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Full Length Research Paper

Cultivation of *Agaricus bisporus* on wheat straw and waste tea leaves based composts and locally available casing materials Part III: Dry matter, protein, and carbohydrate contents of *Agaricus bisporus*

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This study was performed to determine the effects of composts and casing materials on dry matter, protein, and carbohydrate contents of the fruit bodies of *Agaricus bisporus*. Results showed that *Agaricus bisporus* cultivated on group I and group II casing soil groups showed remarkably higher dry matter and carbohydrate contents compared to other casing groups. No significant differences were found among casing soil groups in terms of protein content of *Agaricus bisporus* cultivated on wheat straw. But, there were significant differences between casing soil groups in terms of protein content of *Agaricus bisporus* cultivated on waste tea leaves.

Key words: Wheat straw, waste tea leaves, dry matter, protein, carbohydrate.

INTRODUCTION

Cultivation of edible mushrooms with agricultural residues, such as rice and wheat straw, is a value-added process to convert these materials, which are otherwise considered to be wastes, into human food (Zhang et al., 2002). Since ancient times mushrooms have been consumed by humans not only as a part of the normal diet but also as a delicacy because they have highly desirable taste and aroma (Kurbanoglu and Algur, 2002).

More than 2000 species of mushrooms exist in nature but only approximately 22 species are intensively cultivated, for commercial purposes, on ground or wood and utilizing particular environmental and nutritional conditions (Manzi et al., 2001). Fruit bodies of mushrooms are appreciated, not only for texture and flavor but also for their chemical and nutritional characteristics (Manzi et al., 1999). In most countries, there is a well-established consumer acceptance for cultivated mushrooms (*A. bisporus*, *Pleurotus* spp., *Lentinus edodes*, *Volvariella volvacea*, *Auricularia* spp. etc.) (Diez and Alvarez, 2001). In this study, it was aimed to determine nutritional values such as, dry matter, protein, and carbohydrate contents of *A. bisporus* cultivated on wheat straw and waste tea leaves based composts and using some casing materials.

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MATERIALS AND METHODS

Preparation of compost

Two compost based wheat straw and waste tea leaves using wheat bran, ammonium nitrate, urea, molasses, and gypsum as activator materials were prepared. Percentage nitrogen (N) content of the composts were arranged to 2.5%. Composts used in this study are given in Table 1. The composting of substrates were processed using method of Shandilya (1982). The total outdoor composting process (Phase I) took 28 and 35 days for wheat straw and waste tea leaves based composts, respectively. The phase II was pro-

Table 1. Wheat straw and waste tea leaves based composts.

Compost Types	Fresh weight (kg)	Moisture content (%)	Dry weight (kg)	Nitrogen (%)	Nitrogen (kg)
Wheat straw	460.0	15.0	400.0	0.5	2.00
Wheat bran	137.0	17.0	113.0	2.4	2.71
Ammonium nitrate	17.1	0.0	17.10	26.0	4.94
Urea	10.1	0.0	10.10	44.0	4.84
Mollasses	24.0	50.0	16.0	1.3	0.20
Gypsum	24.0	0.0	24.0	0.0	0.0
TOTAL				**559.80**	**14.01**
Waste tea leaves	448.0	12.0	400.0	2.3	9.20
Wheat bran	132.0	17.0	113.0	2.4	2.71
Ammonium nitrate	3.67	0.0	3.67	26	0.95
Urea	2.17	0.0	2.17	44	0.95
Mollasses	24.0	50.0	16.0	1.3	0.20
Gypsum	24.0	0.0	24.0	0.0	0.0
TOTAL				**580.2**	**14.69**

cessed indoor for 7 days.

Casing soil

Locally available casing materials such as Peat of Bolu (PB), peat of Agacbasi (PA), and peat of Caykara (PC) were used as peats. Peat of Bolu, peat of Agacbasi, and peat of Caykara were supplied, from Bolu district, Agacbasi district (Surmene-Trabzon), and Caykara district (Trabzon), in Turkey, respectively. Also, Forest soil (FS) was used as casing material, supplied from Meryemana-Trabzon district, in Turkey. Also, we used some secondarily casing materials such as perlite (P), sand (S) and piece of mosaic (PM) with mixture of peat (20:80; v: v) in volume.

