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EFFECT OF VARIOUS SUBSTRATES ON PRODUCTION OF OYSTER MUSHROOM

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ABSTRACT

This work was carried out during the period from 2006 to 2007 on a special farm at Kaffer Saker, Sharkia Governorate, processed for mushroom production, to study the effect of organic agricultural wastes substrates; i.e.**,** rice straw, wheat straw, faba bean straw, cotton straw, maize straw, tomato straw, pepper straw, eggplant stalks, snap bean straw, pea straw, cowpea straw, groundnut straw and okra straw on the productivity of oyster mushroom.

The results indicated that the suitable substrates used for cultivation and production of oyster mushroom were rice straw and wheat straw, which gave the highest values of yield and its components and dry matter contents of fruit body.

As for chemical constituents of fruit bodies, fruit bodies produced on *Fabaceae* substrates (faba bean straw, snap bean straw, pea straw, cowpea straw and groundnut straw) had the highest values of nitrogen, potassium, protein and carbohydrates contents when compared with the other substrates.

INTRODUCTION

Oyster mushroom belongs to genus *Pleurotus* which is one of the most famous mushrooms in the Middle East region and in the world. The world consumption amounts of oyster mushroom have come up to the fifth among edible fungi produced over 40 thousand tons per year (Ahmed, 1998).

Oyster mushroom, grow well on many agricultural wastes substrates and is the easy one to grow for a beginner grower.

In addition, it has a broad adaptability for growing under various climatic conditions and on various nutritive substrates (El-Bagori *et al.,* 1996).

Ramesh and Ansari (1987) estimated several locally available substrates such as rice straw, banana leaves, sawdust, oil palm refuse, oil palm bunch refuse or grass straw to study conversion efficiency of *P. sajor-caju*. They found that rice straw and banana leaves were the best substrates, which recorded 60 % increases in conversion efficiency on dry weight basis.

Farrag (1993) cultivated four strains of *Pleurotus* spp.; i.e., *P. ostreatus* NRRL 2366, *P. ostreatus* NRRL 7366, *P. sajor-caju* and *P. columbinus* on various substrates alone or in mixtures. Rice straw resulted in the highest total yield, early yield, cap diameter and protein contents in fruit body followed by the mixed medium of rice straw + faba bean stalks + artichoke waste (1:1:1), while sawdust and artichoke waste resulted in the lowest values.

Deka *et al.* (1994) investigated the cultivation of *Pleurotus flabellatus*, *P. sajor-caju* and *P. ostreatus* on the following agricultural wastes: paddy straw, maize stover, banana pseudostem, *Mucuna bracteata*, *Pueraria phaseoloides*, *Imperata cylindrica* and bamboo leaves. Paddy straw was the best substrate for the three *Pleurotus* spp. with the shortest time for mycelial run and fruit-body formation, and the highest yield [0.759-0.839 kg/ block (50 × 25 × 18 cm)] as well as yield substrate ratio.

Hosni (1996) indicated that phosphorus content in fruit bodies exhibited a linear increase relationship with age advance during growth. The highest concentration was shown in rice straw substrate followed by water hyacinth. Potassium content in fruit bodies increased with age advance in a linear state during development. The highest percentage was obtained from water hyacinth substrate followed by rice straw.

Mohammady (1996) used eleven organic wastes for cultivation of two species of oyster mushroom; i.e., *P. columbinus* and *P. sajor-caju*. She indicated that three substrates; i.e., rice straw, corn stalks and wheat straw showed high productivity of oyster mushroom fruit bodies.

Kalita *et al.* (1997) illustrated that when grew *P. sajor-caju* in polyethylene bags on the following substrates: paddy straw [rice straw], rice straw + rice husk (1:1 v/v), water hyacinth, chopped banana leaves, betelnut [arecaunt] husk or sugarcane bagasse. The fresh weight of mushrooms from each bed was recorded up to the third flush and biological efficiency (B.E.) was calculated. Paddy straw supported the highest yield (450 g/kg dry straw, 45 % B.E.). B.E. values for water hyacinth, paddy straw + rice husk, banana leaves, and sugarcane bagasse and arecanut husk were 35.2, 27.8, 22.6, 16.7 and 12.9 %, respectively.

Radwan (2005) found that there were significant differences in total yield among the different substrates. Rice straw gave the highest yield, early yield, and biological efficiency. On the other hand, using faba bean straw gave the highest values of chemical constituents in fruit body as compared with other substrates.

