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Oilseed rape straw for cultivation of oyster mushroom

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Abstract: Oyster mushroom [*Pleurotus ostreatus* var. *sajor caju* (Fr.) Singer] was grown on five substrates: rice straw, rice straw + oilseed rape straw (75:25, 50:50, and 25:75 dw/dw), and oilseed rape straw alone. Rice straw + oilseed rape straw (25:75) and oilseed rape straw were best for fruit body production of *P. ostreatus*. The time to fruiting for *P. ostreatus* was also shorter on oilseed rape straw. Protein content of the fruit bodies obtained with oilseed rape straw was highest among all substrates. Oilseed rape straw thus appears to be a suitable substrate for oyster mushroom production.

Keywords: *Pleurotus ostreatus*, oilseed rape straw, rice straw

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Introduction

Oyster mushroom [*Pleurotus ostreatus* var. *sajor caju* (Fr.) Singer] cultivation has increased during the last decade [1,2]. This mushroom accounted for 14.2% of the total world production of edible mushrooms produced in 1997 [2]. Although commonly grown on pasteurised straw of wheat or rice, oyster mushroom can be cultivated on a wide variety of substrates containing lignin and cellulose. Oyster mushroom cultivation can play an important role in managing and recycling of organic wastes as an alternative to other methods of disposal [3].

Oyster mushroom can also produce fruiting bodies on straw of goose grass (Eleucine coracana Gaertn.) and kikuyu grass (Pennisetum typhoides S. & H.); stem of sorghum (Sorghum vulgare Pers.) and maize (Zea mays L.) [4,5], as well as on wood and sawdust of poplar (*Populus robusta* Bartr.), oak (*Quercus leucotrichopora* L.), horse chestnut (*Aesculus indica* Colebr.), *Acasia* sp. [6], chopped pseudostem of banana [*Musa paradisiaca* subsp. *sapientum* (L.) Kuntze] [7], cotton (*Gossypium* sp.) stalk, pea **(***Pisum satium* L.) shells [8,9], and straw of some species of wild plants including *Leonotis*

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sp., *Sida acuta* Burm, *Parthenium argentatum* Gray, *Ageratum conyzoides* L., *Cassia sophera* L., *Tephrosia purpurea* (Linn.) Pers., and *Lantana camara* L. [3]. The substrate used depends on its availability in a specific region. Rice is an important agriculture crop in the northern part of Iran, and a staple food for many Iranians. Oilseed rape (*Brassica napus* L. var. Hyola 401) as a secondary crop has been on the increase recently after rice harvesting in this region. Oilseed rape straw is considered to be a kind of wastes and is normally disposed of by burning. This project was undertaken to determine if oilseed rape straw can be used as an alternative to the common straw such as rice and other gramineae straw as a substrate for cultivation of oyster mushroom.

Materials and Methods

Oyster mushroom spawn was purchased from Keshtpashohan Laboratory in Tehran, Iran. The substrates were rice straw, rice straw + oilseed rape straw (75:25, 50:50, and 25:75 dry weight/dry weight), and oilseed rape straw. Rice and oilseed rape straw was obtained locally and stored for approximately 6 and 2 months respectively. The straw was chopped into small pieces (1-2 cm), weighed and soaked in water overnight. Excess water present in the substrates was drained and the substrates were spread on clean blotting paper and air-dried for 15 min to remove excess water. The substrates were pasteurised by boiling for 30 min in water.

A sample of each substrate was weighed before and after drying in an oven at 60^{o}C for 2 days to determine the dry mater (DM) content. Total nitrogen (N), potassium (K), and ash were determined [10,11] (Table 1). Each substrate (3,000 g) with 85% moisture was mixed with 10% spawn (wet weight/wet weight) and placed in a 50×35 cm polythene bag which was then tightly closed. Pin holes were made through the bags (1/100 cm^2) for drainage. It was kept in a spawn running room at 25±1° C in the dark until primordia were formed. After primordial formation, large holes were made in the polythene bag to allow normal development of fruiting bodies. Bags were kept at 22±1°C with a 12-hr photoperiod (1,500–2,000 lux) and 85–90% relative humidity. Adequate ventilation was provided to prevent increased CO_2 concentration in the room**.** The mushrooms were manually harvested three days after primordia initiation.

Biological efficiency were calculated and defined as the ratio of weight (g) of fresh mushrooms harvested to dry weight (kg) of the substrate. Total nitrogen and protein were determined using 0.5 g sample (dry weight) of oyster mushroom by the Kjeldhal method using concentrated H_2SO_4, K_2SO_4 and $CuSO_4$ to digest the sample. Phosphorus (P) was determined by spectrometry [10]. Total carbon (C) was determined by oxidation with potassium dichromate and titration of excess dichromate with ammonium ferrosulfate [12]. A completely randomised experimental design with 15 replications was used. Data were analysed using SAS (ver. 9.00, SAS, Inc., Cary, N.C.). The Tukey-test was performed to separate means.

