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Short Communication

Casing with leached vermicompost improve oyster mushroom biological efficiency

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ABSTRACT- Almost all oyster mushroom producers in Iran produce this kind of mushroom without any kind of casing soil. Although different kinds of casing soils are available for *Agaricus bisporus*, limited information is available regarding *Pleurotus ostreatus*. Availability of peat in many regions around the world is a concern and some researchers' efforts have been devoted to a search for alternative materials which may be used as a substitute or as a combination with peat. This project was undertaken to determine whether vermicompost can be used as a casing soil for oyster mushroom cultivation when cultivated in bins. As a completely randomized experimental design with 3 replications, this study was accomplished with different casing materials including vermicompost+ peat (100:0, 75:25, 50:50, 25:75, 0:100 v/v) and leached vermicompost +Peat (100:0, 75:25, 50:50, 25:75, 0:100 v/v) effects with control (without casing). Results showed when leached vermicompost was added to the oyster casing material, the biological efficiency (BE) in the second flush and the percentage of mushroom dry mater (DM) were increased. The highest BE in the second flush (40%) was observed for cased substrate with 100% leached vermicompost, while the lowest BE (9%) showed the control. Percentage of DM was higher in control (3.44%) compared to cased treatments (1.65–3.29%). The BE was higher than 100% for treatment cased with leached vermicompost. Overall, total BE for treatments cased with leached vermicompost increased by 185% over non-cased treatment. Therefore, considering the fact that using casing for *P. ostreatus* production is a relatively easy and low-cost cultural practice yielding successful results, it can be used to enhance BE and maximize substrate utilization.

INTRODUCTION

Oyster mushroom (*Pleurotus ostreatus* var. Florida (Fr.) Singer) cultivation has been increased during the last decade and accounted for 14.2% of the total edible mushrooms production around the world (Chang, 1999; Royse, 2002; NorouziPeyvast and Olfati, 2008; Olfati and Peyvast, 2008). Oyster mushroom cultivation can play an important role in managing and recycling of agricultural wastes as an alternative to other methods of disposal especially in non-industrial countries (Nirmalendu and Mukherjee, 2007; Olfati and Peyvast, 2008). Oyster mushrooms can produce fruiting bodies on different substrate which depends on its availability in a specific region (Olfati and Peyvast, 2008).

(Rodriguez Estrada et al., 2009) found that cased treatments were likely to result in higher yields of oyster mushroom than non-cased treatments. Since in their experiment, casing and supplementation were always applied together, it is not possible to differentiate the influence of one factor from the other. They believed that primordia formation can be induced by placing a casing layer over a colonized substrate.

Peng,(1996) applied a casing overlay to colonized substrate (rice straw, 70% moisture) and reported relatively low BE (47%). In contrast, Rodriguez Estrada et al. (2009) demonstrated that a casing overlay may increase yield and BE by 141% compared to without casing. Factors such as casing layer depth, chemical and microbial composition, physical properties and moisture content of the casing layer can play important roles in yield and quality of mushrooms (Hayes, 1981; Schroeder and Schisler, 1981; Kalberer, 1985; Cochet Gillman and Lebeault,1992; DeJuan and Pardo, 2002; Gulser and Peksen, 2003).

Availability of peat (casing material) is a concern in many regions around the world and some research efforts have been devoted to a search for alternative materials that may be used as a substitute or in combination with peat (Gulser and Peksen, 2003; Noble and DobrovinPennington, 2004; Peyvast et al., 2007). Casing layer residues on mushrooms are not a major problem since manual or mechanical cleaning or washing could be performed similar to other edible species (Kopytowski Filho et al., 2006).

Although most oyster mushroom producers in Iran produce this kind of mushroom without any kind of casing soils, there are different methods to cultivate it with casing because of the positive effects of casing that have been reported for other mushrooms (Peyvast, et al.,

2007; Rodriguez Estrada et al., 2009). This project was undertaken to determine whether vermicompost can be used as casing soil for cultivation of oyster mushroom when cultivated in bins.

