Cultivation of *Pleurotus ostreatus* L. on different substrates based on JUNCAO technology in EGYPT

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Abstract: Cultivation of *Pleurotus ostreatus* L. starin 66 on different substrates gave high yield quantity and quality during the two experimental seasons of 2013/2014 and 2014/2015. Six substrates were used in this investigation such as berseem straw, wheat straw, sawdust, corn cob, soybean straw and rice straw was investigated. The obtained results showed that berseem straw gave the highest values of number of fruit/bag (13.33 and 13.00 /bag) and corn cop gave heaviest weight of fruit body/bag (311.8 and 316.4 g/bag), and dry weight (11.06 and 11.53 g/100g) in both seasons respectively. The highest nutritional values such as nitrogen, phosphor, protein, fat, carbohydrates and energy were obtained from soy bean substrate. On the other side the best result for ash was obtained from rice straw, fiber and potassium were obtained from the sawdust substrate.
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1. Introduction

Mushroom is an attractive crop to cultivate in developing countries for many reasons. *Pleurotus ostreatus* cultivation has increased and fast distributes throughout the world during the last few decades, and counted for 14.2% of the edible mushroom (**Kannahi and Sangeetha 2015**). Mushrooms are increasingly being recognized as important food products for their significant role in human health, nutrition and protection disease. *Pleurotus* species are rich source of vitamin C, B-complex (thiamin, riboflavin, folic acid and niacin), minerals (Ca, P, Fe,K and Na) and protein **Caglarirmak, 2007).** *Pleurotus* species which makes mushrooms an ideal food for patients suffering from hyper tension, heart diseases against hyper cholesterolemiac conditions, diabetes, cancer, infections etc**.** More than 2000 species of edible mushrooms are known, out of which only few species have been cultivated commercially by preparing beds **(Patil 2012).**

JUNCAO technology is a patented technology invented by FAFU JUNCAO research institute. It utilizes wild or artificially cultivated herbaceous plants which were defined as JUNCAO (JUN is mushroom CAO is grass) to cultivate edible and medicinal mushroom. The application of JUNCAO technology includes: planting JUNCAO conserve soil and water and control desertification, using JUNCAO as substrates to cultivate edible fungi and medicinal fungi at the same time producing fungus protein forage and fungus forage **(Zhanxi 1999 and Rajapakse*et al.*, 2008).**

The maximum number of fruit bodies were found in case of substrate wheat straw, followed by 50% wheat straw + 50% paddy straw. The potential variation in the number of fruiting bodies could be due to different substrate combination in both physical and nutritional composition as well as microclimates **(Amin *et al.*, 2008).** The highest average number of fruiting body/ per bag was observed in the *Rain Tree* **(**12.3fruit) followed by the *Ipilipil tree* was recorded (8.23 fruit), in the contrast, the lowest average number of fruiting body / per bag was in the *Fig tree,* (7.60 fruit) **(Bhattacharjya *et al.*, 2014**). Total number of flushes (flush number) produced per each bag was noted. The distribution of the yield per flush was registered to observe changes in yield over the course of multiple flushes **(Raymond 2013).** The highest yield 381.85g/ kg and biological efficiency 95.46% of this mushroom was obtained from rice straw substrate followed by rice straw plus wheat straw then rice straw plus paper then sugarcane bagasse. The lowest mushroom yield 247.87g/ kg and biological efficiency 61.96 % was obtained from sawdust substrates (**Sharma *et al.*, 2013).** Cultivated *P. ostreatus* on different substrates and reported the highest yield on wheat straw, followed by the combination of paddy and wheat straw **(Kumari and Achal, 2008)**. But on the other study results are not similar with their findings. The weed plants were mixed with rice straw in the ratio 1:1, there is increase in the yield than when used individually **Das and Mukherjee, (2007)**. The highest stipe length (6.18 cm) was observed from sisal: sisal boles (50:50) substrate after addition of 30 % cow dung manure, while the lowest (1.21 cm) was

