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OPTIMIZATION OF KING OYSTER MUSHROOM (*PLEUROTUS ERYNGII*) PRODUCTION AGAINST COTTON WASTE AND FENUGREEK STRAW

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A B S T R A C T

King oyster (*Pleurotus eryngii*) mushroom is a palatable mushroom with high commercial potential due to relative ease of its growing technology, less cost of production and better yield potential, making it popular throughout the world. Therefore, an experiment was set up to assess the efficacy of different agro-wastes [cotton waste (CW) and fenugreek straw (FS)] on the morphology, yield and nutritional components of two strains (*Pleurotus eryngii* P9 strain and *Pleurotus eryngii* P10 strain) of *Pleurotus eryngii*. Studied indicators regarding time for pinhead formation, fruiting body development, biological efficiency and yield of both strains were significantly affected by different formulations of substrates. Substrates with 100 % CW exhibited maximum number of pinheads, yield and biological efficiency for both strains of king oyster as compared to other substrates alone or in mixture. This experiment indicates the possibility of *Pleurotus eryngii* cultivation on cotton waste and fenugreek straw in controlled conditions for enhanced growth and yield.

Keywords: Biological efficiency, Cotton waste, Fenugreek straw, *Pleurotus eryngii*

INTRODUCTION

Pleurotus eryngii mushroom is becoming globally popular because of its outstanding uniformity of cap and stem, gastronomic abilities and extensive shelf life. King oyster is a well-known mushroom suitable for consumption of human and famous for its unique aroma and taste. It belongs to Mediterranean area of Europe and now becoming popular all over the world including China, Japan, and Middle East and in Indo-Pak. King oyster mushroom is one of the greatest mushroom due to its better shelf life and gastronomic properties (Yildiz *et al.*, 2002). It produces less spores than other oyster species that's why this strain has less vulnerability to getting allergy. Due to the plentiful contents of carbohydrates, minerals (i.e. phosphorus, sodium, potassium and calcium), protein, fibres, vitamins (i.e. D, B6, riboflavin, B5, niacin and B1 etc.) etc., King oyster mushroom acts as a promising health beneficial mushroom (Ahmad *et al.*, 2009).

It also comprises diverse types of volatile compounds (Mau *et al.*, 1998). Laccases are also present in King oyster mushroom which are being used in food and beverage industry for unwanted phenolics eradication for control of browning in food items. It has commercial importance due to its use on industrial scale. Compounds i.e. polyphenols, amino acids, polysaccharides and flavonoids etc. having antioxidant properties are also present in king oyster mushroom which play role in health maintenance. King oyster mushroom have nutritional value containing carbohydrates (9.6%), dietary fibre (4.64%), polysaccharides (0.41%), chitin (0.50%) and protein contents (1.88% to 2.65%). It also contains different types of amino acids such as arginine, aspartic and glutamic acid (Manzi *et al.,* 2004).

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Different commercially grown strains of *Pleurotus eryngii* are available and are being cultivated on large scale worldwide. Different strains respond differently regarding yield, quality of mushroom, mycelium growth against different environmental conditions, substrates, supplements and their quantity, (Visscher, 1989). Cultivation of king oyster is easy on straw of rice, wheat, sawdust and cotton waste (Jiskani, 1999). Optimum temperature range for fruit body development of King Oyster and other strains of oyster mushroom ranges between 12-17 °C. Extensively year-round cultivation of *P. eryngii* is difficult as compared to other oyster mushroom strains i.e. *P. florida, P. sajor-caju* and *P. ostreatus* because it requires controlled conditions (Moonmoon *et al*., 2010).