MATERIALS AND METHODS

Oyster spawn was purchased from Keshtpashohan Laboratory in Tehran, Iran. Rice, var. Alikazemi, straw was obtained locally, and was stored approximately 6 months. The straws were chopped into 1–2 cm pieces, weighed, and soaked in water overnight. Extra water present in the substrates was drained and substrates were spread on clean blotting paper and air-dried for 15 min to remove excess water. Substrates were pasteurized by boiling for 30 min in water. A sample of each substrate was weighed before and after drying in an oven at 60°C for 2 days to determine dry mater content. The straw had a total C, N, dry matter (DM) and ash content of 55.39, 0.804,15 and 4.5 % and a total K and P content of 809.5 and 84.2 mg·100 g DM, respectively. Amounts of substrates (3,000 g) with 85% moisture were mixed with 10% spawn (wet wt/wet wt).

Earthworms (*Eisenia fetida*) (at 25 g earthworms·kg^{-1} of cattle manure or 2.5 kg earthworms m^{-2} of bed) were applied to vermicomposted production for two months (Peyvast, et al., 2008a; Peyvast, et al., 2008b). The vermicompost had a water content of 380 g·kg^{-1}, pH 7.6; total C content of 29.41 % DM and a total N content of 1.83 %. 100 kg of the vermicompost was flushed with 50 liters of water and the leachate (vermiwash) was collected. The leached and also unleached vermicompost were mixed with peat in different ratios and used as casing materials.

Inoculated substrates were placed in 50 × 35 × 30 cm bins. Bins were kept in a spawn running room at 25 ± 1°C in the dark until primordia formed then were kept at 22 ±1°C and 85–90% relative humidity. Adequate ventilation was provided to prevent increased CO_2 concentration in the room. Mushrooms were manually harvested 3 days after primordia initiation. Casing was applied an approximate 4 cm layer of pasteurized substrate on the top of fully colonized substrate.

BE were calculated from ratios of weight (kg) of fresh mushrooms harvested per kg of substrates dry weight (10). Total nitrogen was determined in samples of 0.5 g dry weight by Kjeldhal method using concentrated H_2SO_4, K_2SO_4, and $CuSO_4$ to digest the sample and then protein was calculated.

A completely randomized experimental design with 3 replications was used. Different casing materials including vermicompost+ peat (100:0, 75:25, 50:50, 25:75, 0:100 v/v) and leached vermicompost +Peat (100:0, 75:25, 50:50, 25:75, 0:100 v/v) and a control (without casing) were analyzed using SAS (ver. 9.00, SAS, Inc., Cary, N.C.). The Tukey test was performed to separate means.

RESULTS AND DISCUSSION

The casing treatments positively affected the BE and dry mater of oyster mushroom in the second flush but no significant differences were found on total BE, first flush BE, number of hand, mushroom protein, and total nitrogen content (Tables 1-2). The type of casing seemed to affect the BE of mushroom production in the second flush and DM content of the mushrooms. The lowest levels of DM were obtained from fruiting bodies developed from spawn grown on rice straw without casing. The highest BE in the second flush (40%) were observed for cased substrate with 100% leached vermicompost, while the lowest BE (9%) were observed for non-cased substrate (Table 3). The percentage of DM was higher in non-cased treatments (3.44%) compared to cased treatments (1.65–3.29%). The number of mushrooms was not significantly affected by the use of casing layer while for cased treatments, it ranged from 22 to 48, considerably higher than the non-cased control. Similarly, the number of hand, total content of nitrogen and protein content for cased treatments were considerably higher than the control (Table 4). In cased treatments, total BE ranged from 62% to 114% and the highest BE was obtained in the treatment cased with 100% leached vermicompost while the lowest was obtained in control (40%). The differences among the casing treatments, however, were not statistically significant.