observed from sisal leaf decortications residues substrate after addition of 20 % supplement without any significant difference **(Raymond 2013).** On the other tested the highest average length of stripe was observed in the treatment *Mahogany tree* (1.63 cm) followed by mixture of all five tree sawdust(1.3 cm), Fig tree, Rain Tree, and Ipilipil tree, (1.30 cm) treatments. In the contrast the lowest average length of stripe was in the treatment Eucalyptus tree (1.17 cm) (**Bhattacharyya *et al.*, 2014)**. They were reported that the stripe length of *Pleorotus spp.* on different substrate varied from 1.93-2.97cm and the diameter ranged from 0.74-1.05cm **Ruhu Amin (2002) and Sarker*et al.*,(2007).** The stalk diameter of *Pleorotus spp.* on different substrate varied from the diameter ranged from 0.74-1.05cm **(Sarker*et al.* 2007 and Habib 2005).** The maximum diameter of the stalk (2.8 cm) was obtained maize powder then rice bran, while the minimum diameter of the stalk was obtained wheat bran supplementation (**Alam *et al.*, 2010)**. The cap diameter of fruiting body ranged from 1.85 to 5.66 cm without any significant difference between treatments. The cap diameter ranged from 1.91 to 5.69 cm on different substrates **(Samuel and Eugene, 2012**). On the other hand, the mushroom produced from rice straw had the highest mean values of pileus diameter(7.3cm) for second flush while oil palm waste (with four flushes only) had the lowest mean pileus diameter value of 5.20cm for fourth flush. The total mean pileus diameter ranges from 5.21±2.72 to 7.08±0.17cm **(Jonathan *et al.*, 2013)** the total nitrogen content when grow *Pleurotus spp.* on various substrates, the obtained data show that sisal leaf decortication residues contained significantly higher amount being 1.68 % followed by sisal leaf decortication residues: sisal boles (25:75) being 1.53 % while sisal boles recorded significantly lowest value being 1.14 % **(Raymond, 2013).** On the other work the highest nitrogen content was found in the rice straw with grow *Pleurotus spp* mushroom **(Adenipekun *et al.*, 2015)** It was found that the fruit bodies are carbohydrate content in this study (30.24% - 42.26%) is lower than the finding of as 50.50% - 55.33% when grow. on different substrates **Patil *et al.*, (2010).** Mushrooms are a potential source of total carbohydrates in the range of 42.62-66.78 g/100g depending upon the species **Beluham and Ranogajec (2011).** Protein content of *P. sajor-caju* fruiting bodies grown on different substrates ranged from 20.33 to 25.33 %. Significantly maximum protein content of mushroom was 25.33 % in fruiting bodies cultivated on soybean straw while least was 20.33 % on sunflower stalk **(Patil 2012)**. The study indicates that the fruit bodies are quite rich in protein, ranged between 22.89 % - 25.97 %on dry weight basis. Highest protein, were recorded from fruit body grown on rice straw **(Sharma *et al.*, 2013).** It has been reported that not only the protein content in fruit body but also the nature of protein depends on used substrate **(Wang *et al.*, 2001).** Crude protein was found maximum in *P. ostreatus* (27.23%) and minimum in *P. djmor* (24.83%) and found in *Pleurotus sajor-caju* (25.24%) range between *P. ostreatus* and *P. sajor-caju.* Materials rich nitrogenous sources give good mushroom yield as given by the soybean substrate **Onyango *et al.*, (2011).** The total energy contribution of the sample fruit bodies of oyster mushroom ranged between 231.78 kcal / 100 g - 282.73 kcal /100g in fruit bodies for oyster mushroom. The highest energy content in fruit bodies was found with rice straw substrate was recorded number 282.73 kcal /100 g in ones followed by sugarcane bagasse substrate was recorded number 267.588 kcal /100 g of oyster mushroom fruit bodies then sawdust one was recorded number 263.970 kcal /100g in fruit bodies of oyster then rice straw + paper substrate was recorded 263.010 kcal /100g ones, while the lowest energy content was found with rice straw + wheat straw substrate was recorded 231.780 kcal /100g in fruit bodies of oyster **(Sharma *et al.*, 2013)**.

