I.J.S.N., VOL.7 (1) 2016: 104-111 ISSN 2229 – 6441

INTERNATIONAL JOURNAL OF SCIENCE AND NATURE

www.scienceandnature.org

ASSESSING THE POTENTIAL OF LIGNOCELLULOSIC AGRO-WASTES FOR HIGH YIELD OF *AGROCYBE AEGERITA* (BRIG.) SINGER UNDER PUNJAB CLIMATIC CONDITIONS

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ABSTRACT
Agrocybe aegerita grows well on agro-based substrates. The present study focussed on the cultivation of black poplar mushroom; *Agrocybe aegerita* under the climatic conditions of Punjab state. The vegetative growth of *Agrocybe aegerita* can be directly correlated by two factors: mycelial extension rate and spawn run time. During the solid state fermentation in "race tube", it was found that the vegetative growth of this mushroom is faster on 20% wheat bran supplemented wheat straw followed by sawdust and paddy straw. Similar results were found evidently during cultivation trials on these substrates with and without supplementation of wheat bran. Cultivation of *Agrocybe aegerita* was carried out on six lignocellulosic substrates, namely, wheat straw, paddy straw, sawdust, maize stalks, corn cobs and cotton sticks. In respect of fructification, 20% wheat bran supplemented paddy straw supported average number (51/kg) but not economically attainable. Though cultivation on 10% wheat bran supplemented paddy straw resulted in significantly slower spawn run as compared to other substrates, but established high yield (337g/kg) and biological efficiency (36.4%). The biological efficiency of cotton sticks (15%) was lower than non-supplemented paddy straw (20.8%) and wheat straw (20%) but higher than maize stalks (13.7 %) and corn cobs (5.6 %), indicating that cotton sticks can be further assessed for the cultivation of *Agrocybe aegerita.* The value added bioconversion of residue based substrate to this nutritive and medicinal mushroom will contribute to sustainability in health and environment.

KEYWORDS: *Agrocybe aegerita*, biological efficiency, supplementation, paddy straw, mycelial extention

INTRODUCTION

Mushroom cultivation harnesses the major utilization of lignocellulosics in a formative way which otherwise go ravaged (Stamets, 2000). *Agrocybe aegerita* (Brig.) Sing. commonly known as black poplar mushroom belongs to the family Strophariaceae. *Agrocybe aegerita* is one of the palatable mushroom grown in temperate climates mostly on poplar and willow wood. It develops fruit bodies in nature from spring to autumn, has a unique flavour, good nutritive and medicinal value. In the last few years various lignocellulosic residues have been propounded as substrate for the growth of mushrooms (Donini, 2005). The cultivation of *Agrocybe aegerita* on agricultural wastes not only reduces disposal problems caused by detritus accumulation but also provides an economically acceptable alternative for the production of high quality food and fodder through production of proteins. It chips insignificantly to the farmer's income (Philippoussis *et al*., 2000). Varied agroclimatic conditions and availability of agricultural and industrial residues in India offer great opportunities for cultivating specialty mushrooms on commercial scale. Experience has shown that not all lignocellulose is equally useful to every cultivated species (Chang and Miles, 2004). The use of several lignocellulosic by-products such as barley, maize, wheat straw, orange peel, grape stalks, reed, rice husks and sunflower has been reported for the cultivation of *Agrocybe aegerita* (Nicolini *et al*., 1987; Zadrazil, 1994). Sawdust and cereal straw with the addition of supplements are the principal substrates for mushroom cultivation that substantially increase the yield per unit weight (Zadrazil and Grabbe, 1983; Laborde *et al*., 1985). *Agrocybe aegerita* gave higher yields (Biological Efficiency 100 %) on mixture of saw dust, crushed corn cobs and paper pulp (Philippoussis *et al*., 2000). While working on the physiological requirements and cultivation of *A. aegerita*, Sharma *et al*. (2004) observed that sugarcane bagasse and wheat straw supported the fastest growth of A. aegerita. Moreover, wheat straw was found to be the best substrate with 60% Biological Efficiency. However, low yield and a short post harvest life with three commercial strains of *Agrocybe aegerita* compared with other cultivated mushrooms such as *Agaricus bisporus* and *Pleurotus ostreatus*, limits its cultivation (Wang *et al*., 2002). Sarkar *et al*. (2008) cultivated *A. aegerita* on sawdust and paddy straw substrate and found optimum temperature conditions (19-22°C) for fruit body formation. They also reported 32.1 and 28.3% B.E. on saw dust and paddy straw substrate respectively. Omoanghe *et al*. (2009) tried different substrate combinations and found that substrate combination (SC) composed of wheat straw 70%, solid waste 20% and millet 10% validated to be a better substrate for commercial cultivation of *A. aegerita.* Moreover, they also found that biological efficiencies obtained in substrate combinations containing wheat straw, solid waste and millet in two flushes (51.4%) was higher than 33.8 % reported for *Volvariella volvacea* (Salmones *et al*., 1996) but lower than the 86.4 % reported for *Lentinula edodes* and the 93 % reported for *Pleurotus ostreatus* (Royse and Sanchez-Vazquez 2003). Cultivation of A. aegerita was carried out on two substrates namely, wheat straw and sawdust. Sawdust proved to be the better substrate for cultivation of *Agrocybe aegerita* because it resulted in 67.66 % biological efficiency as compared to 56.25 % for wheat straw (Sharma and Sharma, 2009).This high biological efficiency for the first time allows the re-evaluation of this species for commercial cultivation worldwide.

