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Impact of Substrate Volume on Oyster Mushroom Fruiting Bodies Production

Soliman, Marwa M.; M.F. Mohamed; M.H. Dokashi and A.K. Metwally

Department of Vegetable Crops, Faculty of Agriculture, Assiut University, Assiut, Egypt.
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Abstract

Four different rice straw substrate volumes (0.5, 1, 2 and 5 kgs) were assessed for cultivation of oyster mushroom (*Pleurotus ostreatus*). The mushroom grown in 2 kgs substrate volume exhibited the highest biological efficiency and produced the highest fruiting bodies yield. This treatment gave the greatest average weight for the whole fruiting body and for the fruiting body cap. However, mushroom grown in 1 kg substrate volume was earlier than 2 kgs volume to colonize. Both treatments were statistically alike concerning days lapsed to harvest the fruiting bodies, the diameter of the fruiting bodies and the weight and the length of the stem. Further, the mushroom in these treatments degraded the least amount of substrate as shown by both the colonized substrate and spent weight while producing high fruiting bodies yield. Thus a more efficient bioconversion is suggested for the mushroom grown in 1 or 2 kgs substrate. The overall data, however, propose the production of the oyster mushroom (*Pleurotus ostreatus*) in substrate media of 2 kgs volume.

Keywords*: Biological efficiency, colonizing ability, environmental friendly, macrofungi, medicinal values, sustainable clean environment.*

Introduction

The macrofungi 'mushrooms' can convert lignocellulose into healthy, nutritious human food rich in protein. *Pleurotus* mushrooms, commonly called 'oyster mushrooms', are one of the top most widespread mushrooms (Adejoye *et al.*, 2006). The content of essential amino acids in mushroom is high and close to the need of the human body. Also, *Pleurotus* species are rich source of minerals and vitamin (Çağlarırmak, 2007). Mushroom is easy to digest and it has no cholesterol content (Mata *et al* 2005). Oyster mushrooms are characterized by their adaptability to a wide range of temperature conditions (15-30°C). It can grow under both temperate and tropical climatic conditions. Oyster mushrooms have a high saprophytic colonizing ability (Zahida *et al*., 2016). They are easy to cultivate and can degrade wide range of lignocellulosic substrates (Mata *et al.* 2005; (Bonatti *et al*., 2004; Mohamed *et al*., 2012). Therefore, they can play an appreciable role in sustaining clean environment. The mushroom cultivation reduces lignin, cellulose, hemi cellulose, tannin and crude fiber content of straw making it ideal for animal feed (Ortega *et al.,* 1992). Besides their valued nutritional contents, they have medicinal values as well (Agrahar-Murugkar and Subbulakshmi, 2005).

To establish a technology for the oyster mushroom production industry, a great deal of research has been conducted to optimize the various factors of its cultivation. However, the research so far still mostly focusing on the substrate type (Jan-

daik and Goyal, 1995; Khanna and Garcha, 1982; Bonatti *et al*., 2004), substrate mixtures (Mohamed *et al*., 2012), enrichment supplements (Soliman, 2011), the environmental conditions and the fungus species used in cultivation (Mohamed *et al*., 2012), and other preparation processes (Bhatti *et al*., 2007; Mohamed, *et al*., 2011; Mohamed *et al*., 2016). We are unaware of research that considered the medium volume as affecting oyster mushroom production. Commonly, oyster mushroom is incubated in polyethylene bags filled with half or one kg (Mane 2007; Soliman *et al*., 2011), on average. It is unclear whether the production can be enhanced when using other smaller of bigger sizes. The objective of the current investigation was to test four different volumes of the rice substrate as affecting mushroom (*Pleurotus ostreatus*) yield and fruiting bodies characteristics.

Materials and Methods

The current research trial was conducted in the mushroom production laboratory, Department of Vegetable Crops, Faculty of Agriculture, Assiut University. The spawn of oyster mushroom (*Pleurotus ostreatus*) used in this study was obtained from the Agricultural Research Center, Food Technology Research Institute, Giza. Production of the oyster mushroom basidiocarp (fruiting bodies) was assessed in bags containing different volumes (0.5, 1, 2 and 5 kg) of rice straw substrate with no supplements added. The experiment layout was according to randomized complete-blocks with three replicates.