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Results and Discussion

Added oilseed rape straw had the effect of increasing nitrogen and carbon, and decreasing phosphorus, potassium and ash content in the substrate (Table 1). The type of substrate seemed to affect the time to primordial initiation and the biological efficiency of mushroom production (Table 2). Primordia were formed most rapidly on oilseed rape straw alone in the first flush, but in the second and third flush oilseed rape straw increased primordial initiation. Similarly, biological efficiency in the first flush of production was better for fruiting bodies on oilseed rape straw alone and oilseed rape straw + rice straw (75:25). However, it was generally lowest in second and third flushes especially when the substrate was oilseed rape straw.

Table 1. Some determined characteristics of substrates

Substrate	P (mg/100 g DM)	K (mg/100 g DM)	Ash (%)	C (%)	N (%)
Rice straw	84.2	809.5	4.5	55.39	0.804
Rice straw + oilseed rape straw (75:25 dw/dw)	74.6	803.0	4.4	55.63	0.820
Rice straw + oilseed rape straw (50:50 dw/dw)	68.2	780.3	4.2	55.68	0.822
Rice straw + oilseed rape straw(25:75 dw/dw)	66.6	778.4	3.9	55.89	0.828
Oilseed rape straw	57.0	762.5	3.8	55.97	0.830

The type of substrate also affected DM, ash, protein, potassium and phosphorous content of the mushrooms (Table 3). The lowest levels of DM, ash, potassium and phosphorus were obtained from fruiting bodies developed from spawn grown on oilseed rape straw alone. On the other hand, the protein concentration in fruiting bodies was highest when the mushrooms were cultivated on oilseed rape straw. The protein content of fruiting bodies produced on oilseed rape straw alone or mixed with rice straw was higher than that produced on rice straw alone. There was a tendency for potassium, phosphorus, DM and ash level of the fruiting bodies to decrease with decreasing percentage of rice straw in the substrate, the lowest levels thus being found when oilseed rape straw alone was used as substrate.

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Table 2. Effect of substrate on days to primordial initiation and biological efficiency of *P. ostreatus*

Substrate	Days to primordial initiation			Biological efficiency *			
	1st flush	2nd flush	3 rd flush	1st flush	2nd flush	3rd flush	Total
Rice straw	28.25[a]	13.25[c]	14.25[b]	567.01[d]	236.07[a]	108.80[a]	911.88[c]
Rice straw + oilseed rape straw (75:25 dry wt /dry wt)	24.50[b]	14.25[c]	14.50[b]	588.08[c]	233.20[ab]	108.60[a]	929.88[b]
Rice straw + oilseed rape straw (50:50 dry wt /dry wt)	22.75[c]	17.00[b]	14.75[b]	602.52[b]	228.91[ab]	105.22[ab]	936.65[b]
Rise straw + oilseed rape straw (25:75 dry wt /dry wt)	21.00[d]	20.25[a]	16.25[a]	630.00[a]	228.11[ab]	102.04[b]	960.15[a]
Oilseed rape straw	20.50[d]	20.75[a]	16.75[a]	632.33[a]	224.73[b]	99.80[b]	956.87[a]

* Defined as g (fresh weight) of oyster mushroom /kg (dry weight) of substrate

Note: Values in a column followed by the same letter are not significantly different, $P \leq 0.01$, Tukey test.

Table 3. Effect of substrate on nutritive qualities of oyster mushroom

Substrate	DM (%)	Ash (%)	Protein (% DM)	K (mg/100 g DM)	P (mg/100 g DM)
Rice straw	7.99[a]	6.38[a]	18.53[e]	2826.75[a]	952.25[a]
Rice straw + oilseed rape straw (75:25 dw/dw)	7.98[a]	6.26[ab]	18.76[d]	2447.50[b]	931.00[b]
Rice straw + oilseed rape straw (50:50 dw/dw)	7.93[a]	4.14[b]	19.52[c]	2698.75[b]	917.50[c]
Rice straw + oilseed rape straw (25:75 dw/dw)	7.82[ab]	6.11[b]	20.00[b]	2611.75[c]	895.25[d]
Oilseed rape straw	7.52[b]	5.92[c]	20.27[a]	2583.00[c]	837.75[e]

Note: Values in a column followed by the same letter are not significantly different, $P \leq 0.01$, Tukey test.

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Conclusions

Production of oyster mushroom on biological-waste substrates can be a highly efficient method for producing protein-rich food. It appears that oilseed rape straw mixed with rice straw can be used successfully as a substrate to benefit some aspects of oyster mushroom cultivation. It should further be determined if the concentrations of certain components of the oilseed rape straw are at optimum levels for use in a substrate. It also remains to be determined why mixing oilseed rape straw with rice straw produced beneficial results regarding biological efficiency, but this was not the case as regards the nutrient content of the mushrooms, which was benefited by the presence of oilseed rape straw.

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