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Poonam Dehariya and Deepak Vyas

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Evaluation of Supplementation of *Embelica officinalis* on Growth Parameter, Yield and Biological Efficiency of *Pleurotus sajor-caju*

Poonam Dehariya*[1] and Deepak Vyas[2]

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ABSTRACT

Six substrates viz. Soybean straw, wheat straw, paddy straw, domestic waste, fruit waste and used tea leaves was taken for the purpose. For the improvement of yield supplementation of *Embelica officinalis* was done. Among all test substrates soybean straw was give maximum yield 935.0 gm/Kg, 956.7 gm/Kg, 96.0 gm/Kg at 1%, 2% and 3% supplementation respectively. It was observed from the data that different concentrations of *Embelica offcinalis* was proved good for the enhancement of yield but 3% concentration was giving maximum yield and biological efficiency.

***Key words*:** Supplementation, Yield, Biological efficiency, *Embelica officinalis*

Oyster mushroom is one of the most popular edible mushroom and belong to the genus *Pleurotus* and the family *Pleurotaceae* [1] and is now grown commercially around the world for food. Oyster mushroom is one of the most commonly sought wild mushrooms, though it can also be cultivated on straw and other media. *Pleurotus* mushrooms are primary decomposers of hardwood trees and are found worldwide. Fruiting bodies as well as active mycelia of *Pleurotus* species also possesses a number of therapeutic properties like anti-inflammatory, immune-stimulator and anticancer activity, immunomodulatory, ribonuclease activity and many other activities [2]. *P. sajor-caju* is one of the most successfully cultivated species of these mushrooms and it is considered to be delicious [3]. Agriculture residues are the major source of lignocellulosic materials, which is best substrate for solid state fermentation of edible fungi such as *P. sajor-caju*. *P. sajor-caju* has very high saprophytic colonizing ability and can degrade wheat straw efficiently [4]. Growth of mushroom on several different agricultural wastes, including paddy and wheat straws [5]. Growing oyster mushrooms convert a high percentage of the lignocellulosic materials to fruiting bodies. Therefore, cultivation of *P. sajor-caju* on various agricultural residues offers high value products with nutritional and medicinal properties [6].

Mushroom supplementation is an agronomic process which consists of the application of nutritional amendments to the substrates employed for mushroom cultivation. Different nitrogen and carbohydrate rich supplements have been evaluated in crops with a substantial impact on mushroom yield and quality. The addition of external nutrients increases the productivity of some low-yielding mushroom varieties, and therefore is a useful tool for the industry to introduce new commercially viable varieties. On the other hand, a new line of research based on the use of mushroom growth promoting microorganisms is rising above the horizon to supplement the native microbiota, which appears to cover nutritional deficiencies. Several supplements employed for the cultivated mushrooms and their agronomic potential in terms of yield and quality of the crop and to design new formulas for commercial supplementation [7]. Supplementation has been reported to cause a rise in substrate temperature, possibly due to faster metabolic activities triggered by extra nitrogen. Overheating (from 30 to 47°C) in bags where a nitrogen-rich supplement was applied without benomyl (fungicide) treatment and proposed that it could be due to the growth of competitor moulds [8].

Addition of the supplements with basal substrate has been as common practice to enhance the yield, nutritional and medicinal values. In oyster mushroom cultivation, multiple basal substrates and supplements (additives) are reported to used by researches. Therefore, the technology of mushroom agriculture enables us to acquire substrate materials at very low cost or even for free to get biotechnological foods and further led to conserve our environment through efficient bioconversion of wastes with sustainable food security [9]. Present study was therefore

* Poonam Dehariya
dpoonambot18@gmail.com
[1-2] Lab of Mushroom Biology, Department of Botany, Dr. HS Gour, V. V., Sagar, Madhya Pradesh, India

conducted to determine the effects of different substrates viz. Soybean straw, wheat straw, paddy straw, domestic waste, fruit waste and used tea leaves and *Embelica officinelis* supplements on biological efficiency and yield parameters of *Pleurotus sajor caju*.

MATERIALS AND METHODS

Spawn preparation

Clean whole grains were taken for the purpose. The grains were pre-wetted by boiling in water for 20-30 min [10]. After boiling, excess water was drained off by spreading the grains on a wire mesh. Grains were now mixed with gypsum (calcium sulphate) and chalk powder (calcium carbonate) at the rate of 2% and 0.5%, respectively on dry weight basis. The grains were filled in flasks, and plugged then sterilized in autoclave at 22 Lb pressure for 1.5-2 hours. The grains were allowed to cool in room temperature for overnight. Next day flasks were inoculated with two bits of agar medium colonized with the mycelium of pure cultures. About 7-10 days after inoculation, flasks were shaken vigorously. Three weeks after incubation, the stock culture becomes ready for further multiplication of spawn. Inoculated flasks were incubated at 26±2°C.