Preparation of substrate and spawn inculcation

Rice substrate utilized in the current study was chopped into 3 to 5 pieces and moistened thoroughly by soaking in water. Then after, it was subjected to hot water (2 h at 80°C) for pasteurization (Bahukhandi and Munjal, 1989; Balasusbramanya and Kathe, 1996). The pasteurized substrate was left to cool down and to drain excessive water until mean moisture reached about 70%.; estimated by drying samples of 100 g pasteurized substrate in an electric oven at 60°C until constant weight. The pasteurized substrate was manually packaged into clear polyethylene bags containing ½ kg, 1 kg, 2 kgs and 5 kgs of the wet pasteurized substrate. The spawn was inoculated at rate of 5% (based on wet mass of the substrate).

Incubation conditions for spawn running and fruiting bodies formation

The inoculated substrate was incubated for colonization at 24-28°C in darkness. The colonized mushroom bags were subsequently transferred into fruiting room for basidiocarp formation. Polyethylene bags were removed and the cultures were kept at 23-27°C under light provided by cool white fluorescent tubes for 12 h a day (Soliman, 2011). Electric fans were used 2 h and 4 h a day during incubation for spawn running and basidiocarp formation, respectively, to provide homogenous ventilation condition in the incubation room. The bags moisture was maintained by daily water spraying during the whole cropping period. Mushroom fruiting bodies were harvested about a week after pinheads formation that was when the mushroom fruiting body was turned

slightly darker at the cap margins. Each treatment was presented by 5 culture bags within each replicate.

Measurements

Data was recorded for total fruiting bodies yield (g/kg substrate), biological efficiency (%), days lapsed to full-colonized substrate bags, day lapsed to harvest the fruiting bodies, colonized bag weight (g), spent dry weight (g), average weight of the fruiting body (g), weight of the fruiting bodies cap (pileus) (g), diameter of the fruiting bodies cap (pileus) (cm), weight of the fruiting bodies stems (stalks or stipe) (g) and length of the fruiting body stems (stalks or stipe) (cm). Biological efficiency of the mushroom (BE) was calculated as follows: BE (%) = (weight of fresh mushroom fruiting bodies/ weight of dry substrate) x 100 (Ahmed, 1995; Kirbag and Akyilz. 2008).

Statistical analysis

Original means data for total fruiting bodies yield, biological efficiency, colonized bag weight (g) and spent dry weight, were adjusted to 1 kg equivalent volume before conducting the analysis of variance. Separate analysis of variance (ANOVA) was tested for each trial. Upon the establishment of the homogeneity of error variances, combined ANOVA was conducted to test the significance of the interaction of trial and treatments (Gomez and Gomez, 1984). In case of significance of the error term of this interaction, means were compared for each trial. Otherwise, means over the trials were compared. The least significant difference (LSD) test was used for mean separation in either case.

Results

1- Total fruiting bodies yield and the biological efficiency (BE)

1-1- Total fruiting bodies yield (per kg of the rice substrate)

Analysis of variance along with means of the substrate volume is presented for total fruiting bodies yield produced by the oyster mushroom per kg of the rice substrate in Table (1). Clearly, significant differences existed among the treatments of the four substrate volumes both in the separate and combined analyses. The highest total fruiting bodies yield per kg of the rice substrate was produced by the fungus grown in bags containing two kg in both trials. A comparable total fruiting bodies yield per kg of the rice substrate was obtained in the second trial from cultures in bags filled with one kg. Utilizing bags filled with 0.5kg gave the lowest yield in the first trial whereas bags of 5 kg yielded the least amount of total fruiting bodies weight per kg of the rice substrate.

1-2- Biological efficiency (BE, %)

Table (2) shows the analysis of variance for the total variation of the biological efficiency among the four treatments of the substrate volume. Furthermore, the mean performance of the substrate volume is presented for separate and combined analysis of variance. Significant differences were found among the treatments of the four substrate volumes both in the separate and combined analyses. The highest biological efficiency was produced by the fungus grown in bags containing two kg in both trials. A similar biological efficiency was detected in the second trial for cultures in bags filled with one kg. Utilizing bags containing 0.5 kg gave the

lowermost biological efficiency in the first trial. However, bags of 5 kg had the lowest the biological efficiency in the second trial.

