NEW CULTIVATION TECHNOLOGY FOR PADDY STRAW MUSHROOM (*Volvariella volvacea*)

PALITHA RAJAPAKSE
Regional Agricultural Research and Development Centre,
Department of Agriculture,
Makandura, Gonawila (NWP)
Sri Lanka
palitha2@hotmail.com

ABSTRACT

Paddy straw mushroom (*Volvariella volvacea*) is a world famous edible mushroom variety that has high demand due to its deliciousness and nutritive value. Although there is a big demand in Sri Lanka, there was no proper method of cultivation since it needs high temperature (33-35 $^{\circ}$C) and 85-90 % relative humidity in the growing environment.

Therefore, an experiment was designed at Regional Agricultural Research and Development Centre, Department of Agriculture – Makandura during the year 2009 to develop an indoor (poly house) cultivation method that would maintain above environment requirements. The outdoor method was compared with an indoor method in RCBD. Paddy straw and cotton waste were used separately as main composting materials.

The yield of indoor cultivation method of cotton waste and paddy straw were 5.38 kg/m^2 and 4.71 kg/m^2 respectively, while yields for the same parameters in outdoor cultivation method were 1.79 kg/m^2 and 1.73 kg/m^2. There were significant yield differences between indoor and outdoor method in both composting materials.

It is concluded that the indoor method can be successfully used to cultivate paddy straw mushroom profitably in Sri Lanka.

Key words: Indoor cultivation; Paddy straw mushroom

INTRODUCTION

The mushroom defined as “a macro fungus with a distinctive fruiting body, large enough to be seen with the naked eye and to be picked up by hand” (Chang and Miles, 1992). In a narrow sense, the world mushroom also refers only to the fruit body. Unlike green plants, mushrooms are heterotrophs. Not having chlorophyll, they cannot generate nutrients by photosynthesis, but take nutrients from outer sources. Fungi cultivation develops with the advance of science and technology. In history, human beings only hunted and collected wild mushrooms at the beginning. After a long period they observed and learned how to cultivate fungi. Presently, mushrooms have become popular throughout the world since they have wonderful food and medicinal values. The local demand for mushrooms is also steadily increasing [2].

Population increases are creating an alarming situation in the food supply in Sri Lanka. Malnutrition in terms of 'protein' deficiency is becoming a major hazard in developing countries. Exploiting non-traditional food resources can make a substantial breakthrough to meet the serious food deficit. In this circumstance, popularizing mushroom as part and parcel of every day food is

of paramount importance. No food is so wrapped in mystery as mushroom. It is amazing to see tiny pin heads on a composting medium growing into buttons rich in protein, vitamins and minerals. Not only because that mushrooms have a marvelous medicinal values. Mushroom is a protein source without cholesterol. On the other hand, they have an ability to maintain the blood cholesterol at the optimum level. In addition to that there are some other medicinal values that also can be found in mushrooms [3].

Mushroom farming is becoming successful because of its very low inputs. In Sri Lanka, mushroom cultivation is highly rewarding because of the prevailing climatic conditions. The technology profitably is located in areas where land is limiting factor and agricultural residues are abundantly available.

Although the history of the world mushroom cultivation goes back to thousands years the commercial mushroom cultivation in Sri Lanka was started in the middle of 1980's with the cultivation of Oyster (*Pleurotus ostreatus*). However, compared to other countries technological improvements of mushroom cultivation are not satisfactory in Sri Lanka. Oyster, Paddy straw (*Volvariella volvacea*) and Milky (*Calocybe indica*) mushrooms are some of the high potential cultivable mushrooms in Sri Lanka since they can grow well under tropical and subtropical condition.

