Biosciences, Biotechnology Research Asia Vol. **4**(2), 489-494 (2007)

Performance of tea waste as a peat alternative in casing materials for bottom mushroom (*Agaricus bisporus* (L.) Sing.) cultivation

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(Received: September 28, 2007; Accepted: November 03, 2007)

ABSTRACT

In this study we describe the principal physical and chemical characteristics of different mixtures tea production waste and peat (100% tea waste, 75% tea waste + 25% peat, 50% tea waste + 50% peat, 25% tea waste + 75% peat, and 100% peat as control) as casing material in mushroom (*Agaricus bisporus* (L.) Sing.) cultivation. Of possible tea production waste mixture to the traditionally used peat, the treatment 25% tea waste + 75% peat is confirmed as the best because of its highest yield and number of mushrooms. Our results showed also that high EC, high organic matter content and low pH in casing material (100% tea production waste and 75% tea production waste + 25% peat) decreased the total yield but increased dry matter in mushrooms. High iron contents in casing mixtures gave a significant positive correlation with total yield. However a mixture of tea production waste and peat is a practicable casing material for the North regions of Iran, where the peat casing is more expensive and hard to find when compared with the tea production waste.

Key words: *Agaricus bisporus*, casing soil, tea waste, peat, yield

INTRODUCTION

Compost which is completely colonized by mycelium will not on its own produce mushrooms. It is therefore necessary to modify the compost to initiate fructification. The casing layer is the material used as a top covering of the compost and it is here that the ecological modification that involves the change from the vegetative to the reproductive growth phase takes place, and where fructification occurs. Peat constitutes the most widely used material as casing for mushroom cultivation throughout the world. Its water-holding capacity and structural properties are widely accepted as ideal for the purposes of casing (Yeo and Hayes, 1979). However problems associated with its use, especially as its availability, the depletion of reserves and the alteration of ecosystems, have led to the search for alternative materials (Price, 1991).

The required physical and chemical properties of a good casing should be high porosity and water holding capacity (WHC), 7.2- 8.2 pH, 2.5-3.5 % active lime, and 0.7-0.8 % total nitrogen (Couvy, 1974), low content of soluble inorganic and organic nutrients, and free of disease and pests (Gülser and Peksen, 2003). Optimum values for casing soil are as 180-200% WHC, 78% porosity, more than 12% airable capacity, 7.3-7.5 pH, 47% organic mater (OM), 1.22% total N and about 21:1 ratio of C: N (Gierzsynski, M., 1974). It seems that pH is of greater importance than had been believed, that ionexchange, as such, is of little or no importance, but gas porosity is the most important characteristic of casing (Ralph and Kurtznan, 1999).

Several different casing materials instead of peat have been examined by many investigators (Pardo et al., 2003a; Pardo et al., 2003b; Sharma et al., 1996; Noble and Gaze, 1995; Levenon et al., 1986). Locally available casing media is a very important factor to obtain a maximum and assured yield in the mushroom cultivation.

Mushroom cultivation has recently become very popular in North of Iran, but one of the most important problems in mushroom cultivation is to obtain a suitable casing material. Tea plants are commonly grown in the Northern Region of Iran. Therefore, there is much tea production waste in this region. This waste material might be reused as a mixture with peat as a new casing material in mushroom cultivation.

MATERIAL AND METHODS

Compost was supplied by Zarrin Shomal Mushroom Co. in Anzali, Iran. The spawn used in this study (strain 512), was supplied by Keshtpazhohane Damavand Co. in Karaj, Iran. Tea production waste was supplied from the Golestan tea processing Company in Lahijan, Iran.

