ABSTRACT :

Agriculture is the backbone of Economy in India. About 60% of Indian population directly depends on agriculture and its allied fields. The agriculture wastes as byproduct are largely burnt on field that led to emission of air pollutants, one of the major problems by stubble burning practice in India. Recycling these agriculture wastes viz. Paddy straw, Wheat straw and Maize straw by cultivation of Oyster mushroom, Pleurotus sajor-caju, a nutrient rich fungus was studied in the present work to mitigate stubble burning practice. Biological efficiency of this mushroom cultivation on different agro wastes available in my study was studied. It was found that maximum efficiency was found on wheat straw followed by paddy straw and maize straw. So, Oyster mushroom cultivation may be treated as socio-economically and ecologically more effective in consideration of nutritious rich health food to combat malnutrition, economically more profitable and opportunity of new employment generation, recycle of agro wastes which can reduce emission of air pollutants to mitigate stubble burning practice, no land or very small space and minimum capital investment which may be an alternative way of employment opportunity for rural landless farmers.

KEYWORDS : *Oyster mushroom, Stubble burning, Agriculture wastes, Recycling, Pleurotus sajor-caju*

INTRODUCTION:

India lives in village, village is inhabited by farmers and farmers are largely depending on agriculture. So, agriculture is a critical sector for Indian economy. About 60% of Indian population directly depends on agriculture. With increasing human population, demand of nutritious food is exponentially increased day by day that led to food scarcity and malnutrition in many countries. Large scale agriculture release huge bulk of agriculture wastes as byproducts. India produces about 600 million tonnes of agricultural waste per annum and a major part of it is burnt on field **(Figure-A**). This traditional stubble burning practice contribute the emission of greenhouse gases (CO_2, N_2O, CH_4), air pollutants (CO, NH_3, NOx, SO_2, NMHC, volatile organic compounds), particulates matter and smoke thereby poisoning threat to human health (Jain *et al*. 2014). So, large scale production of food to serve its entire citizen is a great challenge in developing country like India, but management of these agro solid wastes as byproduct is a burning challenge for researches. Recycling of these agro wastes by cultivation of edible mushroom can play an important role in managing traditional stubble burning practice and which can be converted into nutritious rich health food; environment may be less polluted (Eswaran and Ramabadran, 2000) and spent mushroom substrate can be converted into organic manure/vermi-compost which can increased soil fertility to promote integrated farming practice .

Mushroom has been defined as a macro fungus with a distinctive fruiting body, which can be either epigeous or hypogeous and large enough to be seen with naked eye and to be picked by hand (Chang and Miles, 1992). Mushrooms pose a range of secondary metabolites of ethno-mycological and pharmaceutical importance such as antitumour, immunomodulatory, antigenotoxic, antioxidant, anti-inflammatory, hypocholesterolaemic, antihypertensive, antiplatelet- aggregating, antihyperglycaemic, antimicrobial and antiviral activities (antitumour, immunomodulation agents, and hypocholesterol-aemic agents and food (e.g. flavour compound) industries (Chang, 2007). The Food and Agriculture Organization have recognized mushrooms as food contributing nutrient rich substance to the countries largely depending on cereals. Oyster mushroom is widely cultivated mushrooms gaining popularity for its rich source of essential amino acids, minerals (Ca, P, Fe, K and Na), vitamin C, B complex (thiamine, riboflavin, folic acid and niacin) and ability to grow on diverse agricultural wastes (Manzi *et al*. 2001). Mushrooms with its lucrative flavour, texture, nutritional value and high productivity per unit area have been recommended as an excellent food source (Eswaran and Ramabadran, 2000). *Pleurotus* is characterized by its high protein content 30-40% on dry weight basis (Sharma and Madan, 1993) which is twice that of vegetable. Poppe (2000) reported about 200 kinds of waste rich in lignocelluloses are being used as substrates for cultivation of *Pleurotus* species. Mushroom cultivation requires no land or very small space and minimum capital investment. So, it can be an alternative way of employment opportunity for landless farmers, educated youth and women in addition to short out the problem of stubble burning. This kind of bioconversion and bioremediation exercise can greatly reduce environmental pollution. The main objectives of mushroom cultivation are (1) to reduce emission of air pollutants by minimize stubble burning practice, (2) to generate relatively cheap source of protein rich heath food by recycling agro wastes, (3) to examine the biological efficiency of *P. sajor-caju* on different agro wastes available in my study areas (4) to study the economics of mushroom cultivation, (5) to generate alternative employment opportunity for empowering women, youth and farmers.

