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S SORGHUM STRAW ENRICHED COTTON WASTE GROWING SUBSTRATE MODULATES GROWTH, YIELD AND NUTRITIONAL PROFILE OF OYESTER MUSHROOM (*PLEUROTUS SAJOR-CAJU*)

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A B S T R A C T

A study was conducted to evaluate growth, yield and biochemical response of *Pleurotus Sajor-Caju* mushroom grown on sorghum straw enriched cotton waste growing substrate in Medicinal and Mushroom Lab, Institute of Horticultural Sciences (IHS), University of Agriculture, Faisalabad. Two substrates (cotton waste and sorghum straw) were used alone and with different combinations. Experiments consisted of five treatments T_0 (100% Cotton Waste), T_1 (100% Sorghum Straw), T_2 (75% Sorghum Straw + 25% Cotton Waste), T_3 (50% Sorghum Straw + 50% Cotton Waste) and T_4 (25% Sorghum Straw + 75% Cotton Waste). Data concerning time taken for spawn run initiation, mycelial growth completion, pinheads initiation, total number of pinheads, time required to harvest 1st, 2ndand 3rd flush, fresh weight of 1st, 2nd and 3rd flush harvested, total yield, pH, total soluble solids, acidity, ascorbic acid contents, total nitrogen, phosphorus, potassium contents, reducing sugars, non-reducing sugars and total sugars was recorded. T_0 (100 % cotton waste) performed considerably well followed by T_4 (75 % cotton waste and 25 % sorghum straw) in relation to different growth, yield and bio chemical attributes.

Keywords: sorghum straw, mushroom flush, biochemical and nutritional quality, cotton waste.

INTRODUCTION

Due to its unique flavour and taste the oyster mushroom, *Pleurotus sajor-caju* isregarded as a delicacy in oriental cuisine. Oyster mushroom, *Pleurotus sajor-caju* is widely cultivated and most popular in various areas of the world like China, Korea, Japan, India, Thailand, Malaysia and Pakistan etc. Oyster mushroom *(Pleurotus sajor-caju)* is an important source of protein, carbohydrate, crude fat, ash, crude fiber, calcium, iron, magnasium, phenols and flavonoids and is known to possess free radical scavenging potential and antibacterial activities due to presence of certain compounds like β- Sistosterol, Cholestanol, 1,5-Dibenzoylnaphthalene and 1,2-Benzenedicarboxylic acid etc. and characteristic flavor component of mushroom i.e. 1-Octen-3-ol. (Gogavekar et al.,2014) and contains low phytic acid and oxalate contents (Goyal et al., 2006). oyster mushroom *(Pleurotus sajor-caju)* is also regarded as an enriched source of nutritionally useful essential amino acids such as leucine methionine and cysteine (Oyetayo et al., 2007).

Now a days in Pakistan oyster mushroom *(Pleurotus sajor-caju)* cultivation is becoming popular due to better market prices. Cultivation of oyster mushroom *(Pleurotus sajor-caju)*in Pakistan is usually carried out on cottonwaste which is available in pakistan only in summer months intradational cotton ginning period. However, in Pakistan in different mushroom growing regions autumn and winter months are natural fruiting period for oyster mushroom *(Pleurotus sajor-caju)* when the temperature is in between 15-25°C (Kashif et al., 2013). But at that time there is shortage of cotton waste in these mushroom growing areas. Hence, it is necessary

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to look for alternative growing substrates for oyster mushroom *(Pleurotus sajor-caju)* cultivation so that year round oyster mushroom *(Pleurotus sajor-caju) production can be ensured*. Dry sorghum straw is readily available in Pakistan as it is commonly used as fodder for animals and can be a viable option for oyster mushroom *(Pleurotus sajor-caju*) production. To the best of our knowledge scanting information is available regarding use of sorghum straw enriched cotton waste for the cultivation of oyster mushroom *(Pleurotus sajor-caju*). So, the objective of this study was to investigate the possibility of growing oyster mushroom *(Pleurotus sajor-caju*) on sorghum straw enriched cotton waste and to explore growth, yield and nutritional quality response on cotton waste, sorghum straw and their various combinations.