2- Phenology traits

2-1- Days lapsed to full-colonized rice substrate bags

Separate and combined analysis of variance along with the means of the substrate volume treatments are shown in Table (3) for days lapsed to full-colonized rice substrate bags with the hyphae of oyster mushroom. Obviously, significant differences were found among the treatments of the four substrate volumes both in the separate and combined analyses. The largest number of days lapsed to full-colonization of the rice substrate bags was detected for cultures in bags containing 5kgs substrate. The least number of days lapsed to full-colonization of the rice substrate bags was detected for cultures in bags containing 0.5 kg or one kg substrate.

2-2- Day lapsed to harvest the fruiting bodies

The means of the substrate volume treatments are shown in Table (4) for days lapsed to harvest the fruiting bodies of oyster mushroom. Separate and combined analyses of variance are also summarized in Table (4). Apparently, significant differences were found among the treatments of the four substrate volumes both in the separate and combined analyses. The largest number of days lapsed to harvest the fruiting bodies of oyster mushroom was resulted from cultures in bags containing 0.5 kg substrate. The remaining three treatments of substrate were almost similar as no significant difference was detected.

3- Weight of colonized bags and dry spent

3-1- Weight of colonized bags (g)

Table (5) shows the analysis of variance for the total variation of the colonized bags weight among the four treatments of the substrate volume. Besides, the mean performance of the substrate volume is presented for separate and combined analysis of variance. Significant differences were found among the treatments of the four substrate volumes both in the separate and combined analyses. The greatest colonized bags weight was produced by the fungus grown in bags containing one or two kg in both trials. Utilizing bags containing 5 kg gave the lowermost colonized bags weight in both trials.

3-2- Dry spent weight (g)

Analysis of variance along with means of the different substrate volume treatments is presented for dry spent weight that remained after the production of the oyster mushroom (Table 6). Obviously, significant differences existed among the treatments of the four substrate volumes both in the separate and combined analyses. The greatest dry spent weight remained after the production of the mushroom was found for bags filled with one kg or two kg in both trials. There was no difference between the bags filled with 0.5 kg or 5 kg substrate in both trials.

4- Characteristics of the fruiting bodies

4-1- Weight of the fruiting body (g)

Table (7) shows partitioning of the total variance due to weight of the fruiting bodies among the four treatments of the different substrate volume. In addition, the mean perform-

ance of the substrate volume treatments is tabulated for the separate and combined analysis of variance. Substantial differences were found among the treatments of the four substrate volumes both in the separate and combined analyses. The greatest weight of the fruiting bodies was exhibited by the mushroom fungus grown in bags containing five kgs in both trials. The second largest weight of the fruiting bodies was detected in the cultures in bags filled with two kgs. Utilizing bags containing half kg gave the lowermost weight of the fruiting bodies.

4-2- Weight of the fruiting body cap (g)

The means of the different substrate volume treatments are shown in Table (8) for the weight fruiting body cap of oyster mushroom. Separate and combined analyses of variance are also summarized in Table (8). Apparently, significant differences were found among the treatments of the four substrate volumes both in the separate and combined analyses. The highest weight for fruiting bodies cap of oyster mushroom was resulted from cultures in bags containing five kgs substrate. The slightest weight fruiting body cap was shown by mushroom produced in bags containing half kg. The remaining two treatments of substrate volume were almost similar as no significant difference was detected.

4-3- Diameter of the fruiting body cap (cm)

Separate and combined analysis of variance along with the means of the substrate volume treatments are shown in Table (9) for the diameter of the fruiting body cap. Clearly, significant differences were found among the treatments of the four different substrate volumes both in the separate and combined analyses. The greatest diameter for fruiting body cap of oyster mushroom resulted from cultures in bags containing five kgs substrate. The slightest diameter of fruiting body cap was shown by mushroom produced in bags containing half kg. The remaining two treatments of substrate volume were almost similar as no significant difference was detected between them.