Different wastes of food and agricultural industry i.e. cereal straws, saw dust, vegetable biomass, waste of paper and food industry and wood shavings etc. which contain plenty of lignin and cellulose can be considered as promising substrates for fruit body development and mycelium growth. Numerous enzymes are present in *Pleurotus* spp. which can decompose complex compounds present in industrial and agro-based wastes. Several substrates like sawdust, wheat and rice straw, cotton seed hull, sugarcane bagasse, corn stover and their combinations in different ratios with wheat bran, soybean and peanut meal can be used as growing media for King oyster mushroom on commercial scale. The optimum conditions for growth and development of fruiting body are temperature (15-21˚C), humidity (85-95%) and light (500-1000 lux). Commonly 50-55 days are obligatory for accomplishment of mycelial growth and 3-4 flushes are obtained.

King oyster mushroom cultivation should be carried under control temperature and humidity level. Small amount of agricultural wastes are utilized effectively whereas large amount of wastes are disposed of or fired which cause serious damage to environment and human health.

At present, very scarce or no literature is available on evaluation of cotton waste and Fenugreek substrates for production of *Pleurotus eryngii*. Keeping in view this gap, a study was conducted to assess the outcome of Cotton waste and Fenugreek straw (alone and in combination) on different strains (P_9 and P_{10}) of *Pleurotus eryngii* under controlled conditions. In this experiment cotton and fenugreek based substrates were used to optimize the growth and development of king oyster mushroom.

MATERIALS AND METHODS

Present research experiment was conducted in Medicinal and Mushroom lab at Institute of Horticultural Sciences, University of Agriculture, Faisalabad, in 2014-2016, to check growth, yield and biological efficiency of two strains (P_9 and P_{10}) of king oyster mushroom (*Pleurotus eryngii*) on different growing media.

Preparation and bag filling of substrate: Different substrates such as cotton waste (T_o=100%) and fenugreek straw (T_1=100%) were used along with different combinations (T_2 = 25% CW + 75% FS), (T_3 = 50% CW + 50% FS) and (T_4= 75% CW + 25% FS) respectively. Both substrates were dipped in water followed by heaping and covering with polythene sheet followed by fermentation for 4 days. Whereas excess moisture was removed by spreading substrates on floor till attaining the ultimate moisture content of 70%. Substrates were filled in polythene bags of size (20×30) cm by following combinations given above and bags opening were loosely tied with rubber band. For the maintenance of pH, 2% lime was added.

For sterilization and pasteurization, local method was adopted by placing bags for two hours in ordinary drum having water in bottom with heating, followed by subsequent cooling for one day. Finally, spawn of strains (P_9 and P_{10}) of *Pleurotus eryngii* were added at the rate of 1% per bag.

Growing Conditions: Optimum growing conditions were maintained by keeping temperature and RH at 20-24˚C and 70-80% respectively for spawn running. While temperature after completion of mycelial growth was lowered and kept between 16-22˚C with increase relative humidity (80-90%) for successful onset of fruiting body.

Parameters: Different parameters like number of days for initiation of spawn running, number of days for 25 %, 50%, 75% and 100% mycelium growth, number of days for initiation of pinhead formation, number of pinhead formation/bag, total flushes/ bag, number of days to complete 1st, 2nd and 3rd flush, yield/bag (g), biological efficiency (%), pH of mushroom, total soluble solids, moisture percentage (%) and fresh weight of mushroom were studied following standard procedure (Ahmed *et al*., 2009).

Statistical procedure: Two factor factorials under completely randomized design was applied in this experiment. Data collected was analysed by using ANOVA techniques. Means values were compared by using LSD test at 1% probability level.