METERIALS AND METHODS

Present study was conducted at Medicinal and Mushroom Lab, Institute of Horticultural Sciences, University of Agriculture, Faisalabad during 2013-2014. For production of oyster mushroom *(Pleurotus sajor-caju*) standard bag cultivation technique for mushroom production was adopted for cultivation of *Pleurotus sajor-caju* on cotton waste, sorghum straw and their various combinations. Experiment consisted of following treatments and each treatment was replicated five times.

T_0= Cotton waste (100%)

T_1 = Sorghum Straw (100%)

T_2 = Sorghum Straw (75%) + Cotton Waste (25%)

T_3 = Sorghum Straw (50%) + Cotton Waste (50%)

T_4 = Sorghum Straw (25%) + Cotton Waste (75%)

Various parameters such as time taken for initiation of spawn run (days), time taken for completion of mycelial growth (days), time taken for initiation of pinhead formation (days), total number of pinheads, time taken to harvest 1st flush (days), time taken to harvest 2ndflush (days), time taken to harvest 3rdflush (days), fresh weight of 1st flush harvested (g), fresh weight of 2nd flush harvested (g), fresh weight of 3rdflush harvested (g), Totalyield (g), pH, Total soluble solids (°Brix), acidity (%) of mushroom (Hortwitz, 1960), ascorbic acid of mushroom (mg/100ml) (Ruck,1969), reducing sugars, non-reducing sugars, total sugars (Hortwitz, 1960.), notrogen contents of mushrooms, phosphorus contents of mushrooms and potassium contents of mushrooms (Chapman and Parker. 1961) were studied.

Statistical Analysis Completely randomized design (CRD) was used in this study. The data collected was analyzed statistically usingLSD test at 5% probability level that provided practical and comprehensive comparison of the treatments for their effectiveness (Steel and Torrie, 1984).

RESULTS

Table 1 shows time taken for spawn run initiation. The minimum time for initiation of spawn run was taken by T_0 (1.00±.01days) followed by T_4 (1.66±.34 days), T_3 (2.00±.01days), T_2 (2.00±.01) and T_1 (2.67±.33 days) respectively. In case of time taken for completion of mycelial growth T_0 took minimum time (21.66±.89 days) followed by T_4 (30.00±1.53 days), T_3 (37.00±.57 days), T_2 (45.33±.88 days) and T_1 (50.00±.57 days) respectively. As for as time taken for Initiation of pinheads is concernedT_0 took minimum time (4.34±.33 days) for pinheads initiation followed by T_2 (5.66±.32 days), T_1 (6.00±.02 days), T_4 (6.00±.03 days) and T_3 (6.40±.01 days) respectively. In case of total number of pinheads, maximum number of pinheads was observed in case of T_0 (88.33±4.40) followed by T_4 (78.33±4.41), T_3 (61.67±1.66), T_2 (50.00±2.88) and T_1 (26.66±1.67) respectively.

Table1. Effect of cotton waste, sorghum straw and their combination on growth parameters of *Pleurotus sajor-caju*.

Treatment	Time for initiation of spawn run (days)	Time for Completion of mycelial growth (days)	Time for Initiation of pinheads (days)	No. of pinheads
T0	1.00±.01c	21.66±.89e	4.34±.33b	88.33±4.40a
T1	2.67±.33a	50.00±.57a	6.00±.02a	26.66±1.67d
T2	2.00±.01b	45.33±.88b	5.66±.32c	50.00±2.88c
T3	2.00±.01b	37.00±.57c	6.40±.01a	61.67±1.66b
T4	1.66±.34b	30.00±1.53d	6.00±.03a	78.33±4.41a
LSD Value	0.6643	3.0078	0.6643	10.238

Figures not sharing the same letters differ significantly at $P = 0.05$.