Mushroom cultivation

Composts were spawned with 30 g mycelium (Type Horst U1) per kg then filled into plastic bags as 7 kg wet weight basis. During spawn run the temperature of the inlet air is automatically regulated by a cooling surface in the recirculation canal such that the compost temperature is maintained at 24 – 25°C with a minimum supply of fresh air. Spawning room arranged to 25°C temperature, and 90% relative humidity without ventilation (Hayes and Shandilya, 1977). After 18 days of mycelia growth, a 3 cm layer casing material covered over the compost. Before casing, chalk was added to give a pH of 7.5 - 8. After 7 days, the temperature was lowered to 16°C, with ventilation, for pinhead production. Watering after casing was done as suggested for commercial growth (Randle, 1984; Shandilya, 1986).

Dry matter content

Fruit bodies of *A. bisporus* were dried at 100°C to constant weight to determine their dry matter content.

Protein content

The protein content of fruit bodies of *A. bisporus* was estimated from the nitrogen content (N x 6.25) as determined micro- Kjeldahl method.

Carbohydrate content

In this study carbohydrates were determined by theorical method using following equation:

Carbohydrate (%) = [100 - (Water + Protein + fat + Cellulose + ash)] x 100

Evaluation of test results

Test results were evaluated by a computerized statistical program composed of analysis of variance and following Duncan tests at the 95% confidence level. Statistical evaluations were made on homogeneity groups (HG), of which different letters reflected statistical significance.

RESULTS AND DISCUSSION

Table 2 shows dry matter, protein, and carbohydrate contents of *A. bisporus* cultivated on wheat straw based compost and using different casing materials. Dry matter values range from 7.90 to 11.36 %, confirming high moisture content of mushrooms (Breene, 1990). This variability is exclusively dependent on the mushroom species since other interfering parameters such as post-harvest period, temperature, relative humidity during growth (Bono and Rajatham, 1988). While the highest dry matter (11.36%) was obtained with PB, mixture of PC+P

Table 2. Dry matter, protein, and carbohydrate contents of *A. bisporus* cultivated on wheat straw based compost.

Group No	Casing soil	Mixture Ratio[a] (%)	Dry matter[b]		Protein[b]		Carbohydrate[b]	
			Mean ± Sd[c] (%)	Mean ± Sd (%)	Mean ± Sd (%)	Mean ± Sd (%)	Mean ± Sd (%)	Mean ± Sd (%)
I	PB	100	11.36±0.31^{j}	10.12±1.22^{b}	23.06±0.63^{h}	20.95±1.75^{a}	5.38±0.16^{j}	4.56±1.05^{b}
	PA	100	8.50±0.36^{bcd}		19.63±0.56^{abc}		3.37±0.10^{bc}	
	PC	100	10.67±0.30^{ij}		20.88±0.31^{bcdefg}		4.94±0.13^{hi}	
	FS	100	9.96±0.40^{gh}		20.25±1.13^{abcde}		5.00±0.26^{i}	
II	PB+PA	(50+50)	9.90±0.30^{gh}	10.05±0.61^{b}	19.13±1.00^{a}	20.37±0.62^{a}	4.84±0.19^{hi}	4.88±0.34^{b}
	PB+PC	(50+50)	10.13±0.25^{h}		20.13±0.88^{abcde}		5.00±0.16^{i}	
	PB+FS	(50+50)	10.66±0.15^{i}		21.19±0.50^{cdefg}		5.01±0.26^{i}	
	PA+PC	(50+50)	9.76±0.38^{gh}		20.81±0.81^{abcdef}		4.71±0.16^{h}	
	PA+FS	(50+50)	9.10±0.36^{ef}		20.38± 1.00^{abc}		4.16±0.14^{fg}	
	PC+FS	(50+50)	10.73±0.32^{i}		20.56±0.94^{bcdefg}		5.36±0.22^{j}	
III	PB+P	(80+20)	9.46±0.21^{fg}	8.88±0.66^{a}	22.31±1.88^{gh}	21.44±0.94^{a}	3.94±0.19^{ef}	3.72±0.60^{a}
	PB+S	(80+20)	8.16±0.31^{abc}		21.56±1.69^{abcdg}		3.05±0.07^{a}	
	PB+PM	(80+20)	9.03±0.45^{ef}		20.44±1.69^{abcdef}		4.18±0.18^{fg}	
IV	PA+P	(80+20)	8.23±0.15^{abc}	8.40+0.50^{a}	19.75±0.94^{abcd}	20.86±1.06^{a}	3.47±0.18^{cd}	3.40±0.31^{a}
	PA+S	(80+20)	8.96±0.30^{def}		21.50±1.50^{efgh}		3.67±0.31^{de}	
	PA+PM	(80+20)	8.00±0.36^{ab}		19.56±0.88^{abc}		3.06±0.10^{a}	
V	PC+P	(80+20)	7.9±0.10^{a}	8.57±0.63^{a}	19.38±0.44^{ab}	20.86±1.25^{a}	3.43±0.22^{bcd}	3.54±0.19^{a}
	PC+S	(80+20)	9.16±0.35^{ef}		21.44±1.38^{defgh}		3.76±0.10^{e}	
	PC+PM	(80+20)	8.66±0.21^{cde}		21.75±1.25^{efgh}		3.42±0.23^{bcd}	
VI	FS+P	(80+20)	9.96±0.38^{gh}	9.03±0.88^{a}	21.50±0.44^{efgh}	20.94±1.25^{a}	4.27±0.04^{g}	3.78±0.54^{a}
	FS+S	(80+20)	8.93±0.11^{de}		21.81±0.75^{fgh}		3.87±0.09^{e}	
	FS+PM	(80+20)	8.20±0.26^{abc}		19,50±0,63^{abc}		3.20±0.08^{ab}	

