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Studies on Utilization of Agrobased Wastes for the Growth and Yield of Mushroom (*Hypsozygous ulmarius*)

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Mushrooms are the fleshy and edible fruit bodies of several species of macrofungi and are consumed by humans as comestibles for their nutritional value and they are occasionally consumed for their supposed medicinal value. Apart from these it can be grown on cheaply available different agro based wastes that can supplement the growth of these mushroom as a substrate, because these mushrooms are efficient degrader of lignocellulosic compounds and the spent obtained after the growth of mushroom can serve as good organic manure, in this context a Study was carried on to know the effect of substrates (Vegetable and flower wastes) on growth of mushroom fungi (*Hypsozygous ulmarius*) was studied. Here the preliminary test was done to know the substrate compatibility for growing mushroom in combination with paddy straw based on the weight loss of the substrate. The best combinations were selected for further studies of mushroom production by bag method. Use of 25 % Chrysanthemum flower waste + 75 % paddy straw as substrate showed higher mushroom yield (641.33 g/bag) and bio efficiency (128.26%) among all the substrate combinations in bag method.

Key words: Mushroom, *Hypsozygous ulmarius,* Substrate, Yield, Bio efficiency.

Mushrooms are fruiting bodies of Basidomycetes and some are Ascomycetes fungi, which are edible. Mushrooms are also called as 'White vegetables' or 'Boneless vegetarian meat, contains 20-35 % protein (on dry weight basis) which is higher than those of vegetables, fruits and is of superior quality (Suresh and Samsher, 2006). Total mushroom production worldwide has increased more than 6 folds within a 30 years, from 12,58,804 metric tons in 1980 to 73,97,558 metric tons in 2010 (FAO, 2012). Mushroom farming is a highly remunerative enterprise with quick return in very short period. India's annual mushroom production is still negligible as compared to world production. Presently, about 70,000 tonnes of fresh mushroom is being produced in India as against over 5 million tonnes world production of mushrooms annually. Inspite of four decades of planned efforts, the pace of mushroom cultivation is slow in our country, while countries like Korea, China and Indonesia are now much ahead of India the climate for cultivation of various kinds of mushrooms is also conducive. *Hypsozygous* spp. is efficient lignin degrading mushrooms, belonging to Hymenomycetes of Basidiomycotina. *Hypsozygous ulmarius* commonly called as elm mushroom or Blue/Black oyster mushroom. Agricultural wastes or by products of agro industry like paddy straw, coir pith, sugarcane bagasse,

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wheat straw, banana leaves, hulled maize cobs *etc*., can be used as substrates for cultivation of these mushrooms (Ahmed *et al*., 2009). However, in big cities most of the time disposal of these agro based wastes like vegetable and floriculture wastes create major problem. To overcome from these problems a study was conducted to utilize the vegetable and floriculture waste effectively for the growth and development of *Hypsozygous ulmarius*.

MATERIAL AND METHODS

Collection of different substrates

Major vegetable wastes such as Cabbage waste, Cauliflower waste and Onion wastes, Flower wastes such as Rose leaves waste and Chrysanthemum flower wastes were collected from Bangalore city market.

Development of Spawn

Spawn for mushroom cultivation was prepared by following procedure. Uninfected, clean sorghum grains were washed in clean water three times and cooked, until the seed coat was just opened. The moisture content of half boiled grains was adjusted by air drying, to obtain around 50 to 55 % moisture. This was followed by mixing with 2 % of Calcium carbonate ($CaCo_3$) and 2 % of Calcium sulphate ($CaSo_4$). This admixture was filled into Poly propylene bags of 15 X 20 cm of 250 gauge thickness. It was filled to 2/3 capacity to have proper aeration and enable easy handling. Mouth of the poly propylene bag was closed with rubber band so as to avoid entry of moisture upon sterilization. The bags were sterilized in an autoclave at 121.5 °C and 15 psi for 45 minutes. After sterilization the bags were cooled and inoculated with mushroom mother culture of *Hypsozygous ulmarius* and incubated at room temperature. Mushroom mycelium (cottony growth) covered the entire sorghum in the bag in about 10-12 days (Krishnamoorthy, 1981). After complete growth on substrate, spawn packets were used for further studies.