Paddy straw mushroom is a popular variety among people because of its distinct flavor, pleasant tastes, higher protein content and shorter cropping duration compared to other cultivated mushrooms. Presently, Sri Lanka imports canned paddy straw mushrooms from China and this mushroom is available in most of the supermarkets. It originally grows in rice straw stack in tropical and sub tropical zones that have high temperature and a rainy climate. Chinese growers developed its cultivation more than 300 years ago. Therefore, it was named "Chinese Mushroom" (Zhanxi and Zhanhua, 2000). *Volvariella* requires a high temperature (35 ± 2 ºC) for better and early hyphal growth. Also 32±2 ºC and 80-90 % RH (relative humidity) are needed for the formation of fruiting bodies [4]. The yield of straw mushroom depends on the cultivation methods and compost (growing) medium. Prior to 1970, rice straw was practically the only material used for preparing the growing medium for *Volvariella volvacea.* Straw alone is not sufficient as a composting material as it contains a little quantity nutrients and has a slow rate of decomposition [5]. Therefore, straw mushrooms presently are grown in some other materials such as cotton waste, sugar cane bagasse, dried banana leaves, oil farm bunch waste etc [4]. However, paddy straw is the material freely available in Sri Lanka and therefore, this cultivation is ideal in rural area where paddy straw is abundant after each paddy harvest and it can provide additional income.

An outdoor cultivation method was introduced for paddy straw mushroom by the Department of Agriculture in the middle of the 1980's. However, farmers are reluctant to produce mushrooms using this method because of the uncertainty of production with irregular and low yield, due to difficulties to control environment factors such as temperature, RH and pest problems. Unlike the oyster mushroom, the straw mushroom is highly sensitive to the climatic conditions and their fluctuation. To overcome these problems, indoor cultivation method under controlled environment may be an effective alternative [6].

Therefore, an experiment was conducted to identify the suitability of an indoor cultivation method for paddy straw mushroom under Sri Lankan conditions, using locally available low cost raw materials.

MATERIALS AND METHODS

The experiment was conducted at the Regional Agricultural Research and Development Centre, Makandura, Sri Lanka from January to July 2009. The site belongs to Law Country Intermediate Zone of Sri Lanka where the average day and night temperatures are 31.9 ºC and 22.4 ºC respectively with an annual rainfall of more than 1,400 mm. Two types of growing media were prepared using paddy straw and cotton waste. Both growing media were tested in indoor and outdoor (existing method) systems. Cost was also calculated for each treatment.

Indoor cultivation. . Composts (growing media) were prepared using paddy straw and cotton waste. Paddy straw composting was done by soaking dried paddy straw (50 kg) in a 2% lime solution for four hours and excess water was allowed to drain. Paddy straw was spread on a clean cement flow (platform) as a thin layer. Urea (1%), gypsum (5%), measured on dry weight of paddy straw were evenly spread on the wetted straw and mixed well to prepare compost medium. A heap was built using the compost medium and it was covered by a black polythene tarp having 300 gauge. The heap was turned twice in two days intervals. Therefore, compost was ready to use after six days. The method of composting of cotton waste was similar to paddy straw and the excess water in soaked cotton waste was removed manually by squeezing.

A barrel-roof-type polythene house (length – 8 m, width – 3 m, height – 3m) was constructed using transparent polythene having 300 gauge. Pre-prepared compost layer was packed (15 cm thick) into a wooden frame (90 x 30 x 30 cm) and surface of the compost was inoculated with 125 g of spawn. The remaining 15 cm of the wooden frame was filled with same amount of compost and another 125 g of spawn was applied on the surface. Then the wooden frame was removed by pulling upwards remaining a block of inoculated compost. The same method was used for both paddy straw and cotton waste compost. The blocks were prepared keeping a 30 cm space between each bed. Finally, the blocks were covered with black polythene (300 gauge) for five days and afterwards removed for fruiting.

Outdoor cultivation. The same composting and block preparation methods were practiced for the outdoor cultivation method. However, the blocks were kept in an open area close to the polyhouse. The blocks were covered with black polythene (300 gauge) for five days as was done also in the outdoor method and afterwards removed for fruiting.

The experiment was arranged in a RCBD (Randomize Complete Block Design) with three replicates and treatments were as follows. Five beds (blocks) were in each treatment.