The addition of supplement to the substrate is a promising way of getting higher mushroom yield. Supplement cause a significant increase in the nutrient content of the substrate. Royse (1989) found that nutrient supplements such as wheat bran, rice bran and corn bran not only enhanced mycelial growth but also increased the production rate. Substrate (sawdust) with higher wheat bran content gave higher yield. Starch based supplements (30-70% dry wt.) such as wheat bran, rice bran, millet, rye and maize may be added to the mix. These supplements serve as nutrients to provide a more optimum growth medium (Royse, 2001). Permana *et al.* (2001) supplemented the sugarcane bagasse with various levels of wheat bran, soybean meal for three fungal species: Pleurotus sajor-caju, Pleurotus eryngii and Agrocybe aegerita. They found that the supplementation of wheat bran increased the fruiting yield of all mushrooms, while the supplementation of soybean meal increased the fruit yield of only Pleurotus species.

According to Moda *et al*. (2005) the supplementation of the substrate is commonly used to raise productiveness, which is evaluated by the biological efficiency. They found that cereal bran is the source of organic nitrogen which is required for the growth of the mycelium mass, which in turn may interfere in productiveness and biological efficiency of the fungus. Sharma and Kumar (2006) found that wheat bran enhanced both linear growth as well as yield of black poplar mushroom significantly. Uhart *et al*. (2008) showed that utilization of soybean flour supplemented wheat straw raised the biological efficiencies (BEs) (137.8 – 179.1 %) of three strains of *A. cylindracea*. They also concluded that supplementation not only enhanced mycelia growth but also increased the production rate. Lignocellulosic materials require different supplements or additives with sufficient amount of nitrogen, phosphate, potassium and vitamins for better growth and yield of mushrooms (Mangat *et al*. 2008). Sharma and Sharma (2009) carried the cultivation of *Agrocybe aegerita* on two substrates- wheat straw and sawdust and found that supplementation with 10% wheat bran resulted in increased biological efficiency on both substrates, the highest being on sawdust (74.33% biological efficiency). Yong (1988) used oat chaff and oil palm pericarp waste, in different proportions as the substrate for cultivation of *Agrocybe aegerita* and concluded the combination of 80:20 oat chaff: oil palm pericarp waste far better than 60:40 combinations. Solomko and Lomberg (2007) found that the yield of fresh mushrooms of *Agrocybe aegerita* IBK-960 was around 20% from the wet mass substrates except for non-supplemented sawdust (only 5%) and for complex mishmash substrates (25 %). Zhao *et al*. (2009) cultivated *Agrocybe aegerita* and *Auricularia auricula* on a series of growth substrates in which the sawdust component (constituting 85% of the basal formula) was replaced to different extents with spent *Pleurotus ostreatus* substrate. They reported that the highest fruit body yields (76.5 g per bag for *A. aegerita* and 43.2 g per bag for *A. auricula*) were obtained using a substrate containing 40% sawdust, 45% spent *P. ostreatus* substrate, 12.5% wheat bran, 1.5% gypsum and 1% sucrose.