Small letters given as superscript over dry matter, protein, and carbohydrate values represent homogenity groups obtained by statistical analysis with similar letters reflecting statistical insignificance at the 95% confidence level.
[a] In volume.
[b]Each reading is average of five test samples.
[c]Standard deviation.

(80:20; v/v) gave the lowest dry matter content (7.90%).

In casing soil groups, group I gave the highest dry matter, but there were no significant differences between group I and group II in terms of dry matter. Dry matter content of *A. bisporus* group I and group II casing materials was significantly higher than those of other casing groups. Protein values vary 19.13 to 23.06 %. While peat of Bolu gave the highest protein content, the lowest protein content was obtained with mixture of PB+PA. Protein content of *A. bisporus* cultivated on all casing groups was not significantly different from each other. Carbohydrate varied from 3.05 to 5.38%. While the highest carbohydrate was obtained with PB, the lowest carbohydrate was obtained with mixture of PB+S. No significant differences were found in carbohydrate content of fruit bodies cultivated on group I and group II casing materials.

Dry matter, protein, and carbohydrate contents of *A. bisporus* cultivated on waste tea leaves based compost and using some casing materials are given in Table 3. Dry matter values range from 7.74 to 11.46%. While, mixture of PA+PC gave the highest dry matter, mixture of FS+S gave the lowest dry matter. In casing soil groups, group II gave the highest dry matter. Protein values varied from 19.63 to 26.94 %. While the highest protein content was obtained with mixture of PB+PC, the lowest protein content was obtained with mixture of PA+S (80:20; v/v). In casing soil groups, group I and group V gave the highest protein content followed by group II and group VI, respectively. But, no significant differences were found in protein content of *A. bisporus* cultivated on these groups. Carbohydrate content of *A. bisporus* varied from 2.88 to 5.70%.

Yildiz et al. (2005) found that protein content was changeable according to growth region and structure of species. Diez and Alvarez (2001), and Yildiz et al. (1998) reported that the C/N ratio of a grown region affects protein in mushrooms. Coşkuner and Özdemir (1997) reported that the protein and carbohydrates levels of mushroom samples are within the range of 19 - 35% and

Table 3. Dry matter, protein, and carbohydrate contents of A. *bisporus* cultivated on waste tea leaves.