4-4- Weight of the fruiting body stem (stalks)

Table (11) shows the partition of the total variance in separate and combined analyses of variance for the stem weight of the fruiting bodies. It exhibits also the means of the different substrate volume treatments. Appreciable, significant differences were shown among the treatments of the four different substrate volumes both in the separate and combined analyses. The least stem weight for fruiting body of oyster mushroom was found in cultures in bags containing half kgs substrate in the first trial. However, such the least stem weight was shown by cultures in bags containing one kgs substrate in the second trial. The greatest weight of the fruiting bodies stem was found in cultures in bags containing 2 kg in the first trial and 5 kg in the second trial.

4-5- Length of the fruiting body stem (stalks) (cm)

Separate and combined analyses of variance are shown in Table (12). Besides, the means of the different substrate volume treatments are shown in Table (12) for the length of the fruiting body stems. Significant

differences were shown among the treatments of the four different substrate volumes both in the separate and combined analyses. The least stem length for fruiting body of oyster mushroom was obtained by cultures in bags containing half kgs substrate. The remaining treatments of substrate volume seemed almost similar since no sizeable difference was found between them.

Discussion

Substrate volume seemed to be an influential factor in optimizing the production of oyster mushroom (*Pleurotus ostreatus*). The mushroom grown in bags containing 2 kg of rice straw gave the highest fresh fruiting bodies total yield. This was 111.9 % increase, as average of a twice repeated trial, over the fruiting bodies yield provided by the mushroom grown in bags filled with 5 kgs straw. Comparing with the yield gained in 0.5 kg straw, the increase was 64.3 % as average of a twice repeated trial. The second highest fruiting bodies yield was produced by mushroom grown in bags filled with 1 kg straw. This treatment was 32.9 % lower in yield than fruit bodies yield produced using bags containing 2 kgs straw, respectively, as average of a twice repeated trial.

There are an agreement between the fruiting bodies yield and the biological efficiency parameter. The mushroom grown in bags containing 2 kg of rice straw gave both the highest fruiting bodies yield and the highest value for biological efficiency. Likewise, the mushroom grown in bags filled with 1 kg straw had the second highest yield and biological efficiency. The lowest yield and biological efficiency were found in mushroom cultivated in bags filled with 0.5 kg and 5 kgs in the first trial and in bags having 5 kgs in the second trial. The colonized bag weight and the dry spent weight jointly with the biological efficiency suggest a greater competence for straw conversion into fruiting bodies yield occurred in the bags contained 1 or 2 kgs. While the mushroom grown in substrate volume of 2 kg had the highest yield of fruiting bodies, it used up the least of the substrate during both the colonization and the fruiting bodies development. The mushroom grown in substrate volume 1 kg followed the substrate volume 2 kgs in this context.

The colonization in bags containing 5 kgs was substantially late comparing with the other substrate volume treatments. Growth of microorganisms may occur due to the longer time lapsed to colonization as the substrate was pasteurized but not sterilized. Such longer time may alter the micro-environment inside the substrate bags and adversely affect the mushroom viability (Mohamed *et al*., 2016). Thus low fruiting bodies yield can happen. Growing the mushroom in bags with 0.5 kg substrate may enforce a volume stress due to limited nutrient supply (Soliman *et al*., 2011). This has been manifested in form of reduced fruiting bodies yield. Further, under such conditions growers have to wait longer time to harvest fruiting bodies of marketable size. Lateness of producing mushroom utilizing bags containing 0.5 kg substrate is estimated to be 9 to 13 days comparing with the other studied treatments.

Considerable alterations occurred in fruiting bodies characteristics as affected by the substrate volumes used. In general, the greatest values for the average weight of the fruiting body and fruiting body cap and the diameter of fruiting body cap were found in mushroom cultivated in substrate volume 5 kg followed by utilizing 2 kgs. The least values for abovementioned parameters were shown by the mushroom produced in substrate volume 0.5 kg. Prominently, utilizing 2 kgs substrate produced fruiting bodies of well marketable characteristics. In conclusion, this study advices the use of substrate volume of 2 kgs for production of oyster mushroom.