This mushroom has so far not been exploited for commercial production in India and there are no reports of its cultivation under Punjab conditions. The purpose of this study was to find out the best substrate and best supplementation rate for the large scale cultivation of *Agrocybe aegerita* under natural season.

MATERIALS & METHODS

Agrocybe aegerita strain available in the Culture Collection Bank, Mushroom Research Centre, PAU, Ludhiana was used in the present study. The strain had earlier been procured from Directorate of Mushroom Research (DMR), Solan. It was frequently sub-cultured and maintained on potato dextrose agar (PDA) medium at 25 ± 2ºC. Mycelial Extension Rate: Mycelial extension rate in solid state fermentation was studied using different agro based lignocellulosic substrates *i.e.* wheat straw, paddy straw and saw dust supplemented with different rates of supplementation (0, 5, 10, and 20%) of wheat bran. In maize stalks, corn cobs and cotton sticks the mycelial extension rate was studied without supplementation. The test was carried out in "race tube" (25mm × 198mm) uniformly filled with the grounded substrate and sterilized at 20psi for 1 hour. The tubes were then aseptically inoculating by placing the fungal bit on top layer of the substrate and incubated at 25 ± 2ºC for 28 days. The mycelial extension rate was measured at weekly intervals for 28 days along the length of the tube with the help of scale from the point where the growth initiated to the point where the growth had reached to maximum for the given period of time.

Spawn preparation: Master spawn was prepared in Spawn Laboratory, Department of Microbiology, Punjab Agricultural University, Ludhiana on wheat grain substrate in empty glucose bottles using standard technique of spawn production (Khanna and Kapoor, 2007). Fresh spawn was used for spawning the substrate. Cultivation trials of one strain of *Agrocybe aegerita* were conducted at the Mushroom Research Complex, Department of Microbiology, PAU, Ludhiana, using standard methodology (Anonymous, 2003). The whole cultivation methodology and process conditions were explained in flow diagram (1)

Substrate Preparation: Five lignocellulosic substrates: wheat straw, paddy straw, saw dust, corn cobs and maize stalks were evaluated for the cultivation of *A. aegerita* strain to compare the biological efficiency. The substrates were spread on a cemented floor and soaked with water overnight. The substrates were then dried upto the moisture content 65 %. Out of the six substrates, wheat straw, paddy straw and sawdust were supplemented with wheat bran @ 5-20% w/w on dry wt. basis. After proper mixing, the substrates were filled in polypropylene bags