Cultivation of Oyster Mushroom

Vegetable and flower wastes in combination with Paddy straw for the cultivation of *Hypsozygous ulmarius* mushrooms were studied for substrate compatibility in a preliminary experiment in flasks. For this, four different combinations of substrates (dry) were used to grow mushroom fungi on 10g of each of below mentioned combinations.

Vegetable wastes

Cabbage waste

1. Cabbage waste alone
2. 75% Cabbage waste + 25% paddy straw
3. 50% Cabbage waste + 50% paddy straw
4. 25% Cabbage waste + 75% paddy straw

Cauliflower waste

1. Cauliflower waste alone
2. 75% Cauliflower waste + 25% paddy straw
3. 50% Cauliflower waste + 50% paddy straw
4. 25% Cauliflower waste + 75% paddy straw

Onion waste

1. Onion waste alone
2. 75% Onion waste + 25% paddy straw
3. 50% Onion waste + 50% paddy straw
4. 25% Onion waste + 75% paddy straw

Flower wastes

Rose leaves waste

1. Rose leaves waste alone
2. 75% Rose leaves waste + 25% paddy straw
3. 50% Rose leaves waste + 50% paddy straw
4. 25% Rose leaves waste + 75% paddy straw

Chrysanthemum flower waste

1. Chrysanthemum flower waste alone
2. 75% Chrysanthemum flower waste + 25% paddy straw
3. 50% Chrysanthemum flower waste + 50% paddy straw
4. 25% Chrysanthemum flower waste + 75% paddy straw

These substrates were taken in Conical flasks, whose weights were recorded initially. Substrates in the flasks were moistened with 15 ml of water and reweighed. Later flasks were stoppered with cotton plugs and sterilized by autoclaving at 121 ºC and 15 lbs pressure for 30 minutes. Sterile substrates in flasks were inoculated aseptically with 2 g of spawn grains (*Hypsozygous ulmarius*) and incubated at room temperature for 20 days. Combinations of substrates that reduced their weight to the maximum extent were chosen for further study by bag method of cultivation of mushroom.

Preparation of substrate

From the above combination, the best weight loss shown substrate and substrate combinations were selected for growing mushroom in bag method. The substrate showed best was

selected, among all the substrate Paddy straw and Rose leaves waste were soaked in water for overnight and remaining substrate were sprinkled with water and kept overnight and later Pasteurisation was carried out for 30 minutes at 85 ºC in a closed chamber and the Pasteurised substrate were spread on a clear cement floor inside the room and allowed to cool at room temperature. At the time bag filling weight of the each substrate combination were taken respectively. Following substrate combinations were used based on the preliminary study for growing mushrooms (Desai and Shetty., 1982).

1. Paddy straw
2. Rose leaves waste
3. 75%Rose leaves waste+25% paddy straw
4. 50%Rose leaves waste+50% paddy straw
5. 25%Rose leaves waste+75% paddy straw
6. 25%Cabbage waste+75% paddy straw
7. 25%Cauliflower waste+75% paddy straw
8. 25% Chrysanthemum flower waste+75% paddy straw
9. 25% Chrysanthemum flower wase+75% paddy straw
10. 25% Onion waste+75% paddy straw

Spawning, Spawn run and Cropping

The different substrates combinations were filled to polythene bag of size 30 cm X 45 cm of 150 gauge thickness. Hundred gram spawn of *Hypsozygous ulmarius* was used for filling of different combination of substrate and layer spawning was done to bags, leaving 5 to 7 cm gap at the top and bag was closed tightly with a rubber band. Three small holes were made at the bottom of the bag and 6 holes all over the bag for drainage and air exchange respectively. These bags were kept on racks in mushroom growing rooms. In which humidity of 70-80 % was maintained in cropping room. After complete growth of mycelium on the substrate, these bags were kept 15 cm apart on racks. Relative humidity was maintained at 70 % by spraying water in the rooms. Watering on the bags was done at regular intervals to maintain moisture on buds. Buds developed into fruiting body. Finally, the fruiting bodies, before they shed the Basidiospores, were harvested and weight was recorded and average yield per bag was calculated. Bio-efficiency of *Hypsozygous ulmarius* mushroom was calculated by using the formula as fallows (Chang and Miles, 1989).

$$\text{Bio efficiency (\%)} = \frac{\text{Fresh weight of mushrooms}}{\text{Dry weight of substrate}} \times 100$$

Chemical analysis of substrates before and after growing mushroom

Nitrogen content of the substrates, *viz.*, Vegetable wastes such as Cabbage waste, Cauliflower waste, Onion wastes and flower wastes such as, Rose leaves waste, Chrysanthemum flower wastes and paddy straw were estimated by micro Kjeldhal method (Black, 1979).

