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# Potential Exploitation of Refuse Tea as an Alternative Medium in Mushroom Cultivation

K.H. Rupasingha and K.A. Nandasena[1]

Postgraduate Institute of Agriculture
University of Peradeniya
Sri Lanka

***ABSTRACT.*** *'Refuse tea' is a waste produced during the manufacture of tea. In Sri Lanka, about 4-6% of the total product of made tea is Refuse Tea. Finding a remedy for this refuse tea problem is very important. Mushrooms can be cultivated on a variety of substrates. Oyster mushroom can be grown indoors on sterilized agricultural residues. The objective of the present study was to determine the suitability of refuse tea as a media for Oyster mushroom cultivation.*

*A study was conducted at Wedamulle estate, Nuwara Eliya. Experimental design was Complete Randomized Design. Six different substrates were prepared by mixing fresh refuse tea, compost refuse tea and saw dust in 100 and 50 to 50% proportions. There were 20 replicates in each substrate. The general procedure for mushroom cultivation was followed and fresh weights of the yield were recorded. A qualitative analysis was done and a statistical analysis of average fresh weights and their comparison was done using SAS, by the Dunnett test and Orthogonal Comparison.*

*All the substrates, which contain fresh refuse tea in 100 or 50%, did not give a significant yield. All other substrates gave significant yield, but still saw dust showed the best performance. Compost refuse tea also gave a higher yield, but comparatively lower than saw dust. According to the results, it can be concluded that the compost refuse tea is suitable to grow mushrooms. However, further studies are needed to improve the quality of the substrate with refuse tea that can be used as an alternative media for mushroom cultivation. This will be a good disposal system for refuse tea and a remedy for the refuse tea problem in Sri Lanka.*

## INTRODUCTION

Tea is the most important plantation crop in Sri Lanka, which plays a vital role in relation to the economical, environmental and social sustainability in Sri Lanka.

'Refuse tea' is a wastage during the course of manufacture of tea. According to the Tea Control Act No. 51 of 1957, the definition for refuse tea, 'Sweepings, red leafs, fluff, mature stalk, or any other product (not being made tea) obtained in the process of manufacture of tea'. About 4-6% the total product of made tea is refuse tea (Zoysa, 2005).

[1] Department of Soil Science, Faculty of Agriculture, University of Peradeniya, Peradeniya, Sri Lanka.

The amount of refuse tea produced depends on the method used in manufacturing of tea. Sometimes under the conditions where unsuitable leaves are available for manufacturing such as coarse plucking or under withered or over withered leaf are available, the percentage of refuse tea could increased even to a level of 8-10% (Zoysa, 2005). Yet, no studies have been carried out to identify a better use of this waste material other than composting. There is a rising illegal market for refuse tea and it has become a challenge for goodwill of the Sri Lankan tea market (Keegel, 1983).

Mushrooms are the fruiting bodies of certain types of fungi. Many of these have unique abilities to break down wood, leaves and other organic matter and recycle nutrients back in to the system (Stamets and Chilton, 1988). Mushrooms can form the basis of viable small business. This is an agricultural crop which does not need any cultivable land. Within the context of increasing population and decreasing cropping land, mushroom is a gift to those who are landless, unemployed and home gardeners. Mushroom cultivation is a new idea in many countries, but the value of the product and the relatively low investment make this a potentially profitable business (Bayer and Wilkinson, 2005).

There are many hundreds of different types of edible mushrooms available. The most common types that are specially cultivated include, Oyster (*Pleurotus* spp.), Straw (*Volvariella* spp.), Button (*Agaricus* spp.), *Pleurotus* spp., and *Volvariella* spp. are usually based on agricultural residues such as paddy straw, saw dust, bagasses, coir dust, cotton waste, *etc*.

Tea estates can make use of compost refuse tea as an additional income source. Mushrooms can be used as a substitute for protein sources in the tea estate sector. By-product of mushroom cultivation can be used as compost in tea plantations. Therefore, this study was carried out to find whether there is any possibility to use refuses tea as an alternative medium, and to ascertain whether there is a potential benefit in using refuse tea for mushroom cultivation.

## MATERIALS AND METHODS

The tea factory selected for this investigation is located in the Wedamulla estate, Ramboda in the Nuwara Eliya district. Oyster mushroom can be grown indoors on sterilized agricultural residues (Chang, 1989) and was selected as the mushroom variety for cultivation.

The research design is Complete Randomized Design (CRD). The number of treatments was 6. The number of replicates from each treatment was 20 and the number of total bags prepared therefore for the investigation was, $6 \times 20 = 120$. Three different materials were taken for the media preparation. They were fresh refuse tea, compost refuse tea and saw dust. Saw dust was taken as the control media. All three materials were taken in 100% form as well as in 50% form. The preparation of treatments with the combination of different percentages of substrates is shown in Table 1.