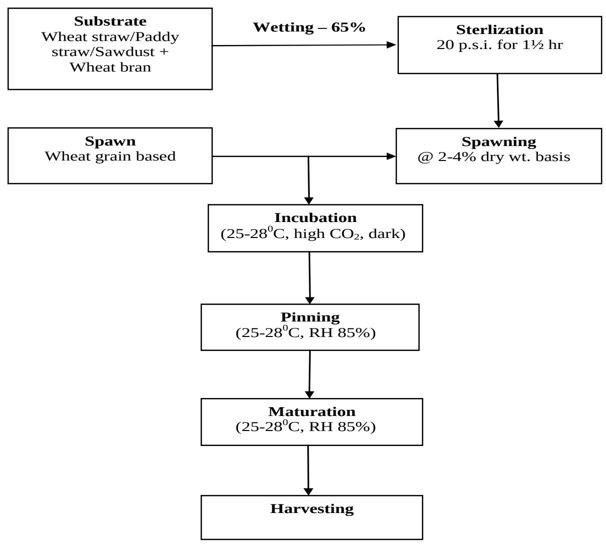
(40 x 25cm) @ 1.0 kg substrate/bag. After putting ring and cotton plug, the bags were sterilized at 20psi for 1 hour. Before sterilization, by using test tubes a centre hole was made in each bag for later inoculation.

Spawning: After cooling, the bags were inoculated aseptically with wheat grain spawn at the rate of 2% (wet weight basis) inside the core formed after removal of test tube. The bags were then incubated in dark by keeping them in growing rooms at ambient temperature 10-25°C and relative humidity maintained at 70%-80%.

Opening of Bags: After complete colonization, the bags were cut with blade to expose the outer surface. Relative humidity of 80-90 % was maintained by sprinkling water and fresh air was introduced for 4-6 h daily. During fruiting, 2-4 hours of light was provided.

Fruiting and Harvesting: The number of days required for pinning after opening of the bags was recorded and mushrooms started appearing in flushes for about 40-50 days. Fruit bodies were then harvested by gentle twisting. The number, size and weight of fruit bodies from each bag were recorded and percent biological efficiency (B.E.) was calculated by the formula:

B.E. % = (Fresh weight of fruiting bodies) × 100/ Dry weight of substrate



Flow diagram 1: Cultivation method and process conditions for *Agrocybe aegerita*