A. MATERIALS AND METHODS

Mushroom Cultivation

Mushroom cultivation is performed in 3 different steps such as pure culture preparation, spawn (artificial mushroom seed) preparation and mushroom crops production. The first two steps are laboratory based and last one is field based.

1. Pure culture

Tissue culture technique

Young basidiocarp is cleaned with sterilized distilled water and dipped into 0.2% mercuric chloride or 3% sodium hypochlorite solution for 1 min under laminar flow chamber. Then it is split open longitudinally with hand. Then little bits of mycelia were taken from the collar region (junction between pileus and stipe) with the help of sterilized cooled laboratory forceps and place this tissue on the Potato Dextrose Agar (PDA) medium on petri plate/slant. The petri plate/slant is then incubated at 25 $\pm 2^0$C in BOD incubator. Within 4-5 days the new mycelia are growing over the media is observed. Sub-culturing/multiplication of pure culture is made by carefully transferring young mycelium from growing edge of the colony from petri-plate/slant to fresh PDA slants and again incubating at 25 $\pm 2^0$C (**Figure-B**).

2. Spawn Production

Mushroom artificial seeds are generally referred to as **spawn.** Spawn is defined as synthetic medium that is impregnated with mycelium of a pure fungal culture of the chosen edible fungal strain which are used as inoculums for initiating mushroom production. Mushroom spawn is produced following the method of Sinden, 1932; Stoller, 1962; Sharma and kumar, 2011 with some modification.

2.1. Spawn media

A number of cereal grains alone or in different combinations are used as substrates for mushroom spawn preparation such wheat, jowar, bajra or rye and agricultural waste like corn cobs, wooden sticks, rice straw, saw dust and spent tea leaves, etc. In our present work mushroom spawn are prepared by using wheat grains for easy availability in my study area. Cereal grains free from diseases and intact are used for spawn preparation.

2.2. Master spawn preparation

The wheat grains are thoroughly washed in sufficient water three to four times to remove debris if any. 100 Kg grains are then soaked in 150 liters water for 20-30 minutes and half-boiled in a container for 20-25 minutes. Excess water is drained off by spreading on a sieve made up with fine mosquito net. The grains are left as such for few hours on the sieve, so, that the water on surface is evaporated. Now the grains are mixed with Gypsum (Calcium sulphate) and chalk powder (Calcium carbonate) in the ratio of 3.5g/1Kg and 35.0g/1Kg cereal grains respectively, to maintain the pH around 7-7.8 and avoid clumps form of the grains respectively.

About 250 g prepared wheat grain mixture as substrate is filled in milk bottles/ polypropylene bags (heat resistant) upto 2/3 volume, plugged with non-absorbent cotton and wrapped with aluminum foil/news papers and rubber band.. These bags/bottles are then autoclaved at 15 lb pressure per square inch (p.s.i.) for 1.5 to 2 hr. These autoclaved bags/bottles are left in the room for 24 hours for cooling and are kept on laminar flow chamber under U.V. tube for 20-30 minutes before inoculation. A piece of mycelium of pure culture is aseptically transferred to these bags/bottles and inoculated at 22-25^{0}C. Inoculated bags/bottles are gently shaken on 5th and 10th day. The spawn will be ready within 15-20 days. This spawn prepared using pure culture is referred as mother spawn. Fully colonized mother spawn can be used for inoculating commercial spawn bags after two to three weeks (**Figure-C**).

2.3. Multiplication of spawn

Multiplications of spawn were done in polypropylene bags (heat resistant). Normally for 250g and 500g spawn, the bags should be of 35 x 17.5cm and 40 x 20cm size, respectively. Polypropylene bags should be double sealed at the bottom and after filling the grains they are plugged with non absorbent cotton and rubber band. The bags are then sterilized at 15 lb p.s.i. pressure for 1.5 to 2 hours. Autoclaved bags are shaken well before inoculation for absorbing water droplets accumulated inside the bags if any by the grains. The sterilized bags are kept on the laminar flow chamber under U.V. tube for 20-30 minutes. 10-15 grains of master spawn is inoculated to the commercial spawn bags under aseptic condition. One bottle of master spawn (250g) is sufficient for inoculating 25-30 commercial spawn bags. Inoculated bags are again shaken for well mixing with other grains. Then the bags are kept in incubation room at 22-25^{0}C .