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Table 1. Total fruiting bodies yield of the oyster mushroom (*Pleurotus ostreatus*) produced using different volumes of rice straw substrate [(1)].

Substrate volume	Total fruiting bodies yield.(g/kg substrate)[1]	
	Trial 1	Trial 2
0.5 kg	204.733 c	184.067 c
1 kg	269.033 b	214.633b
2 kg	339.033 a	299.867a
5 kg	227.367 c	109.200 d
LSD 0.05	31.767	19.799
C.V. 6.11%		c.v. 4.91 %

Separate ANOVA mean squares			
Source of variation	D.F.	Trial 1	Trial 2
Blocks (B)	2	6.763	99.006
Substrate volume (S)	3	10447.202 **	18670.917 **
Pooled Error	6	252.803	98.208

Combined ANOVA				
Source of variation	D.F.	Mean squares		
Trial (T)	1	20253.659	Substrate vol.	Mean
Rep within (T)	4	52.885	0.5 kg	194.400 c
Substrate volume (S)	3	26427.409 **	1 kg	241.833 b
S X T	3	2690.710 **	2 kg	319.450 a
Pooled Error	12	175.506	5 kg	168.283d
LSD 0.05			16.66	
C.V.		5.74 %		

(1) Original mean data were adjusted, before the analysis of variance, to 1 kg equivalent volume.

Table 2. The percentage of biological efficiency for the oyster mushroom (Pleurotus ostreatus) produced using different volumes of rice straw substrate.

Substrate volume	Biological efficiency (%)	
	Trial 1	Trial 2
0.5 kg	61.48 c	55.28 b
1 kg	80.79 b	64.45 b
2 kg	101.81 a	89.82 a
5 kg	68.28 c	24.09 c
LSD 0.05	9.558	17.83
C.V.	6.13 %	15.28 %

Separate ANOVA mean squares			
Source of variation	D.F.	Trial 1	Trial 2
Blocks (B)	2	7.441	28.505
Substrate volume (S)	3	6421.532 **	2211.019 **
Pooled Error	6	22.889	79.668

Combined ANOVA				
Source of variation	D.F.	Mean squares		
Trial (T)	1	2321.650	Substrate vol.	Mean
Rep (T)	4	14.553	0.5 kg	58.390 c
Substrate volume (S)	3	2726.095 **	1 kg	72.612 b
S X T	3	425.978 **	2 kg	95.812 a
Pooled Error	12	51.278	5 kg	46.178 d
LSD 0.05			9.008	
C.V.		10.492 %		

(1) Original mean data were adjusted, before the analysis of variance, to 1 kg equivalent volume.

Table 3. Days lapsed to full-colonized substrate bags of the mushroom (*Pleurotus ostreatus*) produced using different volumes of rice straw substrate.

Substrate volume	Days lapsed to full-colonized substrate bags	
	Trial 1	Trial 2
0.5 kg	43.667 c	42.000c
1 kg	42.667 c	41.667 c
2 kg	50.000 b	50.000 b
5 kg	74.330 a	84.500 a
LSD $_{0.05}$	4.225	6.608
C.V. 4.02 %		**C.V.** 6.06%

Separate ANOVA mean squares				
Source of variation	**D.F.**	**Trial 1**	**Trial 2**	
Blocks (B)	**2**	1.583	6. 271	
Substrate volume (S)	**3**	657.556 **	1241.188 **	
Pooled Error	**6**	4.472	10.938	
Combined ANOVA				
Source of variation	**D.F.**	**Mean squares**		
Trial (T)	**1**	21.094	**Substrate vol.**	**Mean**
Rep (T)	**4**	3.927	**0.5 kg**	42.833 c
Substrate volume (S)	**3**	1852.205**	**1 kg**	42.167 c
S X T	**3**	46.538 **	**2 kg**	50.000 b
Pooled Error	**12**	7.705	**5 kg**	79. 41.a
LSD $_{0.05}$				3.492
C.V. 5.18 %				

Table 4. Day lapsed to harvest the fruiting bodies of mushroom (*Pleurotus ostreatus*) produced using different volumes of rice straw substrate.

