Effect of tulsi leaf powder along with casing mixture on the growth parameters and yield of white button mushroom [*Agaricus bisporus* (Lange) Imbach]

ABSTRACT

Agaricus bisporus (Lange) Imbach commonly known as white button mushroom, is the most widely accepted food globally with nutritional and medicinal properties. The present experiment was conducted during the *Rabi* season 2023 at Mushroom crop room, Department of Plant Pathology, SHUATS, Prayagraj, Uttar Pradesh to evaluate the effect of Tulsi leaf powder at different concentrations (1 %, 1.5 %, 2 %, 2.5 % and 3 %) incorporated into casing mixture (alone and combination) *viz.,* Farm yard manure, Farm yard manure + Cocopeat + Sawdust (1:1:1) with an objective to monitor the growth and yield aspects of white button mushroom. Among all treatments used in the study, the results revealed that minimum average time taken for completion of case run (15.14 days) and pinhead initiation (15.57 days) as well as maximum pileus diameter (4.63 cm), stalk length (3.77 cm), stalk diameter (3.01 cm) and maximum yield (557.9 g), biological efficiency(12.97 %) and highest cost benfit ratio (1: 3.18) were recorded in Farm yard manure + Cocopeat + Sawdust (1:1:1) + Tulsi leaf powder @ 3%. These results indicated that incorporating tulsi leaf powder @3% in casing mixture improves the growth and yield of *A. bisporus* and is preferred over synthetic chemicals as it is ecofriendly and reduces environmental pollution.

Key words: *Agaricus bisporus*, white button mushroom, Casing, Tulsi leaf powder, FYM, Cocopeat, Sawdust.

INTRODUCTION

"The white button mushroom (*Agaricus bisporus*) is the most widely cultivated species of edible mushroom and it is a popular cultivar among the artificially grown fungi of the world. It belongs to the phylum Basidiomycota, class Agaricomycetes, order Agaricales and family Agaricaceae.These are wonderful sources of proteins, vitamins, minerals and low in calories and cholesterol" **(Sharma *et al*., 2017)**. Mushroom production in the world has increased more than five times since 2000 and presently, it stands at as 44 million tonnes (**FAOSTAT, 2023**) Out of the total mushroom produced in India, the share of white button mushroom is 73% . "During the period between 2021- 2022, Bihar (10.82%) with 28000 tonnes tops the list followed by Maharashtra (9.89%) , Orissa (9.66%), Haryana, Uttarakhand in the top mushroom producing states in India" **(NHB, 2021- 22).**

"The white button mushroom [*Agaricus bisporus* (L) sing]. is cultivated on a substrate consisting of a composted mixture of wheat straw compost is prepared in a sequence of processes. Composting and casing are considered the essential steps for the cultivation of *A. bisporus*. The most important step for the cultivation of white button mushroom is the casing layer" **(Murmu and Lal, 2016)**. "The casing layer is one of the important growing parameter and source of variation in production, quality and uniformity of commercial cropping, huge quantities of farm yard manure, vermicompost,saw dust and other organic wastes are generated annually through the activities of agricultural, forest and food processing industries. Mushroom yield can be increased if these available casing mixtures are used to produce button mushrooms". (Kaur and Rampal, 2017).

"The yield and quality of mushrooms are dependent on casing mixtures mainly affected by a wide variety of biotic and abiotic factors. The major biotic factors, viz., fungi, nematodes, mites, insects, pests, and flies, lead to a decrease in mushrooms' yield and quality. Various chemicals are used to control the biotic factors, which leads to a decrease in the yield of button mushroom also. The utilization of these chemicals creates many secondary effects in resistance to pesticides, environmental pollution, and a decrease of non-target organisms, including beneficial microbes. The ingestion of formaldehyde may lead to nausea, vomiting, diarrhea with bloody stool, renal failure, liver failure and tumor development and irreversible neurotoxicity" **(Nowshad *et al.*, 2018)**. Moreover, these days people are more concerned about organic food. Therefore, the present study was planned to evaluate effect of tulsi leaf powder along with casing mixture on the growth parameters and yield potentialof white button mushroom (*Agaricus bisporus*).

Materials and Methods

Procurement of Spawn :

The spawn strain – *Agaricus bisporus* **(DMR NBS-5)**, was procured from Directorate of Mushroom Research, Chambaghat, Solan, Himachal Pradesh.

Composting

"The basic materials for compost, wheat straw was taken from Agro farm. Other ingredients like wheat bran, urea, potassium (Murate of Potash), phosphorus (Single Super Phosphate), gypsum and lindane were obtained from commercial out let. The compost was prepared by long method of composting. Wetted wheat straw had spread thinly over entire floor of the composting yard and then gradually wetted by sprinkling water, till the straw was taken no more water. The straw was then turned for even wetting at the stage and water content was maintained at 75 per cent. The moist straw was mixed with wheat bran and fertilizer uniformly scattered over the straw. A heap was made after each turning but not compressed

tightly so as to maintain the aerobic condition in the compost heap. Gypsum was mixed at the third turning and at each turning water was sprayed to make up the loss of water due to evaporation. Profenofos insecticide was mixed at 7 turning for prevention of insects pests. Total eight turning was done and each turning at four days interval. The compost was then ready for spawning i.e. it was dark brown in colour and without any smell of ammonia and had sufficient moisture content (68-70%) when pressed between palms" [xvii].