Attia (2006) used rice straw, wheat straw and faba bean straw to productive oyster mushroom, found that rice straw substrate recorded maximum total yield, early yield and biological efficiency.

Information about production of oyster mushroom under Egyptian conditions is not available. Therefore, the present study was conducted to investigate the effect of organic agricultural waste substrates on productivity, to determine the suitable substrate. That can be achieved the maximum yield and quality of mushroom fruit bodies.

MATERIALS AND METHODS

This work was carried out during the period from 2006 to 2007 on a special farm at Kaffer Saker, Sharkia Governorate, to produce oyster mushroom.

This experiment included 13 organic agricultural wastes substrates; i.e., rice straw, wheat straw, faba bean straw, cotton straw, maize straw, tomato straw, pepper straw, eggplant stalks, snap bean straw, pea straw, cowpea straw, groundnut straw and okra straw.

These treatments were arranged in a complete randomized block design with three replications. Every replicate consists of three white perforated polyethylene bags contained 3 kg wet substrates, the dimensions of each bag were 50 depth x 35 cm diameter and was manufactured from plastic thickness of 80 microns. This experiment was conducted in two seasons, started on 25th November, 2006 and 2007 seasons.

Preparation of organic substrates

All used organic substrates were chopped particles (4-5cm) and soaked in tap water at 12 hours. The excess water was drained off and pasteurization of organic substrates was carried out using life steam at 80-90 °C for 6 hours.

Chemical constituents of substrates after fermentation (before spawning) are shown in Table 1.

Table 1: Chemical constituents of substrates and mixed substrates after fermentation (before spawning)

Treatments	Mineral contents (%)			Total (%)	
Organic substrates	**N**	**P**	**K**	**Protein**	**Carbohydrates**
Rice straw	0.42	0.18	0.38	2.63	24.25
Wheat straw	0.36	0.20	0.42	2.25	22.35
Faba bean straw	0.59	0.32	0.48	3.69	31.28
Cotton straw	0.40	0.24	0.33	2.50	22.19
Maize straw	0.33	0.16	0.28	2.06	19.27
Tomato straw	0.44	0.21	0.41	2.75	26.19
Pepper straw	0.40	0.16	0.38	2.50	24.18
Eggplant stalks	0.50	0.14	0.33	3.13	22.48
Snap bean straw	0.54	0.29	0.49	3.38	29.79
Pea straw	0.60	0.33	0.50	3.75	34.54
Cowpea straw	0.65	0.30	0.45	4.06	35.21
Groundnut straw	0.58	0.25	0.39	3.63	30.12
Okra straw	0.32	0.16	0.33	2.00	24.17

Spawning

After the pasteurization process completed, the substrates were get out and spread in a 10 cm layer thickness until the temperature reached to 25 ± 3 °C. The substrate was applied in four layers (10 cm thick) into polyethylene bags in 50 cm depth x 35 cm diameter (3 kg wet substrate/ bag). The spawn material was distributed over each layer at the rate of 5 % (w/w)

Mycelia growth

The inoculated polyethylene bags were transferred to incubation room at temperature 25 ± 3°C, till full colonization (two weeks). Then the polyethylene bags were pinned and transferred to production room, where the temperature was 20 ± 3°C and a relative humidity was maintained to about 80 - 90 % by using a foggy system.

Sources of the spawn materials in both experiments

The source of *Pleurotus ostreatus* was the Food Technology Research Institute, Agriculture Research Center.

Data Recorded

Mature fruit bodies of all harvests were picked up at the marketable stage (5-7 days intervals) and the following data were recorded:

I. Yield and Its Components

1. Early yield (g) = yield of first flush (the first 15^{th} days)
2. Weight of total yield (g) / bag.
3. Biological efficiency (%): It was estimated according to the following equation (Chang *et al.,* 1981),

$$\frac{\text{Fresh weight of total yield}}{\text{Weight of dry substrate}} \times 100$$

4. Average weight of cap (g).
5. Average cap diameter (cm).
6. Average weight of fruit body (g).

II. Chemical Constituents

1. Dry matter percentage (D.M. %):

Sample of 50 g fruit bodies from each replicate were mixed and dried in an electrical oven at 105 ºC till constant weight and D.M % determined according to (A.O.A.C., 1980).