RESULTS

Results regarding various parameters such as biological efficiency, yield, moisture % and subsequent number of days for 1st, 2nd and 3rd flush were significantly affected by types of substrates used along with their varying concentrations respectively. T_o yielded highest weight (280-290 g) followed by T_4 which recorded (272-283 g) in both strains (P_9 and P_{10}) respectively (Figure 1). Whereas similar pattern was followed in case of biological efficiency, where T_0 attains maximum biological efficiency (72 %) of both strains (P_9 and P_{10}) followed by combination T_4 that recorded (67.5 and 69%) in (P_9 and P_{10}) respectively. Meanwhile, T_0 also influences time taken for 100% mycelial growth by recording least number of days (62.5), followed by T_4 with (65.6 days), T_3 having (67.4), T_2 recording (67.9) and maximum number of days by T_1 that recorded 70.4 days (Table 1). Number of days taken to 1st, 2nd and 3rd flushes were also highly affected by substrate composition and type with T_0 being the earliest one (83.9, 98.8 and 114.1 days), followed by T_4 (88.1, 101.9 and 117.7 days) and maximum by T_1 (89.5, 113.9 and 119.9 days) respectively (Table 1). Similar result pattern was found in case of time taken for Pin Head initiation (Table 2).

Table. 1. Morphological attributes responses of *P. eryngii* against cotton ginning waste and fenugreek straw

Treatments	Time taken for 100% mycelial growth		Time taken for 1st flush (Days)		Time taken for 2nd flush (Days)		Time taken for 3rd flush (Days)	
	P9	P10	P9	P10	P9	P10	P9	P10
T_0	61.4±0.5	63.6±0.7	81.9±0.8	85.9±1.7	96.7±0.8	100.9±0.8	111.3±0.9	117.0±1.0
T_1	72.6±0.5	68.1±1.0	91.7±1.8	87.3±2.1	104.6±1.9	103.3±2.0	119.1±1.9	118.7±1.9
T_2	67.0±0.6	68.7±0.5	90.3±2.1	90.0±1.3	103.6±1.8	104.3±1.3	118.6±1.5	119.9±1.2
T_3	68.4±0.5	66.3±1.0	85.1±0.8	90.3±1.3	99.9±0.6	104.7±1.4	116.4±0.9	119.4±1.2
T_4	68.3±0.7	62.9±0.8	88.3±1.3	87.9±0.7	102.0±1.0	101.9±0.5	117.4±0.8	118.0±0.8

Table.2. Morphological attributes responses of *P. eryngii* against cotton ginning waste and fenugreek straw

Treatments	Time taken for pinhead formation (days)		No. of Pinheads		Fresh weight of mushroom (g)	
	P_9	P_{10}	P_9	P_{10}	P_9	P_{10}
T_0	74.9±1.2	79.6±1.0	32.6±0.9	29.6±1.3	269.6±2.9	268.0±3.0
T_1	81.9±2.4	78.7±1.6	26.9±0.5	25.6±1.4	243.9±1.9	248.4±2.5
T_2	80.0±2.0	80.0±1.6	30.6±0.6	29.7±2.2	265.6±2.1	258.6±2.1
T_3	78.0±0.5	79.7±1.3	33.7±0.9	29.9±1.6	260.6±1.6	261.7±1.7
T_4	79.7±1.8	76.7±0.6	31.6±1.2	29.1±1.7	260.3±2.6	263.9b±2.0

T_0 attained maximum fresh weight of mushroom as compared to any other substrate alone or in combination. Results depicts that T_0 yielded (268.8 g/bag), followed by T_3 (262.1 g/bag), T_4 and T_2 yielded similar (261.1 g/bag) while least by T_1 (246.1 g/bag). Time taken for pinhead formation showed non-significant results for variety, treatment and variety treatment interaction. Results indicates that both strains of *P. eryngii* recorded least time to induce pinhead formation at T_4 followed by substrate combinations T_3, T_2 and T_1.