Spawning

A unit of 5 kg mildly wet compost was used for each bag in perforated polypropylene bag , which was equally distributed in 6 treatments including control which contain 7 replications each. The moisture content of the compost at the time of spawning was kept around 25-30%. The spawn thoroughly mixed with the compost at the rate of 7.5 g/kg compost (**Kapoor, 2004**) and pressed moderately. The sterilized newspaper was placed on the top of compost bag to preserve moisture and kept folded on top and transferred in to the dark room for spawn run.

Preparation of casing mixtures

The selected basic material for preparation of casing soil such as Farm yard manure was obtained from Agro-farm, SHUATS and other casing materials , cocopeat and sawdust were obtained from commercial outlet Praygraj.

Preparation of Botanicals (Tulsi leaf powder) :

Fresh tulsi leaves were collected, well dried in sunlight and then made into fine powder with the help of mortar pestle and mixer. The dried powder of the selected botanical was mixed with the untreated check bags were kept as control.

Tulsi leaves contain ursolic acid, major compound such as geranyl acetate, linalool, flavonoids such as apigenin, polyphenols, anthocyanins and luteolin, eugenol, methyl chavicol, thymol or sesquiterpene alcohols have been reported to possess antifungal activity **(Rahman *et al.*, 2011).**

Procedure

The different casing material *viz*., FYM, Cocopeat, Sawdust was used alone and different casing mixture with Tulsi leaf powder (TLP) . [FYM, FYM + CCP + SD (1:1:1) + TLP @ 1 - 3%]. First coir pith was soaked in water for 2 hours. Initially individual casing materials , FYM, Sawdust, Cocopeat sterilization was done by using 2% formalin solution. The disinfection process was carried out at a temperature not less than 16ºC, hence at lower temperature formalin doesn't evaporate and therefore wouldn't be effective. Before applying the casing layer to the compost, it was kept under a polythene film so that evaporation occurs and thereby making the casing layer free from contaminants. Each of the casing materials was applied to seven uniform bags (replicates) containing spawned compost. The fourty two bags were arranged in a Completely Randomized Design (CRD) in a covered mushroom crop room. After casing is done

the temperature of the room was again maintained at 23±2 ℃ and relative humidity of 85-90% for another 8-10 days (till case run).

Fruiting and Harvesting

The mycelium emerged on casing soil after 10 days, the environmental conditions were changed in cropping room by providing fresh air through ventilation and light for 6-8hrs, relative humidity 90-95% were maintained by spraying of the water thrice a day. The temperature of cropping room was maintained at 16±2 ^{0}C . Low CO_2 concentration (0.08-0.15%) is favorable for reproductive growth at this stage. Pin heads were appeared between 13-16 days after casing and they became ready for harvesting within next one week.

Observations were recorded

I. Mycelium run on casing layer (days)
II. Initiation of pinheads (days)
III. Pileus diameter (cm)
IV. Stalk length (cm)
V. Stalk diameter (cm)
VI. Yield (g)
VII. Biological efficiency (%)

Biological efficiency:

Biological efficiency will be calculated as follows (**Change *et al*., 1981**)

$$\textbf{Biological efficiency}: \frac{\text{Total weight of fresh mushroom}}{\text{Total dry weight of compost}} \times 100$$

Cost benefit ratio:

The cost benefit ratio was calculated using following formula:

$$\text{C: B} = \frac{\text{Net returns}}{\text{Total cost of cultivation}}$$

Statistical analysis

"In this experiment Complete Randomized Design (CRD) was followed. The analysis of variance (ANOVA) technique was applied for drawing conclusion from data" [xviii]. "The calculated values were compared, the tabulated values at 5% level of probability for the appropriate degree of freedom".**(Fisher, 1949 and Yates, 1937).**

RESULTS

Time taken for the mycelial run on casing layer (days) and Pin head initiation (days): The minimum days required for mycelial run on the casing layer was observed in T_5 [FYM + Cocopeat + Sawdust (1:1:1)+ Tulsi leaf powder @ 3 % (15.14)] followed by T_4 (16.42) and T_3 (16.57). as compared to other treatments including T_0 untreated control.

The minimum days required for pinhead initiation was observed in T_5 [FYM + Cocopeat + Sawdust (1:1:1)+ Tulsi leaf Powder@ 3 % (15.57)] followed by T_4 (16.85) and T_3 (20.14) as compared to other treatments including T_0 untreated control.

Pileus diameter (cm) : The maximum pileus diameter (cm) was observed in T_5 [FYM + Cocopeat + Sawdust (1:1:1)+Tulsi leaf Powder@ 3 % (4.63)] followed by, T_4 [FYM + Cocopeat + Sawdust (1:1:1) + Tulsi leaf powder@ 2.5 % (3.69)] and T_3 [FYM + Cocopeat + Sawdust (1:1:1) + Tulsileaf powder @ 2 % (3.44)]. T_4 and T_3 found to be non-significant each other.