**Table 1. Media used for the cultivation of Oyster mushroom.**

| Treatment | Fresh refuse tea (%) | Compost refuse tea (%) | Saw dust (%) |
|---|---|---|---|
| T1* | 0 | 0 | 100 |
| T2 | 0 | 100 | 0 |
| T3 | 0 | 50 | 50 |
| T4 | 100 | 0 | 0 |
| T5 | 50 | 50 | 0 |
| T6 | 50 | 0 | 50 |

**Note:** * Control.

Steps of spawning the substrates are; composting the Oyster mushroom media, preparation of media and bagging and sterilization of substrates, inoculating the substrate with spawning, and incubating the spawned substrate bags in a cropping hut.

For composting, a 20 kg of refuse tea was wetted till there was excess of $H_2O$, but without over application to generate the runoff. The wetted refuse tea was heaped into a triangular shape (like a pyramid) of 1 m height. Fermentation was done under a shelter. After 1 week of fermentation, $CaCO_3$ and water were added and the heap was turned inside out. Fermentation was continued for another 3 weeks, while adding water and turning the pile inside out in every week (Auetragul, 1986). After 4 weeks, the compost was ready to be used.

For each substrate, media preparation was done separately. All the items ($CaCO_3$, red and white rice bran) were mixed together except $MgSO_4$ and $H_2O$. Subsequently the dissolved $MgSO_4$ in $H_2O$ was mixed thoroughly with previously mixed materials. Heat resistant polypropylene plastic bags (17.5 cm × 2.5 cm) were used to pack the substrate. The bottom edges of the plastic bags were folded to make a platform. About 1 kg of the mixture was placed in each plastic bag. The material in the bag was compressed by folding the mouth of the bag and by pressing. A plastic tube was inserted and tied with a rubber band in each bag by pulling and folding the mouth through the tube. The mouths of each bag were closed with a cotton plug and covered with a piece of paper (Auetragul, 1986).

For sterilization, "Country-Style" steamer was made by using a fertilizer drum of 200 l capacity. The rim and lid of the drum were leveled in order to fit them together snugly to prevent the escape of steam. An old scooter inner tube was used to cover the rim of the drum, a hole was punched using a 7.5 cm nail in the lid to release the pressure. A rack of 15.0 cm height was made to place the bags to be steamed and filled with water up to 12.5 cm from the bottom of the barrel to prevent bags getting wet due to boiling water (Auetragul, 1986).

Water was added in to the drum up to a level of 2.5 cm. Polypropylene bags filled with culture material were places inside the drum on the rack. Brought the water to boil.

Water boiling was ensured when the steam was shoot out regularly through the hole on the lid. The culture material was steamed for 1 h from the time the water started to boil. Then the bags were removed from the drum and left them cooled at room temperature for 12-14 h (Auetragul, 1986).

All the culture material bags were taken to a clean room and surgical spirit was slightly sprayed over the cotton plugs of the bags. An activated grain spawn packet was shaken to loosen the grains with mycelium. With cleaned hands, the plastic bag cotton plug was removed and 15-20 grains (1 tea spoon) of spawn were added to each bag.

Mycelium grows best in the dark (Vedder, 1978). The cropping hut was built using gunny bags for walls, and burned engine oil was applied all over the walls. The hut contains only one door for entrance and the door was kept closed. The best temperature for mycelium growing is 24-26$^{0}$C (Auetragul, 1986). The Oyster mushroom mycelium took about 20-25 days to complete growing over the culture material in the bag.

### Data collection

Treatments 4, 5 and 6 (T4, T5 and T6) did not show any progress on mycelium growth over the culture material, therefore those three culture materials were eliminated from the experiment. After eliminating T4, T5 and T6, the number of bags remained for harvesting was 60. A specific time range was taken for harvesting daily, 10.00 to 10.30 a.m. A uniform size for the fruiting body were taken for harvesting, and the diameter was approximately 5.0-7.5 cm. Mushroom clusters from each bag were harvested at once. Mushroom harvesting was done continuously and the total mushroom harvesting time period was 12 weeks (3 months).

Fresh weights of the harvested mushrooms were recorded daily for all 20 bags from each treatment. Humidity and the temperature inside the cropping hut were recorded. pH of the all used culture materials was also measured.

### Method of analysis

A qualitative analysis as well as a quantitative analysis were done for the data collected. Quantitative analysis was done using SAS. Anova, Dunnet test and Orthogonal comparison were carried out for this analysis. Qualitative analysis was done using Microsoft Excel.