Group No.	Casing Soil	Mixture Ratio[a] (%)	Dry matter[b] Mean±Sd[c] (%)	Dry matter[b] Mean±Sd (%)	Protein[b] Mean±Sd (%)	Protein[b] Mean±Sd (%)	Carbohydrate[b] Mean±Sd (%)	Carbohydrate[b] Mean±Sd (%)
I	PB	100	10.70±0.20^{ij}	9.99±0.71^{b}	25.19±0.44^{1}	23.94±1.62^{b}	4.51±0.27^{hij}	4.05±0.44^{ab}
	PA	100	9.10±0.36^{b}		22.13±0.63^{efgh}		3.49±0.28^{bc}	
	PC	100	9.76± 0.15^{efg}		23.00±0.88^{ghij}		3.96±0.07^{efg}	
	FS	100	10.40±0.20^{hi}		25.44±0.44^{l}		4.25±0.13^{ghi}	
II	PB+PA	(50+50)	9.93±0.25^{fgh}	10.23±0.95^{c}	22.69±0.94^{ghi}	23.56±2.12^{b}	4.39±0.35^{hij}	4.50±0.83^{b}
	PB+PC	(50+50)	11.17±0.29^{jk}		26.94±1.25^{m}		5.04±0.21^{l}	
	PB+FS	(50+50)	10.36±0.12^{hi}		24.44±0.69^{jkl}		4.69±0.20^{jk}	
	PA+PC	(50+50)	11.46±0.45^{k}		24.13±0.94^{ijkl}		5.70±0.10^{m}	
	PA+FS	(50+50)	9.46±0.23^{bcdef}		20.88±1.00^{abcd}		3.67±0.12^{bcde}	
	PC+FS	(50+50)	9.03±0.15^{b}		22.31±1.31^{fgh}		3.52±0.19^{b}	
III	PB+P	(80+20)	9.60±0.20^{cdef}	8.94±0.87^{a}	22.50±0.69^{ghi}	21.58±0.94^{a}	3.90±0.23^{def}	3.76±0.80^{a}
	PB+S	(80+20)	9.26±0.32^{bcd}		20.69±0.63^{abc}		4.48±0.30^{ij}	
	PB+PM	(80+20)	7.96±0.15^{a}		21.56±0.31^{cdef}		2.90±0.10^{a}	
IV	PA+P	(80+20)	9.76±0.76^{efg}	9.14±0.99^{a}	22.81±0.94^{ghi}	21.52±1.62^{a}	4.32±0.18^{hi}	3.68±0.93^{a}
	PA+S	(80+20)	8.00±0.20^{a}		19.63±0.50^{a}		2.61±0.16^{e}	
	PA+PM	(80+20)	9.66±0.29^{defg}		22.13±0.75^{efgh}		4.11±0.10f^{gh}	
V	PC+P	(80+20)	9.30±0.10^{bcde}	9.30±0.15^{ab}	22.69±1.00^{ghi}	23.58±1^{b}	3.72±0.10^{cde}	3.62±0.93^{a}
	PC+S	(80+20)	9.46±0.32^{bcdef}		24.56±0.56^{kl}		3.60±0.10^{bcd}	
	PC+PM	(80+20)	9.16±0.35^{bc}		23.50±0.88^{hijk}		3.55±0.23^{bc}	
VI	FS+P	(80+20)	9.73±0.15^{defg}	9.20±1.28^{a}	24.94±0.56^{kl}	23.19±2.69^{b}	4.90±0.21^{kl}	3.89±1.43^{ab}
	FS+S	(80+20)	7.74±0.20^{a}		20.13±0.25^{ab}		2.88±0.12^{a}	
	FS+PM	(80+20)	10.13±0.12^{gh}		24.50±1.00^{jkl}		4.31±0.29^{hij}	

Note: Small letters given as superscript over dry matter, protein, and carbohydrate values represent homogenity groups obtained by statistical analysis with similar letters reflecting statistical insignificance at the 95% confidence level.
[a] In volume.
[b]Each reading is average of five test samples.
[c]Standard deviation.