DISCUSSION

Mushroom production depends on several factors e.g. substrate type, availability of nutrients, temperature, humidity, oxygen, carbon dioxide and duration of light (Hassan *et al*., 2010). Temperature among one of important factors affecting growth and physiological behaviour of mushroom have affected spawn run rate and pinhead formation as optimum results were found at 25°C and 17-20°C respectively. These outcomes are in accordance with Shah *et al*. (2004). The difference in morphological growth responses (Table 1) of strains might be affected by different chemical composition of agro-wastes materials (Kazeem *et al*., 2017). Cotton waste reported best in terms of yield, fresh weight and chemical composition (Jonathan *et al*., 2012). Differential growth response of strains (P_9 and P_{10}) of king oyster mushroom (*Pleurotus eryngii*) on CW and FS could also be attributed to presence of phenolic substances in CW which have a key role in mushroom spawn running and mycelial growth (Bellettini *et al*., 2016). Results regarding number of days taken to 1st, 2nd and 3rd flush showed that CW significantly affected yield, time taken to complete flushes and biological efficiency by decreasing number of days. However, it could also be associated with temperature and humidity percentage (Girmay *et al*., 2016) as 3-4 weeks were taken from pinhead formation to fruit body formation after spawn running at 22°C (Shah *et al*., 2004; Yang *et al*., 2013). Certain other factors affect the pinhead formation (environmental condition of growth room & physical condition of substrate), yield distribution and final quality of pinhead (Singh *et al*., 2011). On the other hand, substrate type is a major determinant of mushroom quality, up here in this experiment cotton waste (CW) yielded higher quality of fruiting body (Figure 1) that can be ascribed to high concertation of cellulose and lignocellulose presence in cotton waste (Nasir *et al*., 2017). These findings are in accordance with the finding of Khan *et al.,* (2004) who concluded that cultivation of *Pleurotus ostreatus* on different lignocellulosic substrates led to improvement in mean yield (680.9 g) of mushroom per kg of media. Hernandez *et al.*, (2003) also recommended CW as best available substrate for obtaining higher yields of oyster mushroom (*Pleurotus* species) among different substrates evaluated. Parallel consequences were concluded by Obodai *et al*. (2003) who suggested CW as best growing media for cultivation of *Pleurotus ostreatus* among different eight lignocellulosic by-products evaluated as substrate. This may be due to presence of plenty of nutrients availability in the media along with higher fungal activity (Khan *et al*., 2017). Biological efficiency (BE) can be described as amount of conversion (%) of dry substrate weight to fresh mushroom weight (Sharma *et al*., 2013). Varying results could be due to different strains (P_9 and P_{10}) of *Pleurotus ostreatus* that are associated with the conclusions of Kirbag and Akyuz (2008), who concluded that higher percentage of BE of *Pleurotus eryngii* was obtained when grown on various agricultural waste substrates along with supplementation of different chemicals and nutrients.