Substrate volume	Day lapsed to harvest the fruiting bodies	
	Trial 1	Trial 2
0.5 kg	85.833 a	85.000 a
1 kg	74.500 b	72.600 c
2 kg	75.900 b	75.333 bc
5 kg	71.000 c	76.333 b
LSD $_{0.05}$	3.495	3.535
C.V.	2.29	2.29

Separate ANOVA mean squares				
Source of variation	**D.F.**	**Trial 1**	**Trial 2**	
Blocks (B)	**2**	0.601	0.053	
Substrate volume (S)	**3**	121.341**	86.181**	
Pooled Error	**6**	3.061	3.131	
Combined ANOVA				
Source of variation	**D.F.**	**Mean squares**		
Trial (T)	**1**	1.550	**Substrate vol.**	**Mean**
Rep (T)	**4**	0.327	**0.5 kg**	85.417 a
Substrate volume (S)	**3**	191.504 **	**1 kg**	73.550 b
S X T	**3**	16.018 *	**2 kg**	75.617 b
Pooled Error	**12**	3.096	**5 kg**	73.667 b
LSD $_{0.05}$				2.213
C.V.				2.28

Table 5. The colonized bag weight after incubation of the mushroom (*Pleurotus ostreatus*) produced using different volumes of rice straw substrate.

Substrate volume	Colonized page weight (g)[1]	
	Trial 1	Trial 2
0.5 kg	941.933 b	942.000 c
1 kg	974.200 a	981.833 a
2 kg	982.133 a	967.000 b
5 kg	869.667 c	915.900 d
LSD 0.05	12.93	13.81
C.V. 0.69 %	C.V. 0.73%	

Separate ANOVA mean squares			
Source of variation	D.F.	Trial 1	Trial 2
Blocks (B)	2	141.651	75.563
Substrate volume (S)	3	7879.640 **	2517.836 **
Pooled Error	6	41.863	47.797

Combined ANOVA				
Source of variation	D.F	Mean squares		
Trial (T)	1	564.539	Substrate vol.	Mean
Rep (T)	4	39.607	0.5 kg	941.967 b
Substrate volume (S)	3	9373.251 **	1 kg	978.017 a
S X T	3	1024.226 **	2 kg	974.567 a
Pooled Error	12	44.830	5 kg	892.783 c
LSD 0.05				8.423
C.V. 0.71 %				

(1) Original mean data were adjusted, before the analysis of variance, to 1 kg equivalent volume.

Table 6. Spent dry weight after the mushroom (*Pleurotus ostreatus*) production using different volumes of rice straw substrate.

Substrate volume	Spent weight (g)[1]	
	Trial 1	Trial 2
0.5 kg	94.400 b	90.867 d
1 kg	109.200 a	121.700 b
2 kg	104.500 a	166.733 a
5 kg	90.567 b	100.833 c
LSD 0.05	6.813	8.562
C.V. 3.42 %		c.v. 3.57 %

Separate ANOVA mean squares			
Source of variation	D.F.	Trial 1	Trial 2
Blocks (B)	2	319.643	31.676
Substrate volume (S)	3	258.654 **	3403.002 **
Pooled Error	6	11.627	18.365

Combined ANOVA				
Source of variation	D.F.	Mean squares		
Trial (T)	1	2488.807	Substrate vol.	Mean
Rep (T)	4	25.760	0.5 kg	92.633 c
Substrate volume (S)	3	2383.834 **	1 kg	115.450 b
S X T	3	1243.061 **	2 kg	135.617 a
Pooled Error	12	14.996	5 kg	95.700 c
LSD 0.05				4.871
C.V. 3.53%				

(1) Original mean data were adjusted, before the analysis of variance, to 1 kg equivalent volume.

Table 7. Average weight of the fruiting body for the mushroom (*Pleurotus ostreatus*) produced using different volumes of rice straw substrate.