2. Minerals, Protein and Total Carbohydrates

Samples of 50 gm fruit bodies from each replicate as well as samples of 200 gm from all used substrates before spawning and after harvesting were taken , then dried (by using an electrical oven) at 70 °C till constant weight. The dried materials grinded to a fine powder for the following chemical analysis:

a. Minerals Determination

N, P and K were determined according to the methods advocated by Bremner and Mulvaney (1982), Olsen and Sommers (1982), and Jackson (1970), respectively.

b. Crude Protein (%)

It was determined as nitrogen content and multiplying by 6.25 to convert it to equivalent protein content (A.O.A.C., 1980).

c. Total Carbohydrates (%)

It was determined following the methods described by (Dubois *et al,* 1956).

Statistical analysis

The data of both experiments were subjected to proper statistical analysis of variance according to Snedecor and Cochran (1982) and means separation were done according to L.S.D. at 0.05 level of probability.

RESULTS AND DISCUSSION

1. Yield and its Components

1.1 Total yield

Data presented in Table 2 indicate that there were significant differences in total yield among the different substrates; i.e. rice straw, wheat straw, faba bean straw, cotton straw, maize straw, tomato straw, pepper straw, eggplant stalks, snap bean straw, pea straw, cowpea straw, groundnut straw and okra straw.

Rice straw and wheat straw gave the highest total yield, being 1138.92 and 1230.92 g/ 3kg wet substrates in the first and second seasons, respectively. Meanwhile, okra straw recorded the lowest total yield as compared with other substrates. Using rice straw for growing mushroom was the best substrate for increasing total yield. These results are in harmony with those obtained by Mohammady (1996), Radwan (2005) and Attia (2006)

Table 2: Effect of various substrates on early yield (g), total yield (g) and biological efficiency (%) of oyster mushroom

Characters / Substrates	Early yield (gm)		Total yield (gm)		Biological efficiency (%)	
	First season	Second season	First season	Second season	First season	Second season
Rice straw	403.25	417.83	1138.92	1230.92	77.95	80.52
Wheat straw	368.13	391.20	1082.58	1218.26	72.11	72.99
Faba bean straw	342.17	356.05	976.99	1098.65	68.98	69.12
Cotton straw	341.32	339.86	999.29	1035.00	64.46	64.10
Maize straw	370.45	363.40	997.01	1025.09	72.48	69.16
Tomato straw	323.60	309.65	1029.70	1007.82	65.69	65.75
Pepper straw	303.49	293.86	950.54	997.60	67.69	62.88
Eggplant stalks	286.83	288.00	966.06	980.99	61.88	59.55
Snap bean straw	307.97	336.04	988.06	1044.43	59.52	58.63
Pea straw	346.95	353.43	989.00	1002.50	58.54	53.62
Cowpea straw	360.16	347.88	987.18	1000.74	56.29	56.38
Groundnut straw	356.36	348.52	982.50	993.90	52.49	53.54
Okra straw	295.43	295.12	929.59	928.02	54.71	54.44

1.2 Early yield

It appeared from the data in Table 2 that rice straw gave the highest early yield in both seasons as compared with other substrates, being 403.25 and 417.83 g/3kg wet substrate in the first and second seasons, respectively, while eggplant stalks and okra straw gave the lowest early yield. Similar results were obtained by Radwan (2005) and Attia (2006)

1.3 Biological efficiency

As for the effect of various substrates on biological efficiency (%), it is obvious from the results (Table 2) that rice straw gave the highest percentage of biological efficiency. But pea straw, cowpea straw, groundnut straw and okra straw recorded the lowest percentage of biological efficiency as compared the other substrates (rice straw, wheat straw, faba bean straw, cotton straw, maize straw, tomato straw, pepper straw, eggplant stalks and snap bean straw). These results are in harmony with those obtained by Ramesh and Ansari (1987), El-Bagori *et al*. (1996) and Kalita *et al.* (1997).

2. Cap Weight, Cap Diameter and Fruit Body Weight

With regarding to cap weight, the results in Table 3 indicate that rice straw and wheat straw gave the highest cap weight in both seasons, being 19.03 or 17.21 and 20.27 or 19.49 g/3kg wet substrate in the first and second seasons, respectively, while okra straw gave the lowest cap weight, being 11.38 and 12.63 g/3kg wet substrate in the first and second seasons, respectively. These results are in harmony with those reported by Hosni (1996).

With regard to, cap diameter, it is clear from data presented in Table 3 that rice straw gave the highest value of cap diameter. Meanwhile, eggplant stalks and okra straw recorded the lowest value of cap diameter as compared with other substrates. These results are in harmony with those obtained by Farrag (1993), Radwan (2005) and Attia (2006).