Treatment 1 – Paddy straw compost in poly house
Treatment 2 - Cotton waste compost in poly house
Treatment 3- Paddy straw method in outdoor (control)
Treatment 4– Cotton waste compost in outdoor

Mushrooms were harvested at the egg stage before opening in the morning and afternoon. Beds were sprayed with sufficient water twice a day (8 a.m. and 4 p.m.). Minimum and maximum temperatures inside the poly house and open area (outdoor) were recorded and bed temperatures (just below the surface) and RH were also recorded daily at 3 p.m. after removing the black polythene for fruiting. Total number of mushrooms, number of marketable mushrooms, total weight of mushrooms, and weight of marketable mushrooms were recorded daily.

RESULTS AND DISCUSSION

Temperature and relative humidity. Maximum and minimum temperatures inside the polythene house were high compared to the open area (Fig. 1). Similarly, relative humidity was at fairly suitable level for paddy straw mushroom throughout the fruiting period, (Table 1).

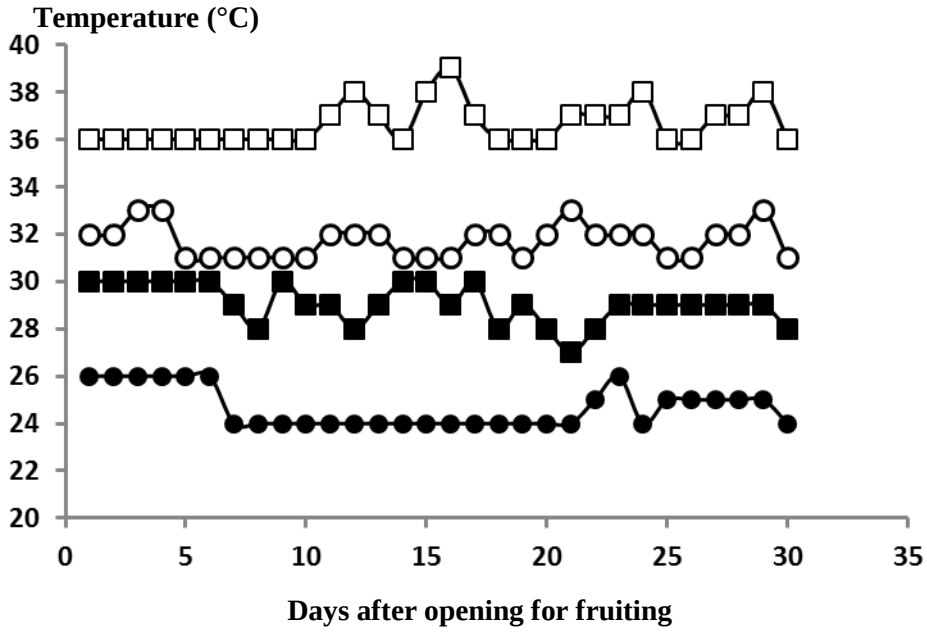

Figure 1: Maximum and minimum air temperatures.
■: indoor, minimal temperature, □: indoor, maximal temperature, ●: outdoor, minimal temperature, ○: outdoor maximal temperature

Table 1: Average minimum and maximum temperature and relative humidity observed during the cultivation period.

Item	Indoor	Outdoor
Maximum temperature	36.53	31.53
Minimum temperature	28.46	23.86
Relative humidity	84%	65%

Bed (block) temperature. Bed temperatures inside the polythene house were high compare to the open area. Increase of the temperature of the beds after the watering was slow in open area compare to the polythene house (Fig. 2).