Materials and Methods

The experiment was conducted in the vegetables laboratory, at Horticulture Department, Faculty of Agriculture in Cairo, Al-Azhar University and central laboratory for agricultural climate at Dokki, Minestry of Agriculture during the two successive seasons of 2013/2014 and 2014/2015 under the environmental control of growth chamber. In this study, cultivar of mushrooms (*Pleurotus ostreatus L* starin *66* was used to evaluate their characterization under different substrates by using JUNCAO technique. The spore of the cultivarwas obtained from Professor Lin Zhanxi of Fujian Agricultural University, Fuzhou, China. Six treatments were prepared for this experiment the plant residues of alfalfa straw, wheat straw, sawdust, corncob, bean straw and rice straw. The straws of alfalfa, wheat, sawdust, were obtained from agricultural field of local farmers in EL-Menofiya and corncob, bean and rice were obtained from Albohirah governorates and chopped into small pieces (3-2 inches long). Each treatment was supplemented as the following JUNCAO formula: 1) *Trifolium alexandrinum* (Berseem straw): 86% Berseem straw, 10% wheat bran, 2 % gypsum powder ($caso_4$) and 2% $Caco_3$. 2) Wheat straw: 86% wheat straw, 10% wheat bran, 2% gypsum powder and 2% $Caco_3$. 3) Sawdust: 75% sawdust, 22% wheat bran, 1% sugar and 2% $CaCo_3$. 4) Corn cob: 83% Corn cob, 15% wheat bran and 2% $CaCo_3$. 5) Bean straw: 86% bean straw, 10% wheat bran, 2% gypsum and 2% $CaCo_3$. 6) Rice straw: 98% rice straw and 2% $CaCo_3$. The mixture of each

substrate and supplements was mixed thoroughly and adjusted it's pH in between 6.5-7. The substrates were soaked in tap water and about 60%-70% moisture was set to each substrate. 350g wet substrate was filled in the polypropylene bag of 40cm×18cm in size and autoclaved at 121°C at 1.5 lbs pressure for two hours and allowed to cool overnight. After cooling, about 2.5 % grain spawn were inoculated on the surface of substrate and incubated in a dark at controlled temperature of 25-27°C. After colonization (full growth of mycelium), the plastic bags were cut from one side and placed in the growing room at temperature between 18-20°C, relative humidity 85-90 % and light intensity of 200-500 lux. The treatments consisted of six substrates applied of the *Pleurotus ostreatus c*ultivar from oyster mushroom was arranged in a randomized complete block) design factorial which have three replicates each consist of 10 of incubated substrate bags. The bags were then marked by permanent marker and were kept on the shelves in an incubation room and were allowed to complete the whitish mycelia growth under the suitable improvement for the three stages which are colonization, primordial initiation and date of first day of harvest in the cultivar of oyster mushrooms.

A - Yield

1) Number of fruit /bag: The harvested mature fruit bodies were counted per bag. **2)** Total yield: The total weight (g) of the first flush, second flushes, third flush and fourth flush were calculated. **3)** Biological efficiency: The biological efficiency was defined as the percentage ratio of the fresh weight of harvested mushroom over dry weight of substrate **(Pokhrel and Ohga 2007).**

B – Physical characteristics

1) Stalk length (cm): The stalk length was measured by ruler from branching start point of junction. **2)** Stalk diameter (cm) was measured by Vernier caliper. **3)** Diameter of cap of fruit body (cm): Diameter of cap was measured by Vernier caliper.