RESULTS AND DISCUSSION

Agrocybe aegerita was cultured successfully on all of the substrates taken in this study. The lignocellusic insoluble matter is converted into utilizable form with the help of cellulases, hemicellulose and laccases. The use of supplements helps to proliferate the culture onto the substrate more readily by fortifying nutrients for growth. Mycelial extension rate was found to be very low in unsupplemented paddy straw and corn cobs during initial days of incubation as compared to other substrates. The wheat straw and cotton sticks supported promising growth of the fungal mycelium as it augments the efficient enzyme system of *Agrocybe aegerita* to utilize these substrates efficiently as compared to other agricultural substrates. Jong (1989) worked with shiitake mushroom concluded that many substrates including sawdust, bagasse, rice hulls, straw, corn cobs etc. are suitable for the growth of shiitake hyphae. Present study concluded highest mycelial extension rate of culture in cotton sticks (13.2cm) after 28 days of incubation second being the wheat straw (10.2cm) (Fig 1). The extension rate observed for unsupplemented cotton sticks indicates the potential of this agricultural residue to be exploited for the cultivation of *A. aegerita* or other similar mushrooms. Amin *et al.* (2009) observed very good mycelium growth rate (0.36 cm/day) in paddy straw, though the days required completing mycelium running was found to be lowest in cotton wastes (33.50 days) in *Agrocybe aegerita*. Philipoussis *et al.* (2001) detected cotton waste to be the best substrate in *Vovariella volvacea* by determining the mycelia growth rates of this mushroom in race tubes. Philipoussis *et al.* (2001) detected the mycelia growth rate of *A. aegerita* and found no significant difference for the growth rate among different substrates. Supplementation is an important attribute to correlate the substrate utilization with the growth of the fungus. Wheat bran is a potential inducer of the lignocellulolytic enzymes of the fungus that are capable of degrading even the inaccessible constituents of the agro wastes. Nikitina *et al.* (2007) and Silva *et al.* (2005) reported that mycelium extension is related to bio availability of nitrogen when they found that eucalyptus residues supplemented with cereal bran supported fast growth of *L. edodes*. Royse (1989) found enhanced mycelia growth on addition of nutrient supplements such as wheat bran, rice bran or corn bran. Aggarwal (2007) and Lalitesh (2009) also reported improved mycelia extension rate and higher biological efficiencies of *L. edodes* strain LeS on supplementation of wheat straw with wheat bran. Similarly, Sharma and Kumar (2006) also observed that wheat bran supplementation of wheat straw substrate improved the linear growth (in mm) of *A. aegerita.* They tested several supplements and concluded that wheat bran supplementation supported faster growth compared to other supplements (cotton seed cake, soya bean meal and deoiled soya bean). In present study, use of wheat bran @ 5% on dry weight basis increased the mycelial extension rate on all substrates in race tubes. The rate is higher than in the non supplemented substrates even after 7 days and kept increasing till 28 days of incubation (Fig.1), proving evident that the wheat bran could overcome the substrate adaptation phase of the *Agrocybe aegerita* by triggering its hydrolytic enzyme system.10% wheat bran supplemented substrates has a more pronounced effect on mycelial extension rate than 5 percent (Fig. 3). With an increase in number of days of incubation, there was an increase in mycelial extension rate. The average rate of mycelial growth with 10% supplementation of wheat bran was 0.44, 0.36 and 0.44cm/day. This suggests that *Agrocybe aegerita* strain proliferate its vegetative growth better on wheat straw and saw dust than on to paddy straw. Permana *et al.* (2000) obtained improvement in yield of *L. edodes* on supplementation of wheat bran upto 15 % on dry weight basis of the wheat straw substrate. The study on effect of supplementation of wheat bran @20% was also found to surge the mycelial growth upto 14 days of incubation with an average 0.96 and 0.95 cm/day on wheat straw and sawdust respectively which later became constant on further incubation till 28 days. Mycelial extension rate in saw dust was almost equal to wheat straw but higher as compared to paddy straw (Fig.4). Oseni *et al.* (2012) found the increase in substrate colonization rate with 20% wheat bran than 5% wheat bran when culturing onto the pine saw dust. Zervakis *et al.* (2001) recorded highest extension rate of on *Pleurotus* spp. and *A. aegerita* on cotton gin trash, peanut shells and poplar sawdust.

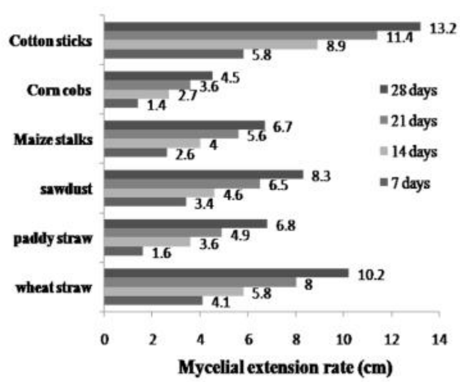


Fig 1: Mycelial extension rate of *Agrocybe aegerita* in different lignocellulosic substrates under solid state fermentation without supplementation.

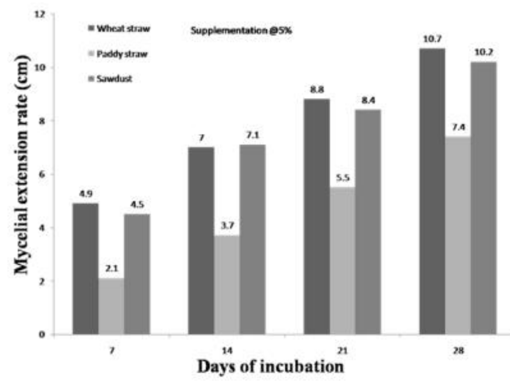


Fig 2: Mycelial extension rate of *Agrocybe aegerita* in different lignocellulosic substrates under solid state fermentation with 5% supplementation of wheat bran.