Table 2 shows data concerning time taken to harvest 1st, 2nd and 3rd flush. T0took minimum time (27.67±.88 days) for harvesting of1st flush followed by T4 (34.00±1.15 days), T3 (40.33±.33days), T2 (45.66±3.66 days) and T1 (50.00±2.88 days) respectively. While, for harvesting of 2nd flush T0 took minimum time

(35.34±1.85 days) followed by T4 (40.66±.32 days), T3 (44.34±.33 days), T2 (50.33±1.76 days) and T1 (56.00±2.31 days) respectively. Similarly for harvesting of 3rd flushT0 took minimum time (43.66±1.21days) followed by T4 (48.33b±.88days), T3 (51.00±.57days), T2 (60.33±3.28days) and T1 (62.00±1.53days) respectively.

Table 2. Effect of cotton waste, sorghum straw and their combination on harvesting pattern of *Pleurotus sajor-caju*.

Treatment	Time toharvest 1st flush (days)	Time to harvest 2nd flush (days)	Time to harvest 3rdflush (days)
T0	27.67±.88d	35.34±1.85d	43.66±1.21c
T1	50.00±2.88a	56.00±2.31a	62.00±1.53a
T2	45.66±3.66ab	50.33±1.76b	60.33±3.28a
T3	40.33±.33bc	44.34±.33c	51.00±.57b
T4	34.00±1.15cd	40.66±.32c	48.33b±.88c
LSD Value	6.9036	4.9042	12.401

Figures not sharing the same letters differ significantly at $P = 0.05$.

Table 3 shows data concerning fresh weight of 1st, 2nd and 3rd flush harvested and total yield of mushrooms. T_0 yielded best (80.00±2.87g) followed by T_4 (63.67±5.84g), T_3 (48.33±6.01g), T_2 (41.66±6.66g) and T_1 (18.33±1.76g) respectively in case of fresh weight of 1st flush harvested. Similarly, in case of fresh weight of 2ndflush harvested T_0 yielded best (51.66±5.81g) followed by T_4 (38.67±2.96g), T_3 (34.00±6.66g), T_2 (23.00±2.55g) and T_1 (23.00±.57g) respectively. While, in case of fresh weight of 3rd flush harvested T_0 yielded best (36.00±2.31 g) followed by T_4 (27.67±.88g), T_3 (17.00±1.15g), T_2 (15.00±.57g) and T_1 (10.33±.88g) respectively. As for astotal yield is concerned, T_0yielded best (167.67±5.61g) followed by T_4 (130.00±5.19g), T_3 (99.34±.33g), T_2 (79.66±4.25g) and T_1 (42.67±.88g) respectively.

Table 3. Effect of cotton waste, sorghum straw and their combination on fresh weight of 1st, 2nd and 3rd flush and total yield of *Pleurotus sajor-caju*.

Treatment	Fresh weight of 1st flush (g)	Fresh weight of 2nd flush (g)	Fresh weight of 3rd flush (g)	Total yield (g)
T0	80.00±2.87a	51.66±5.81a	36.00±2.31a	167.67±5.61a
T1	18.33±1.76d	23.00±.57cd	10.33±.88d	42.67±.88e
T2	41.66±6.66c	23.00±2.55cd	15.00±.57c	79.66±4.25d
T3	48.33±6.01bc	34.00±6.66bc	17.00±1.15c	99.34±.33c
T4	63.67±5.84b	38.67±2.96ab	27.67±.88b	130.00±5.19b
LSD Value	15.825	13.630	4.1219	12.401

Figures not sharing the same letters differ significantly at $P = 0.05$.