Substrate volume	Weight of the fruiting bodies (g)	
	Trial 1	Trial 2
0.5 kg	5.267 c	4.633 b
1 kg	6.100 c	5.567 b
2 kg	9.600 b	9.867 a
5 kg	15.00 a	9.767 a
LSD 0.05	1.971	1.105
C.V.	10.97 %	7.17 %

Separate ANOVA mean squares			
Source of variation	D.F.	Trial 1	Trial 2
Blocks (B)	2	0.173	0.076
Substrate volume (S)	3	58.707 **	24.3119.6540 **
Pooled Error	6	0.973	0.306

Combined ANOVA				
Source of variation	D.F.	Mean squares		
Trial (T)	1	9.882	Substrate vol.	Mean
Rep (T)	4	0.125	0.5 kg	4.950 d
Substrate volume (S)	3	67.617 **	1 kg	6.333 c
S X T	3	10.735 **	2 kg	٩.733 b
Pooled Error	12	o.640	5 kg	12.383 a
LSD 0.05				1.006
C.V. 9.58 %				

Table 8. Average weight of the fruiting bodies cap (pileus) for the mushroom (*Pleurotus ostreatus*) produced using different volumes of rice straw substrate.

Substrate volume	Weight of the fruiting bodies cap (g)	
	Trial 1	Trial 2
0.5 kg	3.933 c	3.167 c
1 kg	4.667 c	5.300 b
2 kg	8.433 b	8.033 a
5 kg	13.000 a	8.133 a
LSD 0.05	1.837	1.127
C.V.	12.24 %	9.16 %

Separate ANOVA mean squares			
Source of variation	D.F.	Trial 1	Trial 2
Blocks (B)	2	0.056	0.286
Substrate volume (S)	3	51.870 **	17.103 **
Pooled Error	6	0.845	0.318

Combined ANOVA				
Source of variation	D.F.	Mean squares		
Trial (T)	1	10.935	Substrate vol.	Mean
Rep (T)	4	0.171	0.5 kg	3.550 c
Substrate volume (S)	3	60.201 **	1 kg	4..983c
S X T	3	8.772 **	2 kg	8.233 b
Pooled Error	12	0.581	5 kg	10.567 a
LSD 0.05				0.959
C.V. 11.16 %				

Table 9. Average diameter of the fruiting bodies cap (pileus) for the mushroom (*Pleurotus ostreatus*) produced using different volumes of rice straw substrate.

Substrate volume	Diameter of the fruiting body cap (cm)	
	Trial 1	Trial 2
0.5 kg	4.067 c	3.700 c
1 kg	7.400 b	6.967 b
2 kg	7.200 b	7.867 b
5 kg	10.333 a	13.467 a
LSD 0.05	1.721	1.052
C.V. 11.88 %		C.V. 6.57 %

Separate ANOVA mean squares			
Source of variation	D.F.	Trial 1	Trial 2
Blocks (B)	2	0.520	0.120
Substrate volume (S)	3	19.666 **	49.460 **
Pooled Error	6	0.742	0.277

Combined ANOVA				
Source of variation	D.F.	Mean squares		
Trial (T)	1	3.375	Substrate vol.	Mean
Rep (T)	4	0.320	0.5 kg	3.883 d
Substrate volume (S)	3	64.958 **	1 kg	7.533 b
S X T	3	4.167 **	2 kg	6.500 c
Pooled Error	12	0.509	5 kg	11.900 a
LSD 0.05				0.898
C.V. 9.36%				

Table 10. Average weight of the fruiting bodies stems (stalks) (stipe) for the mushroom (*Pleurotus ostreatus*) produced using different volumes of rice straw substrate.

Substrate volume	Weight of the fruiting body stem (stalks) (g)	
	Trial 1	Trial 2
0.5 kg	1.30 b	1.533
1 kg	1.433 b	1.167
2 kg	1.167 b	1.633
5 kg	2.133 a	1.733
LSD $_{0.05}$	0.363	------ ns
C.V. 12.05 %		**C.V. 12.56 %**

Separate ANOVA mean squares			
Source of variation	**D.F.**	**Trial 1**	**Trial 2**
Blocks (B)	**2**	0.041	0.081
Substrate volume (S)	**3**	0.556 **	0.121 ns
Pooled Error	**6**	0.033	0.038

Combined ANOVA				
Source of variation	**D.F.**	**Mean squares**		
Trial (T)	**1**	0.007	**Substrate vol.**	**Mean**
Rep (T)	**4**	0.061	**0.5 kg**	1.417 b
Substrate volume (S)	**3**	0.449 **	**1 kg**	1.350 b
S X T	**3**	0.228 **	**2 kg**	1.400 b
Pooled Error	**12**	0.035	**5 kg**	1.933 a
LSD $_{0.05}$				0.235
C.V.	12.32%			

Table 11. Average length of the fruiting body stems (stalks) (stipe) for the mushroom (*Pleurotus ostreatus*) produced using different volumes of rice straw substrate.