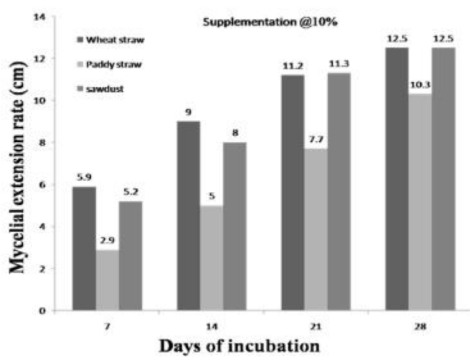


Fig 3: Mycelial extension rate of *Agrocybe aegerita* in different lignocellulosic substrates under solid state fermentation with 10% supplementation of wheat bran.

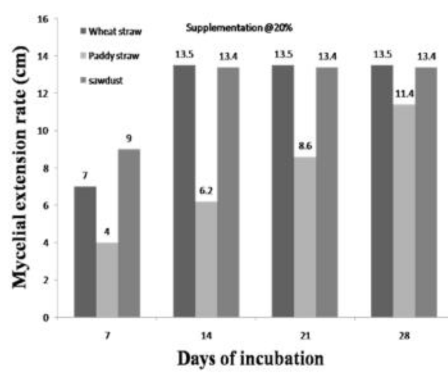


Fig 4: Mycelial extension rate of *Agrocybe aegerita* in different lignocellulosic substrates under solid state fermentation with 20% supplementation of wheat bran.

Incubation temperature: 25± 2ºC, Tube size: 25mm × 198mm (diameter X length), Average height of substrates in tubes: 135mm, Each value is mean of three replicates

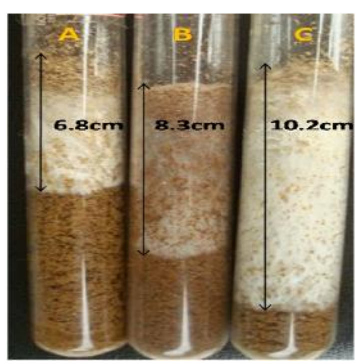


FIGURE 5: *Agrocybe aegerita* mycelial growth in glass tubes A=Paddy straw, B=Sawdust, C=Wheat straw

FIGURE 6: *Agrocybe aegerita* fructification on wheat straw substrate

Cultivation of *Agrocybe aegerita* using different substrate without supplementation

The number of days required for complete impregnation of substrate by the fungus was minimum with wheat straw (45 days) followed by cotton sticks and sawdust at par (60 Days) (Table1). This finding clears that wheat straw reduces the adaptation phase by constant supply of nutrients for the vegetative growth, thereby, the fungal mycelium proliferate easily on wheat straw. Minimum time taken for first pinning was recorded in cotton sticks (6days) followed by wheat straw, paddy straw, maize sticks and corn cobs. No pinning was seen of saw dust impregnated *Agrocybe aegerita* which demonstrates that saw dust mixture might have inhibitors or more of polyphenolic compounds which inhibit its switching to reproductive phase i.e. pinning and fruiting body formation. Average number of fruiting bodies was found highest on wheat straw substrate (32.4/Kg) followed by paddy straw (26.4/Kg), cotton sticks (23.5/Kg), maize sticks (14.11/Kg) and corn cobs (18.3/Kg). Maize sticks hold the highest average weight of fruiting bodies (9.81 g) which is followed by paddy straw, cotton sticks, wheat straw and corn cobs. Paddy straw showed highest yield of 207.8 g/Kg and biological efficiency of 20.8% followed by wheat straw, cotton sticks, maize sticks and corn cobs. Sarkar *et al*. (2008) recorded 64.50 g yield of fruit bodies per 0.5 kg paddy straw. The yield of *A. aegerita* was generally lower using several lignocellulosics by-products such as barley, maize, wheat straw, orange peel, grape stalks, reed, rice husks and sunflower when used as substrates for the cultivation and that refrain its commercial validation (Zadrazil, 1994; Wang *et al*., 2000).