## RESULTS AND DISCUSSION

### Quantitative analysis

The probability value of Table 2 shows that the treatment difference is significant at 5% level. The control substrate T1 and the minimum mean yield difference is given in between the T1 and T3 (Table 2). Therefore, T3 (50% compost refuse tea and 50% saw dust) is the second best next to the control substrate containing 100% saw dust. The maximum yield difference is given in between T1 and T2 (100% compost refuse tea).

**Table 2. Comparison of the mean yields of the treatments with control treatment.**

| Treatment Comparison | Difference between mean yield |
|---|---|
| T3 - T1 | - 906.60* |
| T2 - T1 | -2943.90* |

**Note:** $R^2$ = 0.98; Probability = 0.0001.

A mean separation was done using the LSD method. The mean separation of the different treatments shows that the highest mean yield is given by the T1, 100% saw dust and the second highest is given by the T3, 50% saw dust and 50% compost refuse tea. The lowest mean yield has been recorded from the T2, 100% compost refuse tea (Table 3).

**Table 3. Mean separation of different treatments.**

| Treatment | Substrate composition | | | Mean yield (g) |
|---|---|---|---|---|
| | a | b | c | |
| $T_1$ | 0 | 0 | 100 | 5156.8 |
| $T_2$ | 0 | 100 | 0 | 2212.9 |
| $T_3$ | 0 | 50 | 50 | 4250.2 |

**Note: a** - Fresh refuse tea; **b** - Compost refuse tea; **c** - Saw dust.

## Qualitative analysis

When compared all three treatments for yield variability with time, T1 is shows the best performance (Fig. 1). As shown in Figure 1, in all three treatments, yield increases to the maximum within 3 to 4 weeks from harvested started. The yield of T3 is much closer to T1 and the there is a fairly high yield difference in between T1 and T2. That means, the yield difference between T1 and T3 is lower than the difference between T2 and T3.

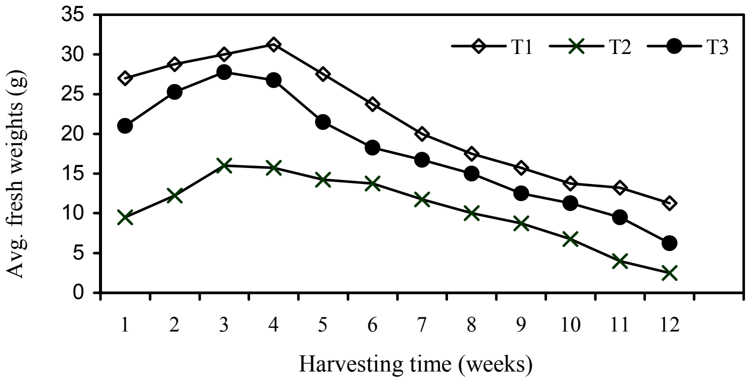


**Fig. 1. Comparison of Average fresh weights of different treatments for yield variability with time.**

## CONCLUSIONS

Fresh refuse tea, composition of 100 or 50% cannot be used as an alternative media for mushroom cultivation. Compost refuse tea can be used as an alternative media for mushroom cultivation. The mixture of 50% compost refuse tea with 50% saw dust gives higher yield than 100% compost refuse tea. When comparing with other substrates, saw dust gave the highest yield.

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## REFERANCES

Auetragul, A. (1986). Instruction for Mushroom Growing, Forestry Development, Regional Office for Asia Pacific, FAO, Bangkok, Thailand.

Bayer, D.M. and Wilkinson, V.L. (2002). Spawn, spawning and spawn growth. Mushroom Science and Technology, Pen State Department of Plant Pathology.

Chang, S.T. (1989). Bioconversion of agricultural lignocellulosic waste through the cultivation of edible mushrooms. Mushroom J. for the Tropics. Vol. 9.

Keegel, E.L. (1983). Introduction to the practice of tea manufacture. *In*: Monographs on Tea Production in Ceylon, No. 04, second edition. Tea Manufacture in Sri Lanka, Aitken Spence & Co., Ltd, Colombo.

Stamets, P. and Chilton, J.S. (1988). A practical guide to growing mushrooms at home. The Mushroom Cultivators, Agarikon Press, Olympia, Washington.

Tea Control Act No. 51. (1957). Control of the position, sale and purchase of made tea, green tea leaves and refuse tea. Chapter 254, Part 4.

Vedder, P.J.C. (1978). Modern Mushroom Growing, Pitman Press, Educaboek,.Culemborg, Netherland.

Zoysa, A.K.N. (2005). Composting of tea waste. A method to produce compost with high content of Humic Substances. *In*: Proceedings of the 211$^{th}$ meeting of the experiment and extension forum, 29 January 2005, Soil and Plant Nutrition Division, Tea Research Institute of Sri Lanka.