RESULTS AND DISCUSSION

The preliminary test was done to test the suitability of different vegetable wastes and flower waste as substrates for *Hypsozygus ulmarius* mushroom production. Mushroom fungi growth was measured as weight loss in substrate.

Vegetable wastes

Effect of Cabbage waste on *Hypsozygus ulmarius*

Results on the effect of cabbage waste on growth of mushroom fungi are given in Table 1. In cabbage waste, the maximum weight loss (4.17g) was recorded in (25 % Cabbage waste + 75% paddy straw) substrate and the maximum weight loss showed treatment was selected for further studies.

Effect of Cauliflower waste on *Hypsozygus ulmarius*

In Cauliflower waste, the maximum weight (4.07g) loss was recorded in (25% Cauliflower waste + 75 % Paddy straw), and the minimum weight loss was observed in Cauliflower waste alone (1.10 g) and is given in Table 1.

Effect of Onion waste on *Hypsozygus ulmarius*

The effects of Onion waste on growth of mushroom fungi are given in Table 1. In Onion waste, the maximum weight loss (4.33g) was recorded in (25 % Onion waste + 75% paddy straw) substrate.

Flower wastes

Effect of Rose leaves waste on *Hypsozygus ulmarius*

In rose leaves waste, the maximum weight loss (5.1 g) was recorded in (25 % Rose leave waste + 75 % paddy straw) substrate. And all other three combinations showed their best by reducing substrate weight loss given in Table 1. Hence all the four combinations were selected for bag method cultivation of mushrooms.

Effect of Chrysanthemum flower waste on *Hypsozygus ulmarius*

The effect of Chrysanthemum flower waste on growth of mushroom fungi are given in Table 1. In Chrysanthemum flower waste, the maximum weight (4.8g) loss was recorded in (25 % Chrysanthemum flower waste + 75 % paddy straw) substrate.

Significantly highest weight loss in all substrates is due to growth of mushroom fungus

Table 1. Effect of Vegetable and Floriculture wastes on growth of *Hypsozygus ulmarius*

Substrate / substrate mix	Weight loss (g)
Cabbage waste	
Cabbage waste alone	1.03
75% Cabbage waste + 25% paddy straw	1.40
50% Cabbage waste + 50% paddy straw	1.83
25% Cabbage waste + 75% paddy straw	4.17
Cauliflower waste	
Cauliflower waste alone	1.10
75% Cauliflower waste + 25% paddy straw	1.37
50% Cauliflower waste + 50% paddy straw	1.63
25% Cauliflower waste + 75% paddy straw	4.07
Onion waste	
Onion waste alone	1.27
75% Onion waste + 25% paddy straw	1.43
50% Onion waste + 50% paddy straw	1.40
25% Onion waste + 75% paddy straw	4.27
Rose leaves waste	
Rose leaves waste alone	4.23
75% Rose leaves waste + 25% paddy straw	4.50
50% Rose leaves waste + 50% paddy straw	4.63
25% Rose leaves waste + 75% paddy straw	5.07
Chrysanthemum waste	
Chrysanthemum waste alone	1.20
75% Chrysanthemum waste + 25% paddy straw	1.37
50% Chrysanthemum waste + 50% paddy straw	4.60
25% Chrysanthemum waste + 75% paddy straw	4.80

Table 2. Effect of different substrate on yield and bioefficiency of mushroom (*Hypsozygous ulmarius*)

Substrate combinations	Yield (g/bag)	Bioefficiency (%)
Paddy straw	625.33[b]	125.0[b]
Rose leaves waste	546.00[f]	109.2d[e]
75% Rose leaves waste + 25% paddy straw	551.67[e]	110.33[d]
50% Rose leaves waste + 50% paddy straw	575.33[d]	115.06[c]
25% Rose leaves waste +75% paddy straw	603.67[c]	120.73[b]
25% Cabbage waste + 75% paddy straw	540.33[g]	108.06[e]
25% Cauliflower waste + 75% paddy straw	520.0[h]	86[g]
25% Chrysanthemum flower waste + 75% paddy straw	641.33[a]	128.26[a]
50% Chrysanthemum flower waste + 50% paddy straw	573.67[d]	114.73[c]
25% Onion waste + 75% paddy straw	506.67[i]	88[f]
SEm±	3.00	0.60
CD at 5 %	8.86	1.77