Table 1. ANNOVA table effects of different casing on biological efficiency

Source of variation	df	Mean square		
		Biological efficiency		
		First flush	Second flush	total
Casing material	9	0.02^{ns}	0.04**	0.05^{ns}
Error	20	0.02	0.01	0.03
CV		16.64	16.03	18.01

** indicate significant at P = 0.01, ns non- significant

The experiment revealed that cased treatments were likely to result in higher yields than non-cased control. Casing appears to negatively affect the percentage of DM. The reason for this remains unknown, but it may be related to an excessive supply of water during mushroom growth. Overall, total BE for treatments cased with leached vermicompost increased by 185% over non-cased treatment. Primordia formation can be induced by placing a casing layer over a colonized substrate. Biological efficiencies of *P. ostreatus* obtained from cased substrates with leached vermicompost were significantly higher than values reported by Norouzi et al., (2008) who produced this fungus on bagged/non-cased substrates with a BE of 96% for *P. ostreatus* grown on rice straw+oilseed rape straw (25:75 dry wt/dry wt) substrate. However, Olfati and Peyvast (2008) obtained a BE of 118% for oyster mushrooms harvested from lawn clipping based substrates. It can be concluded that casing layer and its properties for *A. bisporus* production such as casing layer depth, chemical, physical and microbial composition, and moisture content are essential factors playing important roles in yield and quality of mushrooms (Hayes, 1981; Schroeder and Schisler, 1981; Kalberer, 1985; Cochet et al., 1992; Pardo et al., 2002; Gulser and Peksen, 2003).

Table 2. ANNOVA table effects of different casing on Nitrogen, protein, dry matter, number of hand and number of mushroom

Source of variation	df	Mean square				
		Nitrogen	Protein	Dry matter	Number of hand	Number of mushroom
Casing material	9	0.48^{ns}	18.65^{ns}	1.21^{**}	0.12^{ns}	0.46^{ns}
Error	20	0.23	8.80	0.08	0.14	0.25
CV		9.92	9.91	11.58	17.02	15.86

** indicate significant at P = 0.01, ns non- significant

Table 3. Effect of different casing on biological efficiency

Casing	Biological efficiency (%)		
	First flush	Second flush	total
100% peat	0.68±0.3a	0.17±0.09abc	0.86±0.24a
75% peat+25 % vermicompost (wet vol./ wet vol.)	0.62±0.11a	0.11±0.06abc	0.73±0.07a
50% peat+50 % vermicompost (wet vol./ wet vol.)	0.6±0.36a	0.2±0.03abc	0.8±0.34a
25% peat+75 % vermicompost (wet vol./ wet vol.)	0.7±0.37a	0.21±0.09abc	0.91±0.29a
100% vermicompost	0.49±0.1a	0.32±0.16abc	0.81±0.11a
75% peat+25 % leached vermicompost (wet vol./ wet vol.)	0.57±0.4a	0.26±0.007abc	0.83±0.3a
50% peat+50 % leached vermicompost (wet vol./ wet vol.)	0.7±0.2a	0.34±0.16ab	1.04±0.29a
25% peat+75 % leached vermicompost (wet vol./ wet vol.)	0.33±0.15a	0.29±0.18abc	0.62±0.31a
100 % leached vermicompost	0.74±0.19a	0.4±0.14a	1.14±0.28a
control	0.31±0.18a	0.09±0.04bc	0.4±0.18a

Values in a column followed by the same letter are not significantly different, P<0.01, Tukey's test.

Table 4. Effects of different casing on Nitrogen, protein, dry matter, number of hand and number of mushroom

Casing	Nitrogen (%)	Protein (%)	Dry matter (%)	Number of hand	Number of mushroom
100% peat	5.42±0.51a	33.8±3.18a	3.29±0.15ab	14±4a	38.33±20.03a
75% peat+25 % vermicompost (wet vol./ wet vol.)	5.22±0.58a	32.57±3.63a	1.65±0.58c	11.33±6.11a	47±16.52a
50% peat+50 % vermicompost (wet vol./ wet vol.)	4.88±0.25a	30.43±1.58a	2.25±0.31c	12.33±5.51a	44.33±22.5a
25% peat+75 % vermicompost (wet vol./ wet vol.)	5.02±0.37a	31.35±2.28a	2.47±0.25abc	15±7.94a	47.33±22.12a
100% vermicompost	4.61±0.74a	28.77±4.62a	2.2±0.24c	9.67±5.13a	25.33±15.04a
75% peat+25 % leached vermicompost (wet vol./ wet vol.)	4.57±0.2a	28.54±1.25a	1.82±0.38c	11±3.6a	48±20.66a
50% peat+50 % leached vermicompost (wet vol./ wet vol.)	4.3±0.12a	26.83±0.75a	3.29±0.23ab	13.67±3.06a	40.33±11.15a
25% peat+75 % leached vermicompost (wet vol./ wet vol.)	5.02±0.62a	31.35±3.84a	2.12±0.06c	10.67±7.02a	22.33±10.5a
100 % leached vermicompost	4.76±0.13a	29.7±0.82a	2.3±0.11bc	12.67±8.02a	24.33±6.03a
control	4.14±0.68a	25.83±4.25	3.44±0.2a	5.33±2.08a	16±5.57a