3. Mushroom crop production:

The agriculture waste such as paddy straw, maize straw and wheat straw were collected from local farms and were used as substrate for mushroom cultivation following the method of Bano and Shrivastava (1962) with some modifications. The agriculture wastes as substrates were chopped (2-3 cm. pieces) and soaked in tap water over night and excess water was drained off in the next day. The polythene bags (35 x 45 cm) were filled up with substrates and multi layered technique was adopted for spawning following the stand method. Each bag was filled up with 1.5kg dry substrate and 250g spawn was added to it. After spawning, the bags were kept in cultivation house where the temperature and humidity were maintained around 25ºC and 80 to 90% respectively. The spawn run was completed within 20 -25 days. The polythene bags were tear-off following the spawn run. The beds were water sprayed regularly to moisten it. Formation of fruit bodies as pinheads was evident within 3-4 days after removal of poly bags. The beds were maintained up to the harvest of the third flush, which was completed in 65 days after spawning (**Figure-D**).

4. Biological efficiency and yield performance

Total weight of all the fruiting bodies harvested from all the three pickings were measured as total yield of mushroom. The biological efficiency (yield of mushroom per kg substrate on dry weight basis) was calculated by the following formula of Chang *et al.* (1981).

Biological efficiency = $\frac{\text{Fresh weight (gm) of mushrooms harvested}}{\text{Dry weight (kg) of substrate}} \times 100$

Figure A: Stubble burning practice at Uttar Dinajpur, West Bengal, India: A= Wheat field; B= Paddy field

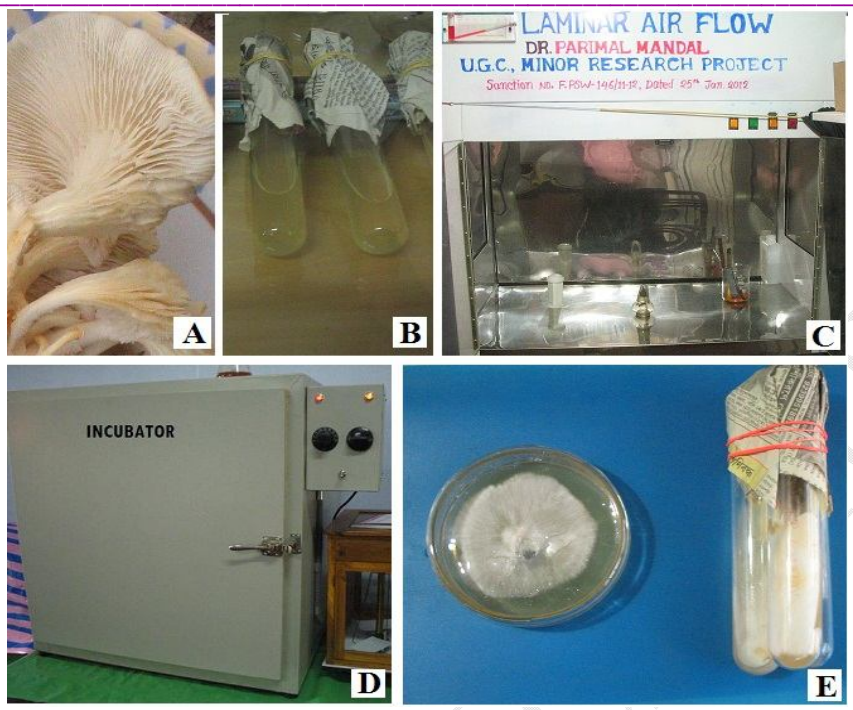

Figure C: Pure culture preparation through tissue culture method: A= Fresh young fruiting body of *Pleurotus* sp; B- Potato Dextrose Agar (PDA) Slants; C- Laminar Air Flow chamber for aseptic transfer of fungal tissue to slants; D= Incubation for proper growth; E= Pure culture