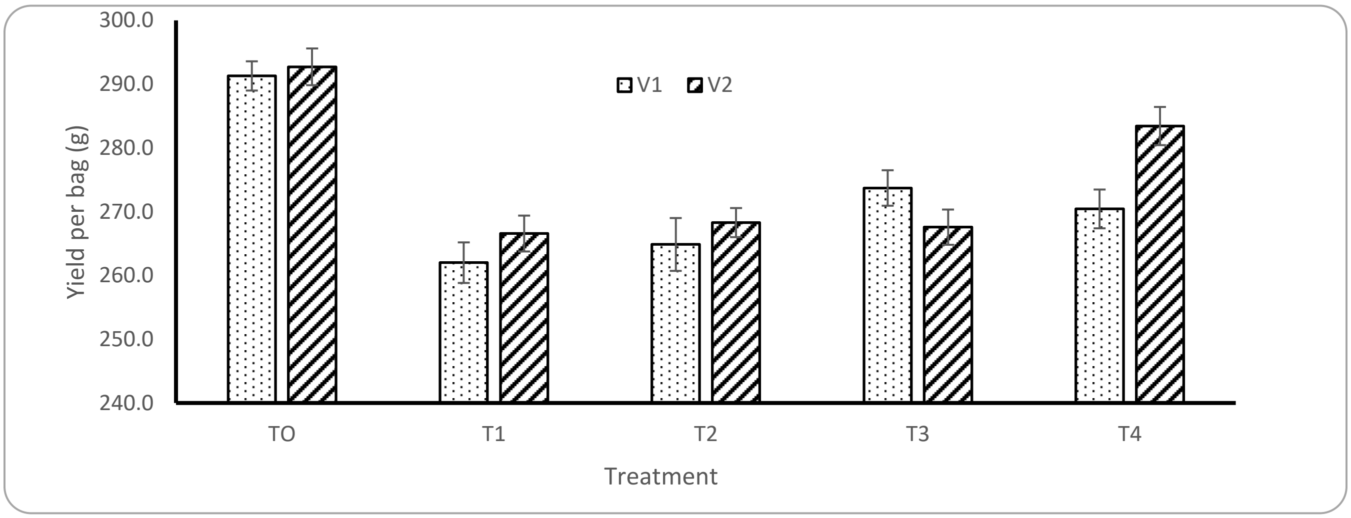

Figure 1. Effect of cotton and fenugreek based substrate and their combination on yield

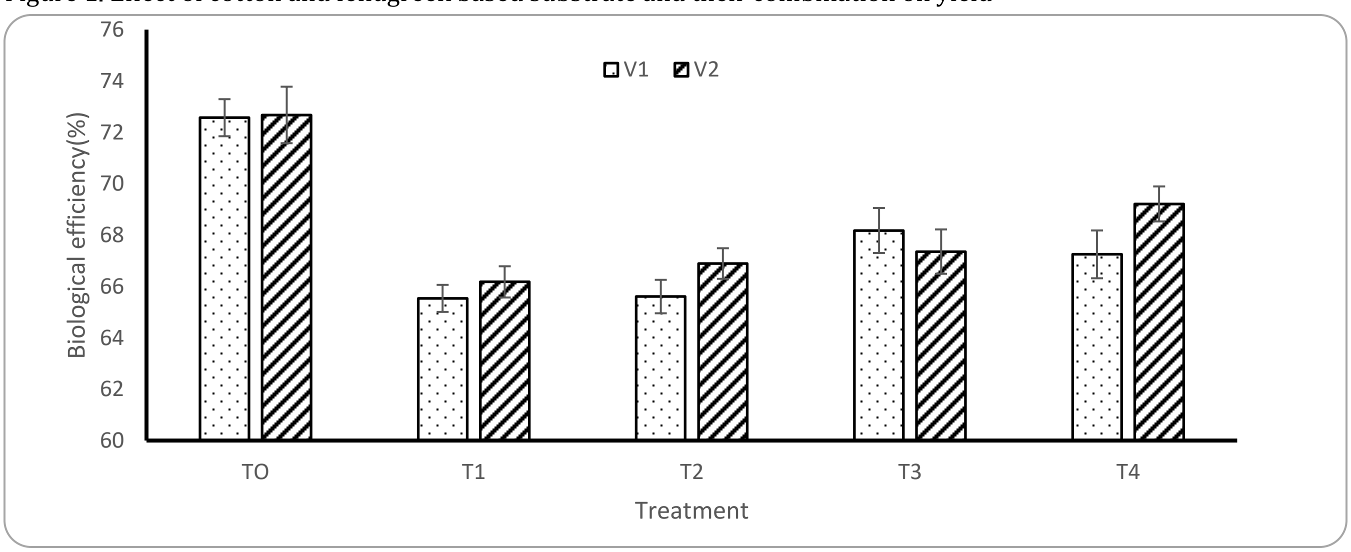

Figure 2. Effect of cotton and fenugreek based substrate and their combination on biological efficiency.

CONCLUSION

In this study, we assessed cotton waste and fenugreek straw and their different combination on mushroom production gap, fresh weight, biological yield, biological efficiency, pinhead formation and other physiological parameter of P_9 and P_{10} strains of *Pleurotus eryngii*. Types of substrate are seriously affect the mushroom production because of increasing and enhancing the enzymatic accessibility of the ingredients for fungus growth and development. It is suggested that production of king oyster mushroom is very capable when cultivated on cotton waste besides fenugreek straw gave an acceptable yield of *Pleurotus eryngii*.

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