Table 3: Effect of various substrates on cap weight (gm), cap diameter (cm) and fruit body weight (gm) of oyster mushroom

Characters / Substrates	Cap weight (gm)		Cap diameter (cm)		Fruit body weight (gm)	
	First season	Second season	First season	Second season	First season	Second season
Rice straw	19.03	20.27	9.87	10.67	25.00	25.33
Wheat straw	17.21	19.49	8.81	9.99	22.14	24.49
Faba bean straw	15.41	17.90	8.03	8.92	21.45	23.06
Cotton straw	14.45	16.75	7.99	8.09	19.84	22.02
Maize straw	14.71	15.99	7.94	7.72	20.01	20.78
Tomato straw	14.83	16.85	7.86	7.74	20.56	21.91
Pepper straw	13.75	14.21	7.35	7.13	18.77	20.41
Eggplant stalks	13.50	12.86	6.62	6.62	17.67	18.81
Snap bean straw	12.40	13.06	6.96	6.91	17.66	19.29
Pea straw	12.77	13.55	7.48	7.69	18.31	19.48
Cowpea straw	12.36	13.55	6.89	8.25	17.87	18.60
Groundnut straw	13.18	12.65	7.08	7.38	17.75	17.98
Okra straw	11.38	12.63	6.34	6.26	16.45	17.21
L.S.D$_{0.05}$	0.89	0.90	0.36	0.65	1.21	0.91

Regarding the effect of organic substrates on fruit body weight, the results in Table 3 indicate that there were significant differences in fruit body weight among the different substrates. Rice straw gave the highest fruit body weight, being 25.00 and 25.33 g in the first and second growing seasons, respectively, as compared with other media growth substrates. While growing of oyster mushroom on okra straw medium gave the lowest fruit body weight, being 16.45 and 17.21 g in the first and second growing seasons, respectively. Similar results were obtained by Hosni (1996), Radwan (2005) and Attia (2006).

3. Minerals Determination (NPK)

Respecting nitrogen content, fruit bodies produced on *Fabaceae* substrates (faba bean straw, snap bean straw, pea straw, cowpea straw and groundnut straw) had the highest values of nitrogen content when compared with the other substrates (Table 4). On the other hand, fruit bodies that produced on rice straw, wheat straw, maize straw and okra straw had the lowest values of nitrogen content when compared with the other substrates. These results agree with those reported by Attia (2006).

With regard to phosphorus content, data presented in Table 4 show that rice straw, cotton straw, maize straw, tomato straw, pepper straw, eggplant straw and okra straw gave the lowest values of phosphorus content in dry fruit bodies of oyster mushroom when compared with the other substrates. On the other hand, wheat straw, faba bean straw, snap bean straw, pea straw, cowpea straw and groundnut straw recorded the highest values of phosphorus content in dry fruit bodies of oyster mushroom.

It is clear from data presented in Table 4 that fruit bodies produced on pea straw had the highest values of potassium content when compared with the other substrates, but using eggplant stalks or okra straw as media growth to oyster mushroom recorded the lowest values of potassium content in dry fruit bodies as compared with other substrates.

Table 4: Effect of various substrates on mineral contents (NPK) in dry fruit body of oyster mushroom

Characters / Substrates	N %		P %		K %	
	First season	Second season	First season	Second season	First season	Second season
Rice straw	2.93	3.04	0.82	0.83	3.82	3.82
Wheat straw	2.88	3.05	0.88	0.88	4.00	3.95
Faba bean straw	3.56	3.51	0.91	0.92	4.06	4.04
Cotton straw	2.94	3.02	0.85	0.82	3.85	3.79
Maize straw	2.87	3.09	0.81	0.74	3.74	3.73
Tomato straw	2.95	3.05	0.84	0.79	3.95	3.88
Pepper straw	2.98	3.06	0.74	0.71	3.73	3.73
Eggplant stalks	3.12	3.08	0.75	0.72	3.77	3.74
Snap bean straw	3.45	3.44	0.89	0.92	3.98	4.02
Pea straw	3.62	3.67	0.90	0.92	4.08	4.06
Cowpea straw	3.63	3.47	0.91	0.86	4.02	3.97
Groundnut straw	3.43	3.43	0.89	0.83	3.93	3.90
Okra straw	2.90	2.84	0.77	0.73	3.75	3.72
$L.S.D_{0.05}$	0.13	0.11	0.06	0.04	0.07	0.05

4. Protein, Carbohydrates and Dry Matter

Crude protein contents in dry fruit bodies, fruit bodies produced on *Fabaceae* substrates (faba bean straw, snap bean straw, pea straw, cowpea straw and groundnut straw) had the highest values of crude protein contents when compared with the other substrates (Table 5).
The best growth media which gave the highest values were pea straw and cowpea straw. On the other hand, okra straw or maize straw recorded the lowest values of crude protein contents in dry fruit bodies. Similar results were obtained by Attia (2006).