Figure D : Mushroom Spawn preparation method: A= Mixing of half-boiled wheat grains as substrate with chemicals to prefer growth of fungi; B= Filling substrates with double layered poly bags; C= Substrate sterilization with high pressure and temperature by autoclave; D= Pure culture of *Pleurotus* sp; E= Inoculation of substrates with pure culture ascetically at Laminar Air Flow chamber; F= Incubation for proper growth of fungi on substrate to achieve mature spawn (i.e., mushroom artificial seeds)

Figure E: Mushroom crop production: A= Chopped paddy straw as substrate for mushroom crop production; B= Mushroom spawn; C= Filling up pasteurized chopped paddy straw in poly bag for preparing mushroom bed; D=Layer of spawning on substrate; E= Making pores on bed for gaseous exchange; F= Mushroom beds placed on cropping room; G= Mushroom fruiting bodies are sprouting as pin heads; H= Immature fruiting bodied; I= Mature fruiting bodies ready for harvesting.

Table 1: Yield performance of *Pleurotus* species on different agriculture wastes.

Substrates	Yield*			Total yield	Biological efficiency**
	1st Flush	2nd Flush	3rd Flush		
Paddy straw	468.00 ±2.5	368.00 ±2.8	52.00 ± 2.7	888.00 ± 2.9	59.2
Wheat straw	432.00 ±3.2	316.00 ± 2.1	158.00 ± 3.5	906.00 ± 1.5	60.4
Maize straw	424.00 ±2.9	306.00 ± 2.0	42.00 ± 3.3	772.00 ± 2.4	51.46

Averages followed by the same letter in a given column are not statistically different from each other based on the Scott-Knott test at a 5% probability level; Data after ± indicate standard error values; *Productivity = g of fresh mushroom; **Biological Efficiency = [(g of fresh mushroom/1.5kg of dry substrate) x 100].

Table 2: Spawn running, pinhead formation and fruiting body formation of *Pleurotus* species on different substrates.

Substrate	Spawn running	Pinhead formation	Fruiting body formation
	Day	Day	Day
Paddy straw	14-16	17-21	22-25
Wheat straw	16-18	19-25	26-30
Maize straw	17-20	21-26	27-31

Table-3: Economics of *Pleurotus sajor-caju* cultivation in a small scale farm with 300 bags of Mushroom bed (Each bag contain 1.5kg dry Agro waste and 250gm spawn)

	Items	Amount
	Cost of 150kg of wheat straw @50/-per 100kg	Rs. 150.00
	Polythene bags @ 1/- per bag	Rs. 250.00
	Cost of 150 packet Spawn @ 20/- per 250gm	Rs. 3000.00
	Cost of labour (Own labour)	Rs. 0.00
	Cost of Water and Electricity	Rs. 200.00
	Pesticides, fungicides, bleaching powder, etc.	Rs. 100.00
	Rent of mushroom house or spaces (Own house)	Rs. 0.00
	Miscellaneous	Rs. 300.00
	Total Expenditure Rs.	Rs. 4000.00
	Expected yields from 300bags (Average 800g per Bag) = 240kg. So, expected returns (Minimum price @ 150/- per kg)	Rs. 36,000.00
	Net Profit Rs.	Rs. **32,000.00**

B. RESULT AND DISCUSSION

Workshop cum training programme on Oyster mushroom cultivation was conducted at different places for empowering women, youth and farmers Figure 2.

The results reveal the yield or biological efficiency (B.E.) of the *Pleurotus sajor-caju* cultivated on different agricultural wastes (**Table: 1**). Significantly maximum yield of *P. sajor-caju* was 4obtained when it was cultivated on wheat straw (906.00gm/1.5kg straw) with B.E. 60.2 %, this was followed by yield on paddy straw (888.00gm/1.5kg straw) with B.E. 59.2 Similar results were reported with *P. sajor-caju* by Patil (2012). Comparing the five lignocellulosic residues as substrates for the cultivation of *P. sajor-caju* shows that, wheat straw and paddy straw have been supported best growth of *P. sajor-caju* with a compact white mass of mycelium within 2-3 weeks of spawning (**Table: 2**).