Values in a column followed by the same letter are not significantly different, P<0.01, Tukey's test.

CONCLUSIONS

Casing of substrate used to produce *P. ostreatus* is a relatively easy and low-cost cultural practice that may successfully be used to enhance BE and maximize utilization of substrate. Because availability of peat (casing material) is a concern in many regions around the world where mushrooms are produced, some research efforts have been devoted to a search for alternative materials that may be used as a substitute or in combination with peat (Gulser and Peksen, 2003; Noble and DobrovinPennington, 2004). Vermicompost production can solve many environmental problems in a safe way. However, vermicompost had high EC which limits its use in mushroom cultivation. Hence, the present research indicated that leaching can solve this problem. Nevertheless, further research is needed to test more casing materials in combination with vermicompost on oyster BE.

REFERENCES

Chang S.T. (1999). World production of cultivated and medicinal mushrooms in 1997 with emphasis on *Lentinus edodes* (Berk) Sing, *International Journal of Medicinal Mushrooms,* 1, 291–300.

Cochet, N., Gillman, A., & Lebeault J.M. (1992). Some biological characteristics of the casing soil and their effect during *Agaricus bisporus* fructification. *Acta Biotechnol,* 12, 411–419.

Gulser, C., & Peksen, A, (2003). Using tea waste as a new casing material in mushroom (*Agaricus bisporus* (L.) Sing.) cultivation. *Bioresource Technology,* 88, 153–156.

Hayes, W.A. (1981). Interrelated studies of physical, chemical and biological factors in casing soils and relationships with productivity in commercial culture of *Agaricus bisporus*. *Mushroom Science*, 11, 103–129.

Kalberer, P.P. (1985). Influence of the depth of the casing layer on the water extraction from casing soil and substrate by the sporophores, on the yield and on the dry matter content of the fruit bodies of the first three flushes of the cultivated mushroom, *Agaricus bisporus*. *Scientia Horticulturae*, 27, 33–43.

Kopytowski Filho, J., Minhoni, M.T.A., & Rodriguez Estrada, A.E. (2006). *Agaricus blazei*: ‘‘The Almond Portabello”, cultivation and commercialization. *Mushroom News*, 54, 22–28.

Nirmalendu, D., & Mukherjee, M. (2007). Cultivation of *Pleurotus ostreatus* on weed plants. *Bioresource Technology,* 98, 2723–2726.

Noble, R., & Dobrovin Pennington, A. (2004). Use of fine particle tailings in mushroom casing. *Mushroom Science*, 16, 335–341.

Norouzi, A., Peyvast, G. & Olfati, J.A. (2008). Oilseed rape straw for cultivation of oyster mushroom. *Maejo International Journal of Science and Technology*, 2(3), 502-507.

Olfati, J.A., & Peyvast, G. (2008). Lawn clippings for cultivation of oyster mushroom. *International Journal of Vegetable Science*, 14(2), 98-103.

Pardo, A., DeJuan, J.A., & Pardo, J.E. (2002). Bacterial activity in different types of casing during mushroom cultivation (*Agaricus bisporus* (Lange) Imbach). *Acta Aliment,* 31, 327–342.

Peng, J.T. (1996). The cultivation of *Pleurotus eryngii* (DC.:Fr.) Quel. on rice straw substrate. Journal of Agricultural Research China, 45, 382–387.

Peyvast, G., Shahbodaghi., J., Ramezani, P., & Olfati, J.A. (2007). Performance of tea waste as a peat alternative in casing materials for bottom mushroom (*Agaricus bisporus* (L.) Sing.) cultivation. *Biosciences Biotechnology Research Asia,* 4(2), 489-494.