As for the effect of various substrates on carbohydrates contents in dry fruit bodies, results in Table 5 indicate that there were significant effects of growth media on carbohydrates contents. It is obvious from the same data that using faba bean straw or pea straw as growth media to oyster mushroom recorded the highest values of carbohydrates contents in dry fruit bodies as compared with other substrates. Meanwhile, okra straw or maize straw recorded the lowest values of carbohydrates contents. Concerning dry weight of fruit body, the effect of rice straw, wheat straw, Faba bean straw, cotton straw, maize straw, tomato straw, pepper straw, eggplant stalks, snap bean straw, pea straw, cowpea straw, groundnut straw and okra straw on dry weight of fruit body are shown in Table 5, it is obvious from the data that oyster mushroom grown on wheat straw, faba bean straw, tomato straw, snap bean straw, pea straw or cowpea straw gave the highest values of dry weight of fruit body as compared with other substrates. But oyster mushroom grown on okra straw recorded the lowest values of dry weight of fruit body. These results are in harmony with those reported by Radwan (2005)**.**

Table 5: Effect of various substrates on crude protein and carbohydrates contents in dry fruit body and dry weight of fruit body (gm) of oyster mushroom

Characters	Crude protein (%)		Carbohydrates (%)		Dry weight of fruit body (gm)	
Substrates	First season	Second season	First season	Second season	First season	Second season
Rice straw	18.29	19.02	33.79	35.87	7.56	7.74
Wheat straw	17.98	19.07	31.87	34.03	8.48	8.56
Faba bean straw	22.25	21.92	37.44	39.99	8.76	8.20
Cotton straw	18.35	18.90	31.86	33.46	7.38	6.80
Maize straw	17.92	19.29	30.85	33.77	7.03	7.30
Tomato straw	18.46	19.06	33.30	34.44	8.18	8.14
Pepper straw	18.60	19.10	32.09	32.43	7.91	7.12
Eggplant stalks	19.50	19.27	32.38	31.84	7.02	7.17
Snap bean straw	21.54	21.50	35.00	36.46	8.42	8.68
Pea straw	22.65	22.92	37.15	39.23	8.40	8.30
Cowpea straw	22.71	21.67	36.45	38.07	8.46	8.55
Groundnut straw	21.54	21.46	33.54	36.54	7.26	7.06
Okra straw	18.10	17.73	30.34	32.76	5.86	5.22
$L.S.D_{0.05}$	0.79	0.68	1.31	1.47	1.36	1.79

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تأثير البيئات المختلفة على إنتاجية عيش الغراب المحارى

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أجريت هذه التجربة خلال الفترة من ٢٠٠٦ – ٢٠٠٧ فى مزرعة خاصة لانتاج عيش الغراب بكفر صقر، محافظة الشرقية، لدراسة تأثير المخلفات الزراعية العضوية (قش الارز، وتبن القمح، وتبن الفول، وحطب القطن، وقش الذرة، وقش الطماطم، وقش الفلفل، وسيقان الباذنجان، وقش الفاصوليا، وقش البسلة، وقش اللوبيا، وقش الفول السودانى، وقش الباميا) على انتاجية عيش الغراب المحارى.

اوضحت النتائج ان أنسب البيئات المستخدمه لزراعة وانتاج عيش الغراب المحارى هى قش الارز، وتبن القمح. حيث أعطيا اعلى القيم للمحصول ومكوناته، والمادة الجافة للجسم الثمرى.

أما بالنسبة للتركيب الكيماوى للأجسام الثمرية، الاجسام الثمرية المنتجه على مخلفات العائلة البقولية(تبن الفول، قش الفاصوليا، قش البسلة، قش اللوبيا، قش الفول السودانى) أعطت اعلى القيم للمحتوى من النيتروجين، والبوتاسيوم، والبروتين، والكربوهيدرات مقارنة بباقى البيئات الاخرى