Different volume proportions of tea production waste (contains dried straw and fiber of tea leaves after manufacturing process) and peat (T1= 100% tea waste, T2= 75% tea waste + 25% peat, T3= 50% tea waste + 50% peat, T4= 25% tea waste + 75% peat, and T5= 100% peat as control) as casing material in bottom mushroom cultivation was investigated in a completely randomized design by four replications. In order to adjust the pH level to neutral, gypsum was added to all the casing materials. To sterilize all the casing materials, 2% formalin was sprayed and aired after two days. Mushroom production used bags (35×40×20 cm), each containing 10 kg spawned compost. The bags were incubated at 23±2°C. After the spawn run was complete, casing was done as 4 cm in depth for each material (Peyvast and Askari Rabrary, 2003). The humidity in the cropping room maintained around 80-85%. Ventilation was provided to induce fruit body formation when the mycelium reached the surface of the casing layer. Mushroom yield obtain from 3 flushes and mushrooms graded in three size including large (more than 4 cm in diameter), medium (between 1.5 -4 cm in diameter) and small (smaller than 1.5 cm in diameter). Data were subjected to a one-way analysis of variance to test for Duncan's multiple range tests. All analyses were performed using SAS statistical package (SAS Institute, Inc., 1989).

Some physical and chemical properties of the casing materials were determined as follows: organic carbon (OC) and OM content, which was calculated through the differences between the dry matter and the ash content, were determined according to Kacar (1994); pH and EC in saturation extract by using 130 Conductronic pH meter (Conductronic S.A. Puebla, Pue, Mexico) and EC meter respectively (Black, 1965); total Ca, Mg and Fe content in ash using an atomic absorption spectrophotometer an P by spectrophotometer in 410 nm; Total N was determined in 0.1 g dry weight samples using the Kjeldhal method with concentrated H_2SO_4, K_2SO_4 and HgO to digest the sample (Kacar, 1994). To determine the water holding capacity (WHC), Casing material was dried for 24 h at 105^{0}C and then submerged in water and left for 12 h (Labuschagne et al., 1995). WHC was calculated from the following equation: WHC= (wet mass×100)/dry mass

RESULTS

Table 1 summarizes the physical properties of the materials studied (bulk density, particle real density, total porosity, WHC, solid particle and water percent). Table 2 shows the results obtained for the chemical parameters studied (pH, EC, Mg, organic C, organic matter, Fe, P, Ca and total N). Results showed that addition of tea production waste to the peat decreased bulk density, particle real density and percent of solid particle but increased porosity and WHC. Total N, organic matter and EC of the peat casing were lower than other casing materials. However Fe, Ca, Mg content and pH of peat casing was higher than other casing soils.

According to the main production parameters measured (number of mushroom produced, yield and dry matter content in mushrooms) 25% tea waste + 75% peat performed similarly to peat and obtained the highest yield by 23.42 kg m^2. Although highest amounts of tea waste (100 and 75%) in the casing soil increased dry matter in mushrooms, but decreased significantly the yield Table 3.

As showed in Fig. 1 and 2, EC and OM gave significant negative correlations with the cumulative yield (r= -0.9127** and -0.9001** respectively). Figures 3 and 4 showed that Fe content and pH gave significant positive correlations with the cumulative yield (r= +0.9141** and +0.9576** respectively).

DISCUSSION

According to the results, tea production waste as a mixture with peat can be used as a casing materials in mushroom cultivation. A mixture of tea waste with peat (25% tea waste+75% peat) provided a higher cumulative yield than other treatments. Therefore this mixture can be used profitably as a casing material in mushroom cultivation.

It has been noted that a good casing should have a high WHC and high porosity (Vijay et al., 1988). A positive relationship between porosity and mushroom yield was obtained by Rainey et al., (1986). In the present study, the highest cumulative yield was obtained from the 25% tea waste+75% peat which had a low WHC like peat alone.