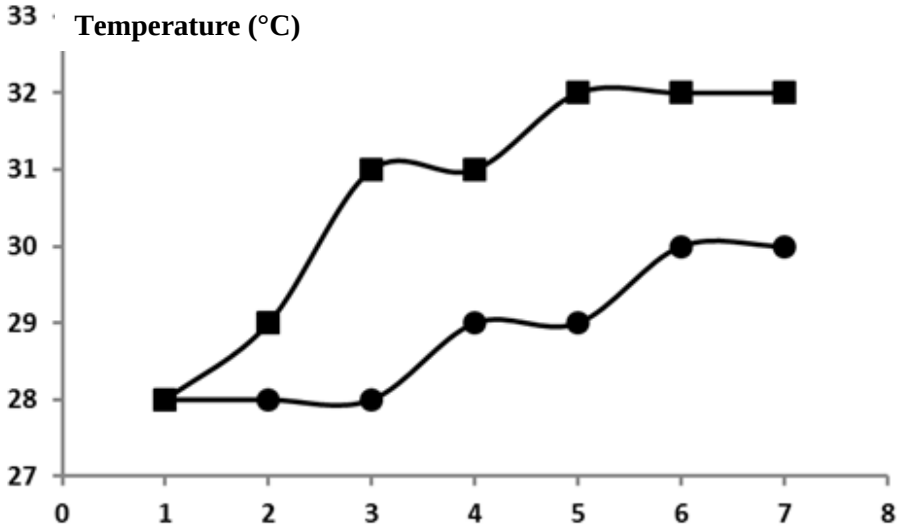

Figure 2: Bed (block) temperature after watering
■: indoor, ●: outdoor

Yield. A significantly higher yield (5.38 kg/m^2) was observed in cotton waste medium in indoor method (T-2) while the lowest value (1.73 kg/m^2 block) was observed from paddy straw in outdoor method (T-3) (Table 2).

Table 2. Fruit bodies (egg stage mushroom) weight of each treatments in (kg/m^2)

Treatments	R-1	R-2	R-3	R-4	Means
T-1	4.8	4.6	4.7	4.7	4.71 [a]
T-2	5.3	5.9	5.1	5.2	5.38 [a]
T-3	1.8	2.1	1.6	1.4	1.73 [b]
T-4	1.9	1.7	1.8	1.7	1.79 [b]

Means followed by the same letters in each treatment are not significant at 5% probability level

Significant differences in the number of fresh mushrooms were observed among four treatments at 5% probability level. The highest number of fruits (49.7 kg/m^2) was recorded in cotton waste medium in indoor method while the lowest (17 kg/m^2) was given by the paddy straw compost in out door method. (Table 03)

Table 3. Number of fresh mushroom harvested per m^2

Treatments	R-1	R-2	R-3	R-4	Means
T-1	48	52	45	31	44.0 [a]
T-2	46	54	50	49	49.7 [a]
T-3	17	14	10	27	17.0 [b]
T-4	20	13	14	13	15.0 [b]

Means followed by the same letters in each treatment are not significant at 5% probability level

Economical balance. The study reveals that the indoor cultivation method with cotton waste compost substrate gives the highest yield and indoor cultivation method with paddy straw compost also resulted higher yield compared to the existing outdoor cultivation method. But, highest benefit:cost ratio was observed with the paddy straw in indoor method since additional labor cost needed to prepare the cotton waste medium (Table 4).

Table 04 Cost of different treatments and income related to the yields

Treatments	Material cost in Rs	Labor cost in RS	Depreciation value of poly house in Rs	Total cost in Rs	Income in Rs	Economical balance : income/costs
T-1	3500	5000	2000	10 500	29 437	2.80
T-2	4500	6000	2000	12 500	33 625	2.69
T-3	3500	5000	0	8 500	10 812	1.27
T-4	4500	6000	0	10 500	11 187	1.06

- Labour charges 500 Rs / day
- Two years warranty for the growing house
- Price of 01 kg of fresh mushroom – 250 Rs
- 115 Rs equal to one USD

The poly house was able to maintain day temperature around 36 °C, relative humidity at 84% and provided shade needed for mushroom production during the experimental period giving ideal conditions for straw mushroom cultivation. Outdoor cultivation does not provide the necessary environmental controls as indoor cultivation method. Requirement of the additional initial cost to construct growing house is the main drawback of indoor cultivation method.

CONCLUSION

Indoor cultivation method can be used to cultivate paddy straw mushroom profitably in Sri Lanka using both paddy straw and cotton waste growing media.

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