Peyvast, G., Olfati, J.A., Madeni, S., & Forghani, A. (2008a). Effect of vermicompost on the growth and yield of spinach (*Spinacia oleracea* L.). *Journal of Food Agriculture and Environment,* 16(1), 110-113.

Peyvast, G., Olfati, J.A., Madeni, S., Forghani, A., & Samizadeh, H. (2008b). Vermicompost as a soil supplement to improve growth and yield of parsley. *International Journal of Vegetable Science*, 14(2), 82-92.

Rodriguez Estrada, A.E., Del Mar Jimenez Gasco, M., & Royse, D.J. (2009). Improvement of yield of *Pleurotus eryngii* var. eryngii by substrate supplementation and use of a casing overlay. *Bioresource Technology,*100, 5270–5276.

Royse, D.J. (2002). Influence of spawn rate and commercial delayed release nutrient levels on *Pleurotus cornucopiae* (oyster mushroom) yield, size and time to production. *Applied Microbiology and Biotechnology*, 58, 527–531.

Schroeder, G.M., & Schisler, L.C. (1981). Influence of compost and casing moisture on size, yield and dry weight of mushrooms. *Mushroom Science*,11, 495–509.

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کاربرد خاک پوششی با ورمی‌کمپوست شسته شده بر راندمان بیولوژیکی قارچ صدفی

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واژه های کلیدی:
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چکیده- تقریباً همه تولید کنندگان قارچ صدفی در ایران این قارچ را بدون کاربرد خاک پوششی تولید می‌کنند. اگرچه انواع خاکهای پوششی برای تولید قارچ دکمه‌ای وجود دارد اما اطلاعات کمی در مورد قارچ صدفی موجود است. وجود پیت در بسیاری از نقاط جهان محدود است از این رو تحقیقات زیادی برای یافتن موادی برای جایگزینی یا ترکیب با پیت انجام شده است. این تحقیق به منظور بررسی امکان استفاده از ورمی‌کمپوست به عنوان خاک پوششی برای تولید قارچ صدفی زمانیکه در قفسه پرورش می‌یابد انجام شد. آزمایش در قالب طرح کاملاً تصادفی با سه تکرار اجرا شد و تیمارهای آزمایش ترکیبات مختلف خاک پوششی شامل ورمی‌کمپوست+ پیت (۰:۱۰۰، ۲۵:۷۵، ۵۰:۵۰، ۷۵:۲۵ و ۱۰۰:۰) و ورمی‌کمپوست شسته شده+پیت (۰:۱۰۰، ۲۵:۷۵، ۵۰:۵۰، ۷۵:۲۵ و ۱۰۰:۰) به همراه تیمار شاهد (بدون خاک پوششی) بودند. نتایج نشان داد وقتی ورمی‌کمپوست شسته شده به خاک پوششی قارچ صدفی اضافه می‌گردد راندمان بیولوژیکی در فلاش دوم و درصد ماده خشک افزایش می‌یابد. بالاترین راندمان بیولوژیکی در فلاش دوم (۴۰٪) از بستری به‌دست آمد که با ۱۰۰ درصد ورمی‌کمپوست شسته شده خاکدهی شده بود درحالیکه کمترین راندمان بیولوژیکی (۹٪) از کنترل به‌دست آمد. درصد ماده خشک در کنترل (۳/۴۴٪) در مقایسه با تیمارها (۳/۲۹٪-۱/۶۵) بیشتر بود. راندمان بیولوژیکی برای تیمار خاک پوششی با ورمی‌کمپوست شسته شده بیش از ۱۰۰ درصد بود. روی‌هم‌رفته راندمان بیولوژیکی کل در تیمار خاکدهی شده با ورمی‌کمپوست شسته شده ۱۸۵٪ بیشتر از تیمار بدون خاک پوششی بود. استفاده از خاک پوششی برای تولید قارچ صدفی نسبتاً آسان و کم هزینه است و منجربه بهبود راندمان بیولوژیکی و حداکثر استفاده از بستر می‌گردد.