Paddy straw

25% Chrysanthemum flower waste+ 75% paddy straw

Rose leaves waste

75% Rose leaves waste +25% paddy Straw

50% Rose leaves waste +50% paddy straw

25% Rose leaves waste +75% paddy straw

25% Onion waste+75% Paddy straw

25% Cabbage waste +75% paddy straw

50% Chrysanthemum flower waste +50% paddy straw

25% cauliflower waste +75% straw paddy straw

Plate 1. Mushroom (*Hypsozygous ulmarius*) growth on different substrates

which degrades the substrate. Substrate combination influences growth of mushroom fungi in confirmation with the findings of Mohan and Vijaykumar (2011).

Effect of different substrate on yield and bio-efficiency of *Hypsozygous ulmarius*

The yield and bio-efficiency of *Hypsozygous ulmarius* mushroom on different substrate is presented in the Table 2. The maximum mushroom (*Hypsozygous ulmarius*) yield (641.33g/bag) was recorded in (25 % Chrysanthemum flower waste + 75 % paddy straw) substrate followed by (625.33g/bag) in paddy straw alone and (603.67g/bag) in (25 % Rose leaves waste + 75 % paddy straw) substrate. The minimum (506.67g/bag) yield was recorded in (25 % Onion waste + 75 % paddy straw) substrate. Similarly, maximum bio efficiency (128.26%) was recorded in (25 % Chrysanthemum flower waste + 75 % paddy straw) substrate followed by (125.0%) Paddy straw alone and (120.7%) in (25 % Rose leaves waste + 75 % paddy straw) substrate. The minimum bio efficiency (88 %) was recorded in (25 % Onion waste + 75 % paddy straw) substrate (Plate 1). In different substrates the mushroom yield varies. This could be due to the nature and nutrient content of the substrate by Desai and Shetty (1982).

Similar trend in results was also reported by various authors. Balakrishna (1995) reported that among sunflower plant waste, paddy straw

Table 3. Effect of mushroom (*Hypsozygous ulmarius)* growth on nitrogen content of substrate

Substrate combinations	N content (%)	
	Before growth	After growth
Paddy straw	0.54	1.15
Rose leaves waste	1.01	1.14
75%Rose leaves waste + 25% paddy straw	1.37	1.41
50%Rose leaves waste + 50% paddy straw	1.14	1.32
25%Rose leaves waste + 75% paddy straw	1.12	1.30
25%Cabbage waste + 75% paddy straw	0.96	1.49
25%Cauliflower waste + 75% paddy straw	1.30	1.37
25% Chrysanthemum flower waste + 75% paddy straw	1.05	1.75
50% Chrysanthemum flower waste + 50% paddy straw	1.34	1.43

Note: Values are mean of three replications

and cotton plant waste, the cotton plant waste gave the highest yield and bio efficiency when *Pleurotus sajor – caju* was grown.

Effect of mushroom (*Hypsozygous ulmarius)* growth on Nitrogen content of substrate.

Nitrogen content of substrates before and after the growth of *Hypsozygous ulmarius* is presented in the Table 3.

Before growing *Hypsozygous ulmarius* mushroom, maximum nitrogen content (1.37%) was observed in (75 % Rose leaves waste + 25 % paddy straw) substrate followed by (1.34 %) in (50 % Chrysanthemum flower waste + 50 % paddy straw) substrate and (1.30%) in (25 % Cauliflower waste + 75 % paddy straw) .The minimum nitrogen content (0.54%) was recorded in paddy straw alone.

After growing mushroom maximum increase in nitrogen content (0.70%) was observed in spent (25 % Chrysanthemum flower waste + 75 % paddy straw) substrate followed by (0.61%) in spent paddy straw alone and (0.53%) in (25 % Cabbage waste + 75 % paddy straw) substrate. The minimum nitrogen content (0.07%) was recorded in spent (25 % Cauliflower waste + 75 % paddy straw) substrate. Similar results were noticed by Satyanarana *et al*. (1984) and Gupta *et al.* (2004).

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