Table 4 shows data regarding pH of mushroom, total soluble solids of mushroom (°Brix), acidity of mushroom (%) and ascorbic acid contents of mushroom (mg/100ml). Highest pH value was observed in case of T_2(7.87±.09) followed by T_1 (7.84±.03), T_3 (7.60±.05), T_0 (7.53±.03) and T_4 (7.50±.01) respectively. In case of total soluble solids of mushroom maximum total soluble solids were observed in case of T_0 (4.00±.01) and T_4 (3.56±.23) followed by T_2 (3.20±.30) and T_3 (3.10±.05) and T_1 (3.04±.34) respectively. In case of acidity of mushroom maximum acidity of mushroom was observed in case of T_0 (0.05±.04) followed by T_4 (0.04±.04) T_3 (0.03±.02) and T_2 (0.03±.01) and T_1 (0.03±.01) respectively.

Table 4 . Effect of cotton waste, sorghum straw and their combination on biochemical parameters of *Pleurotus sajor-caju*.

Treatment	pH of mushroom	Total soluble solids of mushroom (°Brix)	Acidity of mushroom (%)	Ascorbic acid of mushroom (mg/100ml)
T0	7.53±.03b	4.00±.01a	0.05±.04a	18±.03a
T1	7.84±.03a	3.04±.34b	0.03±.01b	11±1.41b
T2	7.87±.09a	3.20±.30b	0.03±.01b	12±.01b
T3	7.60±.05b	3.10±.05b	0.03±.02b	14±1.15b
T4	7.50±.01b	3.56±.23ab	0.04±.04ab	14±3.60ab
LSD Value	0.1649	0.7790	0.0102	4.23

Figures not sharing the same letters differ significantly at $P = 0.05$.

In case of ascorbic acid contents of mushroom, maximum ascorbic acid contents were observed in case of T_0 (18±.03mg/100ml) followed by T_4 (14±3.60mg/100ml),T_3 (14±1.15mg/100ml), T_2 (12±.01mg/100ml) and T_1 (11±1.41mg/100ml) respectively.

Table 5 shows data concerning nitrogen, phosphorus and potassium contents of mushroom (%). As for as nitrogen contents of mushroom (%) are concerned, maximum nitrogen contents were observed in case of T_0 (0.71±.02%) followed by T_4 (0.67±0.15%),T_3 (0.63±.06%), T_2 (0.60±.06%) and T_1 (0.50±.01%) respectively. While in case of phosphorus contents of mushroom (%), maximum phosphorus contents were observed in case of T_0 (0.46±.01 %) followed by T_4 (0.45±.07%),T_3 (0.37±.01%), T_2 (0.24±.06%) and T_1 (0.24±.03%) respectively. Similarly, in case of potassium contents of mushroom maximum potassium contents were observed in case of T_0 (0.77±.03%) followed by T_4 (0.73±.03%),T_3 (0.63±.02%), T_2 (0.58±.01%) and T_1 (0.57±.02%) respectively.

Table no 5. Effect of cotton waste, sorghum straw and their combination on nitrogen, phosphorus and potassium contents of *Pleurotus sajor-caju*.

Treatment	Nitrogen contents of mushroom (%)	Phosphorus contents of mushroom (%)	Potassium contents of mushroom (%)
T0	0.71±.02a	0.46±.01a	0.77±.03a
T1	0.50±.01b	0.24±.03c	0.57±.02c
T2	0.60±.06ab	0.24±.06c	0.58±.01c
T3	0.63±.06a	0.37±.01b	0.63±.02b
T4	0.67±0.15a	0.45±.07a	0.73±.03a
LSD Value	0.1276	0.0286	0.0477

Figures not sharing the same letters differ significantly at $P = 0.05$.

Table 6 shows data related to reducing sugars, non-reducing sugars and total sugar contents of mushroom (%). Maximum reducing sugars contents were observed in case of T_0 (3.95±.04%) followed by T_4 (3.94±.04%), T_3 (3.30±.10%), T_2 (3.06±.07%) and T_1 (3.06±.06%) respectively. Similarly In case of non-reducing sugars contents of mushroom (%), maximum non reducing sugars contents were observed in case of T_0 (7.80±.26%) followed by T_4 (7.01±.50%), T_3 (6.33±.16%), T_1 (6.07±.06%) and T_2 (6.01±.01%) respectively. Similarly in case of total sugars contents of mushroom (%), maximum total sugars contents were observed in case of T_4 (10.96±.47%) followed by T_0 (10.63±.37%), T_3 (10.26±.15%), T_1 (9.74±.32%) and T_2 (9.41±.49%) respectively.