Table 1: Physical properties of casing soil

Treatment	Bulk density ($g.cm^{-3}$)	Water content (%)	Particle real density($g.cm^{-3}$)	Porosity (%)	Solid particle (%)	WHC (%)
T1	0.81	66	1.99	59.1	40.9	261.3
T2	0.86	64	2.07	58.6	41.4	258.8
T3	0.93	60	2.11	55.7	44.3	239.5
T4	1.03	57	2.18	52.7	47.2	231.2
T5	1.11	57	2.21	43.8	50.2	225.4

Table 2: Chemical properties of casing soil

Treatment	N(%)	Ca(%)	P(%)	Mg(%)	Fe(mg kg^{-1})	OM(%)	OC(%)	EC(μS $/cm^2$)	PH
T1	0.934	11.9	0.150	0.40	1715	42.88	9.9	6.3	6.4
T2	0.924	11.6	0.150	0.54	1841	36.54	10	6.8	6.47
T3	0.902	10.1	0.140	0.70	2567	32.91	10.6	5.5	6.78
T4	0.788	9	0.100	0.81	2621	27.67	9.88	5.13	6.73
T5	0.656	8.6	0.140	1.08	3512	25.33	10.5	5.02	7.34

Table 3: Effect of different casing soil proportion on yield and dry matter content

Treatment	Yield ($kg\ m^{-2}$)	Dry matter (%)	No. of Mushrooms in m^{-2}			
			Large	Medium	Small	Total
T1	17.73 ^{c}	8.83 ^{a}	476 ^{a}	256 ^{c}	66.67 ^{ab}	799.33^{b}
T2	18.09 ^{c}	8.757 ^{a}	476 ^{a}	320 ^{bc}	36 ^{c}	832 ^{b}
T3	21.34^{b}	8.147 ^{b}	496 ^{a}	386.7 ^{ab}	40 ^{bc}	922.7 ^{ab}
T4	23.42 ^{a}	8.083 ^{b}	586.7 ^{a}	456 ^{a}	72 ^{a}	1112 ^{a}
T5	23.09 ^{a}	7.840 ^{b}	522.7 ^{a}	304 ^{bc}	34.7 ^{c}	861.3 ^{ab}

Mean separation within columns by Duncan multiple range test at P= 0.01

Labuschagne et al. (1995) mentioned that WHC of the different casing materials varied from 207% to 887%. Although they found a significant variation in the WHC of the different casing materials, but the yields were not significantly different. In another study by Noble and Gaze (1995), no relationships were found between the bulk density, porosity of a peat-based casing material and mushroom yield or dry matter content. These results indicate that having a high WHC in casing materials is not enough to obtain a higher yield in mushroom cultivation. Besides WHC and porosity, organic matter content of casing also has important effects on mushroom yield. According to Hayes (1981), a good casing soil should have low availability of soluble inorganic ions and of organic nutrients. In our study those mixtures that have high amount of tea production waste (75 and 100%) brought the high salt content and therefore the yield decreased.