Cultivation

A medium was prepared using soybean straw (SS), wheat straw (WS), paddy straw (PS), domestic wastes (DW), Fruit waste (FW), used tea leaves (UTL), All substrates were washed in fresh water. The chopped straw substrates were steeped in water containing 75 ppm bavistin + 500 ppm formaldehyde for 18 hours [11] for preventing mould infestation due to various other competiting fungi. In the present investigation *Embelica officinalis* supplementation was used as 1, 2, 3 percent concentration on the dry weight basis of substrate respectively. Supplements were sterilized with 25 ppm bavistin for 12-18 hrs. Excess water was drained and was dried in shed to retain 65-70% moisture content by squeezing with hands and then allowed to cool down for a certain period (1hr.). Spawning was done @ 2% wet weight basis of substrate by thoroughly mixing. Spawned substrate was filled up in perforated polythene bags (60 × 40 cm) and polythene mouth was closed with rubber band. These bags were transferred to crop room for spawn run. Three replications were maintained for each substrate. For spawn run, temperature and relative humidity were maintained between 25-30°C and 65-90%, respectively. Polythene bags were cut open when the mycelium run was completed. The substrate beds were moistened by sprinkling of water thrice a day which was stopped a day before harvesting. Average values of observation with respect to duration of spawn run, time taken for first harvest yield and total yield was recorded. Biological efficiency of mushroom on fresh weight basis was calculated by using formula given by Chang and Miles [12].

$$\text{Biological efficiency (\%)} = \frac{\text{Yield of fruiting body (gm)}}{\text{Total weight of substrate used (gm)}} \times 100$$

RESULTS AND DISCUSSION

The data presented in (Table 1) shows the impact of supplementation of *Embelica officinalis* on the growth and yield of *P. sajor-caju* cultivated on three conventional substrates viz. soybean straw, wheat straw and paddy straw. It was observed that supplementation of 1% powder of *E. officinalis* improve growth parameter as well yield but significant change was recorded with 3% supplementation. As soybean straw was give 935.0gm/Kg, 956.7.0 gm/Kg, and 960.0 gm/ Kg at 1%, 2% and 3% supplementation respectively. Paddy straw was given comparatively lower yield viz. 750.0gm/Kg, 761.7 gm/Kg and 778.4 gm/Kg at 1%, 2% and 3% supplementation respectively. The data presented in (Table 2) shows the impact of supplementation of *Embelica officinalis* on the growth and yield of *P. sajor-caju* cultivated on three non-conventional substrates viz. Domestic waste, fruit waste and used tea leaves. It was observed that among all the test three non-conventional substrates domestic waste was give maximum yield at 1%, 2% and 3% supplementation 730.0gm/Kg, 745.0gm/Kg, 763.4gm/Kg respectively. Used tea leaves shows comparatively lower yield which was 666.7 gm/kg, 671.7gm/Kg and 683.4 gm/Kg respectively at 1%, 2% and 3% supplementation. Interesting trend of increasing yield was similar in conventional and non-conventional test substrates.

Table 1 Effect of supplementation of different concentration of *Embelica officinalis* on growth parameter and yield of *P. sajor- caju* in selected conventional substrates

Substrates	Supplementation concentration (%)	Spawn run (days)	Pin head appearance (days)	Stipe length (cm)	Cap diameter (cm)	Total yield (gm/kg)	BE (%)
Soybean straw	Control	17.66	22.4	2.9	7.8	933.4	93.3
	1%	17.0	21.4	2.9	7.8	935.0	93.5
	2%	16.7	20.7	3.0	7.9	956.7	95.6
	3%	16.0	20.0	3.1	8.0	960.0	96.0
Wheat straw	Control	19.0	23.4	2.6	8.1	800.0	80.0
	1%	18.0	22.7	2.7	8.7	810.0	81.0
	2%	18.16	21.7	2.8	8.8	821.7	82.1
	3%	17.0	21.4	2.9	9.0	850.0	85.0
Paddy straw	Control	21.4	25.4	2.7	8.0	743.4	74.3
	1%	21.0	24.7	2.8	8.1	750.0	75.0
	2%	20.0	24.4	2.9	8.3	761.7	76.1
	3%	19.0	23.0	2.9	8.4	778.4	77.8

Values are given in average of three replicates

Addition of organic and inorganic supplements to other substrates are known to influence the yield of various species of mushroom [13]. The addition of protein-rich supplements is a common practice for nitrogen-deficient composts in the cultivation of mushrooms. Various researchers have used supplements from animal and plant origins, including protein-, carbohydrate- or oil-rich substances, for *Pleurotus* species [14].