Table 6. Effect of cotton waste, sorghum straw and their combination on reducing sugars, non-reducing sugars and total sugars of *Pleurotus sajor-caju*.

Treatment	Reducing sugars of mushroom (%)	Non reducing sugars of mushroom (%)	Total sugars of mushroom (%)
T0	3.95±.04a	7.80±.26a	10.63±.37ab
T1	3.06±.06c	6.07±.06c	9.74±.32bc
T2	3.06±.07c	6.01±.01c	9.41±.49c
T3	3.30±.10b	6.33±.16bc	10.26±.15abc
T4	3.94±.04a	7.01±.50ab	10.96±.47a
LSD Value	0.2076	0.8381	1.2038

Figures not sharing the same letters differ significantly at $P = 0.05$.

DISCUSSION

Button mushroom (*Agaricus bisporus*), shiitake mushrooms (*Lentinus edodes*) and the oyster mushroom, (*Pleurotus ostreatus* and *Pleurotus sajor-caju*) consitute important components of globally expanding mushroom industry (Suguimoto et al., 2001). Production of these speciality mushrooms constitutes major mushroom industry in south east Asian countries and elseware in the world. Cultivation of *Pleurotus spp*. especially *Pleurotus sajor-caju* has been stimilated in different asian countries due to easy availability of lignocellulosic raw materials (Sangwan and Saini, 1995). Time taken for initiation of spawn run, completion of mycelial growth and initiation of pinheads was lower with

maximum total number of pinheads formation in case of cotton waste as compared to sorghum straw and its various amendments. This is understandable due to complete, faster and heavy colonization of cotton waste substrate forming a compact white mass of mycelium as compared to other substrates. Our findings are in agreement with the studies conducted by Khan et al., 2009. who reported better performance of *Pleurotus* species on cotton waste as compared to other mushroom growing substrates. The variation in above mentioned parameters may be attributed to variation in chemical and lignocellulosic composition of substrates (Iqbal et al., 2005). As for as behaviour of mushroom harvesting pattern is concerned our results are supported by the findings of Dundar and Yildiz. 2009 who reported similar behaviour of mushroom harvesting pattern in their study. Better total yield obtained by using cotton waste may be attributed to presence of large quantity of cellulose and hemicellulose (Khan et al., 2010). Gradual decrease in yield was observed from 1st flush to 3rd flush in case of all treatments which might be attributed to gradual decrease in nitrogen contents of substrates with passage of time (Mandeel et al., 2005). pH, total soluble solids, acidity and ascorbic acid contents are important indicators of mushroom quality (Eissa, 2008). Phosphorus, potassium and sodium are some important minerals present in mushrooms and constitute major part of total minerals present in mushrooms (Chang and Miles, 1989). As for as reducing sugars, non-reducing sugars and total sugars of mushroom are concerned, they function to provide support and expansion of the fruit body of mushrooms and determine nutritional quality of mushrooms (Barros et al., 2007). Variation in reducing sugars, non-reducing sugars and total sugars of *Pleurotus Sajor-Caju* mushroom can be attributed to variety of substrates used as substrates normally affect fungal nutritional composition (Sturion and Oetterer 1995).

CONCLUSIONS

Pleurotus Sajor-Caju mushroom performed best when grown on T_0 (cotton waste 100%) and T_4 (75% cotton waste + 25% sorghum straw) as for as different growth, yield and bio chemical parameters are concerned. We are of the openion that cotton waste should be first preference for cultivation of *Pleurotus Sajor-Caju* mushroom. However, in case of limited availability of cotton waste, production of *Pleurotus Sajor-Caju* mushroom can be carried out on cotton waste amended with sorghum straw generally in those areas where there is shortage of cotton waste.

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