Moisture , total carbohydrate, protein, fat, crude fiber and ash content of mature fruiting bodies of *P.sajor-caju* cultivated on different agro wastes are measured (data not shown). Moisture content of *P. sajor–caju* was found maximum when cultivated on paddy straw (79.4 %), followed by on wheat straw (78.7 %). Carbohydrate content of *P. sajor-caju* was found 48.8% grown on wheat straw being the highest followed by paddy straw on (46.4%). These results are confirmed with the findings of Patil *et al.,* (2012). Protein content of *P. sajor-caju* fruiting bodies grown on wheat straw was found 26.5% being the height followed by paddy straw (25.6%) and saw dust (23.2%). Fat content of *P. sajor-caju* fruiting bodies was found on waste paper (3.27%) being the height followed by maize straw (3.22%), saw dust (3.12%). Protein and fat contents were found similar trend by Patil *et al.,* (2012). The crude fiber content of *P. sajor-caju* fruiting bodies was ranged from 3.1 to 5.8 % when grown on different agro wastes.

Economics of mushroom cultivation was calculated in the present study in (**Table: 3**). It was found that a small scale farm of mushroom cultivation with 300 beds gives 2 fold returns within 2 month. A capital expenditure of Rs.4000.00 for preparing 300 beds was given returns of Rs. 36,000.00 with net profit of Rs.32000.00 within 2 months. Mushroom cultivation can plays an important role in overall economy in supplementing family incomes and generating employment in the rural sector particularly among the land-less, small and marginal farmers, youth and women.

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REFERENCES

Sharma, V.P., Kumar, S. (2011). Spawn production technology.In: Mushrooms: cultivation, Marketing and Consumption (Manjit Singh, Bhuvnesh Vijay, Shwet Kamal and GC Wakchaure, eds.). Directorate of Mushroom Research (ICAR), Chambaghat. Pp. 31-42.

Sinden, J.W. (1932). Mushroom spawn and method of making the same. US Patent 1, 869, 5.

Stoller, B.B. (1962). Some aspects of making mushroom spawn. Mushroom Science V: 170-184.

Bano, Z. & Srivastava, H. C. (1962): "Studies in the cultivation of *Pleurotus* sp. On paddy straw. Food Science", 12, 363–368.

Bonatti, M., Karnopp, P., Soares, H. M. & Furlan, S. A., (2004): "Evaluation of *Pleurotus ostreatus* and *P. sajor-caju* nutritional characteristics when cultivated on different lignocellulosic wastes. Food Chemistry", 88, 425-428.

Chang, S. T. (2007): "Mushroom cultivation using the "ZERI" principle: potential for application in Brazil. Micologia Aplicada Internatonal", 19, 33-34.

Chang, S.T., Lau, O. W. & Cho, K.Y. (1981): "The cultivation and nutritive value of *P. sajor-caju.* European Journal of Applied Microbiological Biotechnology", 12, 58-62.

Eswaran, A. & Ramabadran, R. (2000): "Studies on some physiological, cultural and post harvest aspects of oyster mushroom, *Pleurotus ostreatus.* Tropical Agricultural Research Journal", 12, 360-374.

Jain, N., Bhatia, A. & Pathak, H. (2014): "Emission of Air Pollutants from Crop Residue Burning in India. Aerosol and Air Quality Research", 14, 422–430.

Khydagi, K. S., Sharada, G. S. & Rao, M. (1998): "Proximate composition of oyster mushrooms. Karnataka Journal. Agriculture Science", 11, 548.

Manzi, P., Aguzzi, A. & Pizzoferrato, L. (2001): "Nutritional value of mushrooms widely consumed in Italy. Food Chemistry", 73, 321.

Patil, S. S. (2012): "Cultivation of *Pleurotus sajor-caju* on different agro wastes. Science Research Reporter", 2, 225-228.

Poppe, J. (2000): "Use of agricultural waste materials in the cultivation of mushrooms", In: L. Van Griensven ed: Proceedings 15th International Congress on Science and Cultivation of Edible Fungi, Balkema Rotterdam, 3-23.

Sharma, S. & Madan, M. (1993): "Microbial protein from leguminous and non-leguminous substrates. Acta Biotechnologica", 13, 131-139.

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