Stalk length (cm) : The maximum stalk length (cm) was observed in T_5 [FYM + Cocopeat + Sawdust (1:1:1) + Tulsi leaf Powder@ 3 % (3.77)] followed by T_4 [FYM + Cocopeat + Sawdust (1:1:1) + Tulsi leaf powder@ 2.5 % (3.13)] and T_3 (3.06) as compared to other treatments including T_0 untreated control.

Stalk diameter (cm) : The maximum stalk diameter (cm) was observed in T_5 [FYM + Cocopeat + Sawdust (1:1:1)+Tulsi leaf Powder@ 3 % (3.01)] followed by T_4 [FYM + Cocopeat + Sawdust (1:1:1) + Tulsi leaf powder@ 2.5 % (2.76)] and T_3 (2.40) as compared to other treatments including T_0 untreated control.

Yield (g) and Biological efficiency (%) :

The maximum yield and biological efficiency (557.9g and 12.97 %) was recorded in T_5[FYM + Cocopeat + Sawdust (1:1:1)+ Tulsi leaf powder @3%] followed by (481.6g and 11.19 %) from the T_4 [FYM + Cocopeat + Sawdust (1:1:1) + Tulsi leaf powder@ 2.5 %] as compared to other treatments including T_0 untreated control which had the lowest yield and biological efficiency (250.8g and 5.82%).

Cost benfit ratio : The maximum cost benfit ratio was recorded in T_5 [FYM + Cocopeat + Sawdust (1:1:1)+Tulsi leaf Powder@ 3% (1:3.18)] followed by T_4 [FYM + Cocopeat + Sawdust (1:1:1) + Tulsi leaf powder@ 2.5% (1:2.61)] as compared to other treatments including T_0 untreated control.

Table 1: Effect of tulsi leaf powder along with casing mixture on the growth parameters and yield of white button mushroom (*Agaricus bisporus)*

Trt. no	Treatments	Case run (days)	Pinhead initiation (days)	Pileus diameter (cm)	Stalk length (cm)	Stalk diameter (cm)	Yield (g)	BE (%)	C : B ratio
T_0	FYM (Untreated)	21.14	24.14	2.64	2.14	1.77	250.8	5.82	1:1.01
T_1	FYM + CCP + SD (1:1:1) + TLP @1%	19.00	21.42	3.10	2.32	2.30	295.1	6.85	1:1.20
T_2	FYM + CCP + SD (1:1:1) + TLP @1.5%	17.42	20.42	3.21	2.97	2.37	350.1	8.14	1:1.55
T_3	FYM + CCP + SD (1:1:1) +TLP @2%	16.57	20.14	3.44	3.06	2.40	382.7	8.89	1:1.86
T_4	FYM + CCP + SD (1:1:1) +TLP@2.5%	16.42	16.85	3.69	3.13	2.76	481.6	11.19	1:2.61
T_5	FYM + CCP + SD (1:1:1) +TLP @3%	15.14	15.57	4.63	3.77	3.01	557.9	12.97	1:3.18
SEM (±)		0.36	0.32	0.10	0.05	0.03	13.66	0.31	
CD (0.05)		1.04	0.84	0.29	0.11	0.10	39.17	0.91	

Trt no = Treatment number, FYM = Farm yard manure, CCP = Coconut coir pith, SD = Sawdust, TLP = Tulsi leaf powder, BE = Biological efficiency, C:B = Cost benfit ratio.

Discussion

The probable reason for such findings may be that tulsi (*Ocimum sanctum*) has ursolic acid, major compound such as geranyl acetate, linalool, flavonoids such as apigenin, polyphenols, anthocyanins and luteolin, eugenol, and many other important compounds which have antifungal properties. These may have suppressed the growth of mycoflora which may have favored the fast growth of *Agaricus bisporus* mycelium. Tulsi at higher concentration (3%) promoted faster mycelial run and thus resulted in requiring least days for mycelium run. Due to the inhibitory effect of *Ocimum sanctum* on the growth of weed molds and dry bubble ,wet bubble incidence due to which larger fruiting bodies and higher yield of *Agaricus bisporus* was obtained. Also recorded maximum yield of *Agaricus bisporus*, in tulsi leaf powder at 2.5 - 3% concentration. Similar findings have been reported by **Pervez *et al.* (2012), Mousumi *et al.* (2017), Singh *et al.* (2017),**

Kakraliya *et al*. (2022), Kumar *et al*. (2023) and **Kakraliya and Paswal (2024).**

CONCLUSIONS

Casing mixture of FYM + Cocopeat + Sawdust (1:1:1) + @ Tulsi leaf powder at 3% recorded minimum days for spawn run and pinhead initiation as well as maximum pileus diameter (cm),stalk length (cm), stalk diameter (cm), yield (g), biological efficiency (%) and highest cost benfit ratio of *Agaricus bisporus* (White button mushroom) . The results of the present study are of one crop season (October 2023- March 2024) under Prayagraj agroclimatic conditions as such more trials should be carried out in future to validate the present findings.

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