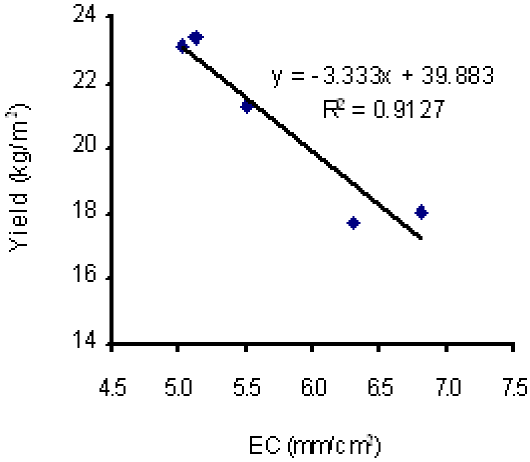

Fig. 1: **Regression between casing soil EC and yield**

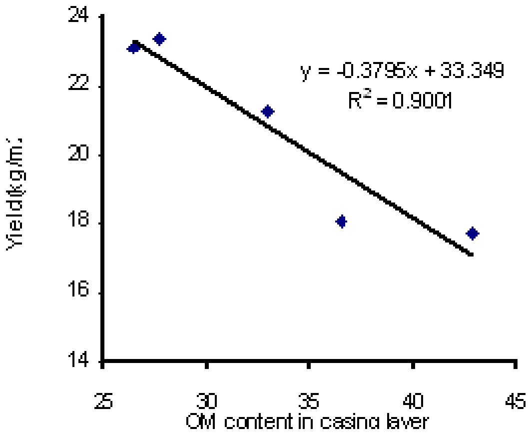

Fig. 2: **Regression between casing soil organic matter and yield**

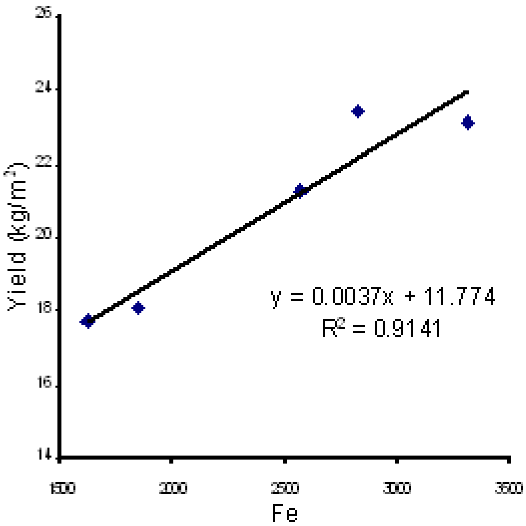

Fig. 3: **Regression between casing soil Fe and yield**

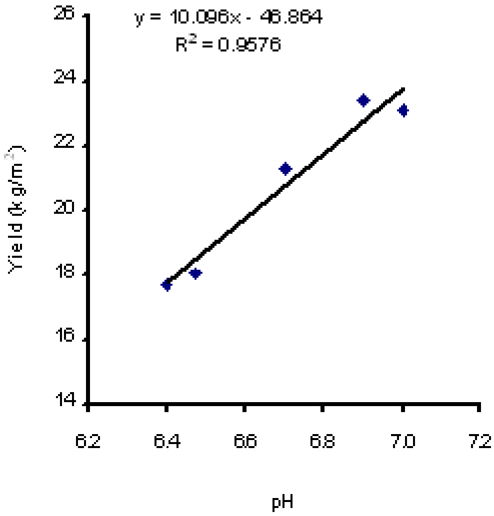

Fig. 4: **Regression between casing soil pH and yield**

The total nitrogen content in casing is usually required to be between 0.7% and 0.8% in mushroom cultivation (Couvy, 1974; Boztok, 1990). We don't found definite relationship between OC and total yield in this study but the lower OM in casing soil brought the highest yield.

In mushroom cultivation, using a casing material which has a high Mg content causes a half percent decrease in yield and a delay in mushroom growth (Flegg and Wood, 1985). We found that the salt effects of magnesium may have caused an increasing in yield. As result showed iron ion concentration in casing had a positive effect on mushroom yield as Hayes (1972) reported previously.

Conclusion

These results showed that a mixture of tea production waste and peat is a practicable casing material for the North regions of Iran, where the peat casing is more expensive and hard to find when compared with the tea production waste. To increase the yield and mushroom quality, different application and mixing ratios of tea production waste and peat should be investigated in more detail.