Fungi contain direct absorption mechanism; thus, they utilize all the nutrients from plant material. Carbon and nitrogen plays an important role in the nutrition of fungi. Fungal species utilize various polysaccharides, monosaccharides, organic acids, amino acids, certain alcohols, polycyclic compounds, and natural products such as lignin and cellulose as carbon sources. The principle substrates for fungi in nature are plant materials. The plant cell wall consists of the polysaccharides cellulose, lignin and hemicelluloses which are the carbon compounds utilized by fungi. These polysaccharides are insoluble and consequently they must be broken down to soluble units (monosaccahrides) by the excretion of extracellular enzymes (e.g., cellulase, lignase) from the hyphae [15].

Table 2 Effect of supplementation of different concentration of *Embelica officinalis* on growth parameter and yield of *P. sajor- caju* in selected non-conventional substrates

Substrates	Supplementation concentration (%)	Spawn run (days)	Pin head appearance (days)	Stipe length (cm)	Cap diameter (cm)	Total yield (gm/kg)	BE (%)
Soybean straw	Control	24.7	29.0	2.4	6.2	718.4	71.8
	1%	24.0	28.7	2.6	6.3	730.0	73.0
	2%	23.0	28.7	2.7	6.4	745.0	74.5
	3%	23.7	27.0	2.8	6.8	763.4	76.3
Wheat straw	Control	30.4	35.0	2.5	5.1	635.0	63.5
	1%	29.0	34.7	2.7	5.6	640.0	64.0
	2%	28.7	34.4	2.8	5.9	656.7	65.6
	3%	28.0	33.0	2.9	6.4	673.4	67.3
Paddy straw	Control	25.7	31.7	2.3	5.6	655.0	65.5
	1%	25.0	31.0	2.4	5.7	666.7	66.6
	2%	24.7	30.7	2.5	5.9	671.7	67.1
	3%	24.0	30.0	2.6	6.1	683.4	68.3

Values are given in average of three replicates

Supplementation with various materials is recommended prior to spawning for enhancement of yield of Oyster mushrooms. Some of the recommendations are various oil seed meals and cakes, powdered pulses, wheat and rice bran etc. [16], oil seed cake and meals, powdered pulses, sterilized chicken manure [17-19], addition of oat meal [20], rice bran [21], wheat bran [22-25] rice bran [26-27], oil seed cake [28] broken corn and mineral solution [29], mustard seed cake [30], soybean bran, soybean choker and groundnut bran [31], soybean choker [32], wheat bran and soybean flour [33], rice and wheat bran [34], cotton seed cake [35], wheat bran and urea [36]. Effect of supplements on the yield of some high adaptive *Pleurotus species* in sub-tropics of Jammu [37]. Perhaps the level of nitrogen content might be one of the most important criteria to decide one of the positive effects on mushroom. The addition of amendments to the substrates influences the sporophore production of *Pleurotus* spp. [38]. The effect of supplementing straw substrates with ammonium nitrate, soybean meal or alfalfa meal on the fructification and yield coefficient [39]. Organic supplements affected not only yield raise but also raise in protein content and higher yield coefficient. Addition of organic supplements in the form of horse gram powder, cotton seed powder yeast mud, ground nut cake or rice bran also showed enhance yields coupled with increase in the protein content of fruit bodies of the several nitrogen sources tried as supplements to the rice straw substrate during the growth and fructification of *Pleurotus* species, oil seed cakes proved ideal in increasing the mushroom yield and its protein content [40-41]. Cultivated *Pleurotus sajor-caju* on *Pycnanthus angolensis* sawdust supplemented with 0, 5, 10, 15, and 20% palm kernel cake, oil palm fibre, rice bran, wheat chaff, and corn cobs [42]. Cultivated the *Pleurotus sajor-caju* on sugarcane bagasses with supplementation with corn grits and mineral solution [43]. Residual biogas slurries of mahua cake and cow dung for supplementation in *Pleurotus sajor caju* for enhancement of nutritional contents [44]. The comparative study of natural (wheat flour, rice flour, soya flour, maize flour with cotton seed cake) and chemical supplements (Lactose, $ZnSO_4$, $MgSO_4$, $FeSO_4$ with Peptone) for yield and biological efficiency of *Pleurotus sajor caju* [45]. The survival and multiplication of mushrooms is related to a number of factors, which may act individually or have interactive effects among them. The combination of the best air temperature, moisture, nutrient conditions as well as other variables, provides a synergistic effect optimizing the production of mushrooms, with a consequent loss and cost reduction [46].

CONCLUSION

In order to select cheaper and better amendment of bio efficiency of *P. sajor caju* an experiment was conducted in completely randomize design. As it is clearly evident from the result that supplement of *Embelica officinalis* not only reduced the spawn run time but also increases yield of *Pleurotus sajor-caju* in all three test lignocelluloses conventional substrate (wheat straw, paddy straw and soybean straw) and non-conventional substrates (domestic waste, fruit waste and used tea leaves). Supplementation of 3% concentration of *Embelica officinalis* gave best result in all three conventional and non-conventional substrates tested. These supplements were selected purposely because both have some nutritional values, easily available and their application can be exploited in production of potential food for men. So, they have used with positive hope of effectiveness.

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