TABLE 1: Cultivation of *A. aegerita* on six substrates without supplementation

Substrate	Days to spawn run	Days of pinning after spawn run	ANFB/Kg	AWFB	Yield/Kg	B.E. (%)
Wheat Straw	45	11	32.4	6.85	200.3	20
Paddy Straw	72	13	26.4	7.9	207.8	20.8
Sawdust	60	-	-	-	-	-
Corn cobs	80	25	18.3	3.4	55.5	5.55
Maize sticks	72	17	14.1	9.81	137.5	13.74
Cotton sticks	60	6	23.5	6.4	150.1	15.00
CD (5%)	4.49	2.72	0.44	0.19	2.44	2.31

Data of 10 bags each
WB – Wheat Bran
ANFB – Average Number of Fruiting Bodies
AWFB – Average Weight of Fruiting Bodies
B.E. (%) – Percentage Biological Efficiency

Effect of different supplementation rate of wheat bran on cultivation of *Agrocybe aegerita* on wheat straw

The time taken for spawn run was less (50 days) by the fungus @5% wheat bran as compared to days taken when grown on wheat straw at supplementation rate of 10% (60 days) and 20% (57 days). Pinning started earlier in 5 days in 20% supplemented wheat straw and also the average number of fruiting bodies were found highest (41.6/Kg) (figure 6). The yield 301.2g/Kg was recorded maximally in 20% supplemented wheat straw along with biological efficiency of 30.1% (Table 2). This is evident that the high rate of wheat bran augments the reproductive ability of the fungus. Uhart *et al.* (2008) showed that utilization of three naturally occurring strains using soybean flour supplemented wheat straw can highly raise B.E. in *A. cylindracea* cultivation. Supplementation with soybean flour leads to the highest B.E. average values ever reported for *A. cylindracea* (137.8– 179.1%). Omoanghe et al. (2009) tried different substrate combinations and found that the substrate combination (SC) composed of wheat straw 70%, solid waste 20% and millet 10% proved a better substrate for commercial cultivation of *A. aegerita*. Moreover, they also found that BE obtained in SCs containing wheat straw, SW, and millet in two flushes (51.4%) was higher than 33.8% reported for *Volvariella volvacea* (Salmones et al. 1996), but lower than the 86.4% reported for *Lentinula edodes* and the 93% reported for *Pleurotus ostreatus* (Royse and Sanchez-Vazquez 2003).

TABLE 2: Cultivation of *A. aegerita* on wheat straw supplemented with different rates of supplementation of wheat bran.

Rate of supple-mentation (WB)	Days to spawn run	Days to pinning after spawn run	ANFB/Kg	AWFB	Yield/Kg	B.E. (%)
5%	50	18	29.1	7.31	213.2	21.3
10%	60	25	33.8	7.6	256.5	25.62
20%	57	5	41.6	7.24	301.2	30.1
CD (5%)	6.32	3.82	1.63	0.71	2.58	1.15

Data of 10 bags each
WB – Wheat Bran ANFB–Average Number of Fruiting Bodies
AWFB – Average Weight of Fruiting Bodies B.E. (%) – Percentage Biological Efficiency

Effect of different supplementation rate of wheat bran on cultivation of *Agrocybe aegerita* on paddy straw

The days required to spawn run was almost equal in 10% and 20% supplementation and took less time than 5% supplementation (Table 3). Amin *et al.* (2009) observed the highest mycelium growth rate (0.36 cm/day) in paddy straw, though the days required to complete mycelium running was lowest in cotton wastes (33.50 days) while assessing sawdusts: Gorjan, mango, acacia, teak, chamble, mara, mahogany, rain tree sawdust, mixed saw dust, cotton waste, paddy straw and paper waste for the cultivation of poplar mushroom.The days required for pinning were found minimum in case of 10% (9 days) supplementation followed by 20% and 5%. Alam et al. 2010 recorded that *calocybe indica* took only 15 days to first primordial formation when cultivated on rice straw supplemented with 10% wheat bran.