REFERENCES

1. Black, C.A., *Methods of soil analysis.* Part 1, American Soc. of Agron. No. 9 (1965).
2. Boztok, K., Mantar uretin teknigi. Ege universitesi ziraat fakultesi yayinlari. No.489. Ege univ. Basimevi, 168 s., Bornova. Izmir (1990).
3. Couvy, J., Les facteurs de la fructification de *Agaricus bisporus*. Bulletin de la Federation National des Syndcats Agricoles des *Cultivateurus de Champignons.* **1:** 653-657 (1974).
4. Flegg, P.B. and D.A. Wood., Growing and fruiting. In: Flegg, P.B., Spencer. D.M., Wood. D.A. (Eds.). *The Biology and Technology of the Cultivated Mushroom.* John Wiley & Sons Ltd., 141-178 (1985).
5. Gierzszynski, M., The effect of the physical and chemical properties of the casing layer on cropping in mushroom and biological factor. *Hort. Abst.* **45**: 4200 (1974).
6. Gulser, C. and A. Peksen. Using tea waste as a new casing material mushroom (*Agaricus* bisporus L.) cultivation. *Bio. Resource Technology* **88**: 153-156 (2003).
7. Hayes, W.A., Nutritional factors in relation to mushroom production. *Mushroom Science.* **8**: 663-674 (1972).
8. Hayes, W.A. Interrelated studies of the physical, chemical and biological factors in casing soil and relationship with productivity in commercial culture of *Agaricus bisporus*. *Mushroom Science.* **1**(2): 103-129 (1981).
9. Kacar, B., Bitki ve Topragm Kimyasal Analizler: III. *Toprak Analizleri.* 149-165. Ankara Universitesi Zir. Fak. Egit., Arast. Ve Gelistirme Vakfi Yay., No. 3. Ankara (1994).
10. Labuschagne, P., Eicker, A., and M. van Greuning. Casing mediums for Agaricus bisporus cultivation in South Africa: a preliminary report. In: Elliott, T.J. (Ed). Mushroom Science XIV, *Science and Cultivation of Edible Fungi.* Vol. 1 Balkema. Rotterdam. 339-344 (1995).
11. Levenon, D., Motro, B., Dosoretz, C., and Y. Henis., Differential utilization of nutrients present in the casing layer by *Agaricus bisporus. Mushroom J.,* 151-159 (1986).
11. Noble. R., and R.H. Gaze. Properties of casing peat types and additives and their influence on mushroom yield and quality. In: Elliott, T.J. (Ed.). Mushroom science XIV, *Science and Cultivation of Edible Fungi.* Vol. 1 Balkema. Rotterdam. 305-312 (1995).
12. Pardo, A., J.A. De Junas. and J.E. Pardo. Characterization of different substrates for possible use as casing in mushroom cultivation. *Food, Agriculture and Environment.* **2**: 107-114 (2003a).
13. Pardo, A., De Junan, J.A., and J.E. Pardo., Performance of compost vine shoots as a

peat alternative in casing materials for mushroom cultivation. *Food, Agriculture and Environment*., **2**: 209-214 (2003).

14. Peyvast, Gh. and N. Asskari Rabrary., Effect of Casing Layer Deep on the Yield of White Mushroom. The 3rd *Iranian Horticultural Science Conference.* Karadj, Iran, 1-3 (2003).
15. Price, S., The Peat Alternatives Manual. A Guide for the Professional Horticulturist and Landscaper. *Friends of the Earth,* London, UK. P. 40-51 (1991).
16. Rainey, P.B., Cole, A.L.J., and F.R. Sanderson. Air filled pores an important component of the mushroom casing layer. In: Wuest, P.J., Royse. D.J., Beelman, R.B. (Eds.), Proc. Intl. Symp. *Scientific and Tech. Aspects of Cultivating Edible Fungi.* Elsevier, Amsterdam, 501-514 (1986).
17. Ralph, H and J.R. Kurtznan. Casing properties: required. Desired and beliefs. World society for Mushroom Biology and Mushroom Products, Proceeding of 3rd ICMBMP, 1-9 (1999).
18. Sharma HSS, McCall D and G. Lyons. Chemical changes in peat as a result of neutralizing with lime during the preparation of mushroom casing. In: Royse D (ed) The Proceedings of the 2nd *Mushroom Biology and Mushroom Products*, Penn State University, University Park, Pennsylvania, 363-372 (1996).
19. Vijay, B., Saxena, S. and H.S. Sohi. Studies on new casing media for *Agaricus bisporus* (L) Sing. *Science into Practice.* **3**: 313-315 (1988).
20. Yeo, S.G. and W.A. Hayes. A new medium for casing mushroom beds. *Mushroom Science.* **10**: 217-229 (1979).