Substrate volume	Length of the fruiting body stems (stalks) (cm)	
	Trial 1	Trial 2
0.5 kg	3.300 c	2.433 b
1 kg	6.500 a	3.067 a
2 kg	6.933 a	3.267 a
5 kg	5.167 b	3.567 a
LSD $_{0.05}$	0.958	0.580
C.V.	8.75%	9.41 %

Separate ANOVA mean squares			
Source of variation	**D.F.**	**Trial 1**	**Trial 2**
Blocks (B)	**2**	0.017	0.041
Substrate volume (S)	**3**	8.003 **	0.690 *
Pooled Error	**6**	0.230	0.084

Combined ANOVA				
Source of variation	**D.F.**	**Mean squares**		
Trial (T)	**1**	34.320	**Substrate vol.**	**Mean**
Rep (T)	**4**	0.029	**0.5 kg**	2.867 c
Substrate volume (S)	**3**	5.862 **	**1 kg**	4.783 ab
S X T	**3**	2.832 *	**2 kg**	5.100 a
Pooled Error	**12**	0.157	**5 kg**	4.367 b
LSD $_{0.05}$				0.499
C.V. 9.26 %				

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تأثير حجم بيئة الزراعة على انتاج الاجسام الثمريه لعيش الغراب المحاري

مروه محمد سليمان، محمد فؤاد محمد، محمد حمام زين العابدين الدقيشى وايمن قطب متولى

قسم الخضر – كلية الزراعه – جامعة اسيوط

الملخص

أجريت هذا الدراسة بمعمل عيش الغراب قسم الخضر– كلية الزراعة – جامعة اسيوط . وتم فيها إختبار تاثير حجم بيئة قش الأرز على محصول الأجسام الثمرية ومواصفاتها وذلك لعيش الغراب المحاري (بلوروتس اوستراتس)، وتمت التجربة في قطاعات كاملة عشوائية ذات ثلاث مكررات، وكانت أحجام البيئة المختبرة في عبوات أكياس بولي ايثيلين كالتالي:– ١– بيئة بوزن نصف كيلو جرام، ٢– بيئة بوزن كيلو جرام، ٣– بيئة بوزن ٢ كيلو جرام ، ٤– بيئة بوزن ٥ كيلو جرام. لقد وجد من الدراسة أن عيش الغراب النامي على حجم بيئة قش ٢ كيلو جرام قد أظهر أعلى قيم كفاءة بيولوجية كما أنه أنتج أعلى محصول أجسام ثمرية ، وهذه المعاملة أيضا أعطت أعلى متوسط لوزن الجسم الثمري وكذلك للقبعة ، إلا أن عيش الغراب النامي على بيئة ١ كيلو جرام قش أرز كان أسرع في التحضين (نمو هيفات الفطر بكثافة)، وقد وجد أن معاملتي ١ و ٢ كيلو جرام كان متشابيهين احصائيا فيما يخص عدد الأيام حتى حصاد الأجسام الثمرية وقطر الجسم الثمري ووزن وطول الساق، إضافة إلى ذلك فإن عيش الغراب في هاتين المعاملتين استهلك أقل كمية من البيئة بينما أعطى أكبر كمية لمحصول الاجسام الثمريه. وهذا يمكن أن يشير الي ان هاتين المعاملتين لهما قدرة حيوية اعلى لتحويل مكونات البئية إلى أجسام ثمرية. عموما بالنظر إلى مجمل النتائج فإنه يرجح زراعة عيش الغراب المحاري في بيئات بوزن ٢ كيلو جرام.