Average number of fruiting bodies per kg was found in 20% (51) supplementation followed by 10% and 5%. Use of 30% maize powder supplement and 40% rice bran supplement supported the maximum number of effective fruiting bodies of *Calocybe indica* 16.8 and 16.3 respectively (Alam *et al*., 2010).

Average weight of fruiting bodies and yield per kg was found highest in 10% supplementation (8.0 AWFB and 364g/Kg) (Table 3). *Pleurotus sp.* when cultivated on rice straw supplemented with different nitrogen sources increased yield to 70-80% (Nayak *et al.*, 2015). The biological efficiency, in 10% supplemented wheat straw was 36.4% which is highest among other supplemented substrates studied.

TABLE 3: Cultivation of *A. aegerita* on paddy straw supplemented with different rates of supplementation of wheat bran.

Rate of supplementation (WB)	Days to spawn run	Days to pinning after spawn run	ANFB/Kg	AWFB	Yield/Kg	B.E. (%)
5%	75	24	28.5	6.16	175.8	17.6
10%	69	9	45.6	8.0	364	36.4
20%	68	12	51.0	6.6	337	33.65
CD (5%)	3.46	3.46	1.19	0.59	2.30	2.85

Data of 10 bags each
WB – Wheat Bran ANFB–Average Number of Fruiting Bodies
AWFB – Average Weight of Fruiting Bodies B.E. (%) – Percentage Biological Efficiency

TABLE 4: Cultivation of *A. aegerita* on saw dust supplemented with different rates of supplementation of wheat bran

Rate of Supplementation (WB)	Days to spawn run
0%	60
5%	65
10%	72
20%	64

Data of 10 bags each
WB – Wheat Bran ANFB–Average Number of Fruiting Bodies
AWFB – Average Weight of Fruiting Bodies B.E.(%) – Percentage Biological Efficiency

Effect of different supplementation rate of wheat bran on cultivation of *Agrocybe aegerita on* Saw dust

The days required for complete impregnation of the substrate was found maximum (72 days) in 10% supplementation followed by 5%, 20% and unsupplemented sawdust (Table 4). Although complete spawn run was obtained on sawdust but it failed to develop primordia. As a result, no fruit bodies were obtained on sawdust based substrate even after keeping it for 120 days. This might be due to the availability of mixed saw dust in plains of north India. Various workers have reported saw dust to be the best substrate for the cultivation of *A. aegerita.* Sarkar *et al.* (2008) used saw dust and paddy straw as substrate for the cultivation of *A. aegerita* and obtained maximum biological efficiency (32.1%) on saw dust. Sharma and Sharma (2009) concluded saw dust to be the best substrate for the cultivation of *A. aegerita* because it resulted in maximum biological efficiency (67.66%) as compared to wheat straw (56.25%). Other factors which might affect the sporophore formation is Sawdust as a substrate provide low availability to nitrogen which is the determinant of primordial formation, high laccase activity which turned off the key to fructification and the wood components of mixed sawdust possessing antimicrobial properties.

CONCLUSION

Lignocelluloses rich crop residues are always a challenge to communal farmers. This organic waste can be used effectively to meet increasing demand of mushrooms. The present study demanded the analysis of suitable substrate for the growth of edible *Agrocybe aegerita* mushroom under Punjab Climatic conditions. The study revealed the significant positive correlation between the wheat bran supplementation rate and the mycelial growth of *Agrocybe aegerita.* As far as the yield is concerned, paddy straw supplemented with 10% wheat bran was found best suited to increase the biological efficiency. The cotton sticks used as a substrate proved to be promising as compared to maize sticks and corn cobs. The substrate and supplementation combination for cotton sticks might enhance the yield as this substrate remarkably reduced the time for primordial initiation. Commercialization of this demanding mushroom will soar farmer's economy and summarize the produced agro waste in an effectual way.

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