4 - 8.1% respectively, of the dry weight basis. Our results agree with those reported by Coşkuner and Özdemir (1997) for dry matter and protein content of mushroom samples (*A. bisporus*). Han (1999) studied dry matter and protein content of *A. bisporus* cultivated on a mixture of horse manure, straw, chicken manure, gypsum, and water. He found that dry matter and protein contents of *A. bisporus* were 7.19 to 9.14% and 32.92 to 34.08%, respectively. Dry matter values in our study are consistent with the values in Han's (1999). But, protein values in our study were lower than Han's findings. It may be due to the differences in the region where mushrooms grown (Yildiz et al. 2005), C/N ratio of a grown region (Diez and Alvarez, 2001; Yildiz et al., 1998), different casing materials used for cultivation of *A. bisporus* (Baysal, 1999).

Conclusion

This study was designed to determine dry matter, protein, and carbohydrate contents of *A. bisporus*, cultivated on wheat straw and waste tea leaves based composts and using different casing materials. Dry matter and carbohydrate contents of *A. bisporus* cultivated on group I and group II casing materials were higher than those of other casing groups. Protein content of *A. bisporus* cultivated on wheat straw and using different casing materials was not significantly different from each other.

REFERENCES

Baysal E (1999). Utilization possibilities of waste tea leaves in the cultivation of *Agaricus bisporus* (Lange) Sing., Ph.D. Thesis, Karadeniz Technical University, Trabzon, Turkey, p. 157.

Breene WM (1990). Nutritional and medicinal value of specialty mushrooms. J. Food Prot. 53(10): 883-894.

Bono Z, Rajarathnam S (1988). *Pleurotus* mushrooms. Part ii, nutritional value, post harvest physiology, preservation and role as human food. CRC Crit. Rev. Food Sci. Nutr. 27(2): 87-158.

Coşkuner Y, Özdemir Y (1997). Effects of canning processes on the elements content of cultivated mushrooms (*Agaricus bisporus*). Food Chem. 60(4): 559-562.

Diez VA, Alvarez A (2001). Compositional and nutritional studies on two wild edible mushrooms from northwest Spain. Food Chem. 75: 417-422.

Han J (1999). The influence of photosynthetic bacteria treatments on the crop yield, dry matter content, and protein content of the mushroom *Agaricus bisporus,* Sci. Horticult. 82: 171-178.

Hayes WA, Shandilya TR (1977). Casing soil and compost substrates used in the artifical culture of *Agaricus bisporus*, the cultivated mushroom. Ind. J. Mycol. Pl. Pathol. 7: 5-10.

Kurbanoglu EB, Algur OF (2002). The influence of ram horn hydrolyzate on the crop yield of the mushroom *Agaricus bisporus*. Sci. Horticult. 94: 351-357.

Manzi P, Gambelli L, Marconi S, Vivanti V, Pizzoferrato L (1999). Nutrients in edible mushrooms: an interspecies comparative study. Food Chem. 65(4): 477-482.

Manzi P, Aguzzi A, Pizzoferrato L (2001). Nutritional value of mushrooms widely consumed in Italy. Food Chem. 73: 321-325.

Randle PE (1984). Supplementation of mushrooms composts: A rev. Mush. J. 151: 241-269.

Shandilya TR (1982). Composting betters mushroom yield. Ind. Hort. 27(1): 13-18.

Shandilya TR (1986). Effect of differently pasteurized composts on the yield of *Agaricus bisporus,* Indian J. Pl. Pathol. 4(1): 89-90.

Yildiz A, Karakaplan M, Aydın F (1998). Studies on *Pleurotus ostreatus* (Jacq. Ex. Fr.) Kum. Var. Salignus (Pers. Ex. Fr.) Konr. Et Maubl.: Cultivation, proximate composition, organic and mineral composition of carpophores. Food Chem. 61: 127-130.

Yildiz A, Yeşil ÖF, Yavuz Ö, Karakaplan M (2005). Organic elements and protein in some macrofungi of South east Anatolia in Turkey. Food Chem. 89: 605-609.

Zhang R, Li X, Fadel JG (2002). Oyster mushroom cultivation with rice and wheat straw. Bioresour. Technol. 82: 277-284.