C – Chemical characteristics

1) TSS% was determined by hand Refractometer according to AOAC**, (2000). 2)** Ascorbic acid (mg/100g. f. W.) was determined by the method of titration with 2,6- dichlorophenol indophenol dye according to AOAC**, (2000). 3)** Nitrogen (g/100g. d. w.): The method for determining the nitrogen content was employed after Pella **(1990).**4) Phosphorus and Potassium (g/100g. d. w.): Phosphorus and Potassium content were determined using an inductively coupled plasma atomic emission Spectrometer (ICP-AES0) according to **Pella (1990). 5)** Carbohydrates %: The Total carbohydrate in mushroom sample was calculated by using the following equations (Nilsen 2010): Carbohydrate (%) = [100 – the contents of moisture – total ash – fiber – protein and fat] **(Sharma *et al.* 2013). 6)** Protein %: The crude protein content of the samples was estimated by the macro Kjeldhal method employed to find the total nitrogen content. The percentage content of the total nitrogen was multiplied by a factor of 6.25 to find the crude protein of the mushroom sample after **AOAC, (1990). 7)** Fat %: The Fat in the mushroom sample was determined by extracting certain weight of powdered sample with petroleum ether using the soxhlet apparatus as described in the **AOAC, (1990). 8)** Fiber %: The crude fiber was determined by acid and alkali digestion method on the mushroom sample according to the method reported by **Raghuramulu *et al.*, (1983). 9)** Dry weight (mg/100g.f.W.) = Dry weight of certain weight / fresh weight the same weight × 100 as reported by **Shah, *et al* (2004).** 10) Ash %: The ash content was determined by igniting the mushroom sample in silica crucibles in a muffle furnace at 620°C for 3 hours as described in **AOAC, (1990). 11)** Energy (Kcal/100gm): was determined by the equation after **Sharma *et al.*, 2013** = [(protein×4) + (Carbohydrate×4) + (fat×9)]**.**

Statistical analysis:

All experiments were statistically analyzed in a complete randomized design with three replicates. Obtained data were subjected to the analysis of variance procedure and means were compared by L.S.D. method at 5% level of significant according to Snedecor and Cochran (1982).

Results and discussions

Six different types of substrates were investigated to determine the yield and their quality of *Pleurotus ostreatus.* The highest number of fruit bodies/ bag was found from berseem straw which records number of 13.33 fruits / bag during both seasons and corncob substrate with records of 12.33 and 11.50 fruits / bag in the first and second seasons respectively, while, the lowest value of the number of fruits was found with wheat straw substrate which recorded number of 7.50 and 9.19 fruits / bag in the two season this result may be due to the different substrate combination in both physical and nutritional composition as well as microclimates **(Amin *et al.*, 2008).** Concerning the maximum value of weight fruit bodies /bag and biological efficiency/bag was obtained from corn cop substrates which register number of weight 311.80, 316.40 g/ bag and biological 89.09 and 90.37 percentages in the first and second seasons respectively. In the contrast the lowest number of weight fruit bodies /bag was found with wheat and berseem straw substrate which rerecording of weight 178.80 and 228.40 g/ bag and biological efficiency/bag 53.80 and 65.20 percentage in the first and second seasons respectively. This result may be due to the increases in yield of mushroom which

grown in corn cop were similar to obtained result by **Ponmurugan *et. al.* (2007)** which grew mushroom on body straw substrate gave the highest mushroom yield and that due to easier way of getting sugars from the cellulosic substances. Number of fruits, weight fruit bodies and biological efficiency are presented in Table (1).

Table (1): Effect of different substrates on yield and their components of *Pleurotus ostreatus L.* during 2013/ 2014 and 2014/2015 seasons

Characteristics	Number of fruits / bag		Weight of fruits / bag (g)		Biological efficiency/bag (%)	
Substrates	2013/2014	2014/2015	2013/2014	2014/2015	2013/2014	2014/2015
Berseem straw	13.33	13.00	245.50	228.40	70.33	65.20
Wheat straw	7.50	9.16	178.80	264.43	53.80	72.80
Sawdust	10.50	10.50	234.27	247.20	66.76	70.60
Corn cop	12.33	11.50	311.80	316.40	89.09	90.37
Soybean straw	10.50	12.00	253.30	270.53	72.40	77.27
Rice straw	9.33	10.00	245.00	246.33	69.96	70.33
L.S.D. at 5%	0.54	0.22	5.21	7.14	2.11	3.18

Significant differences were found in between some treatments (Table 2). The highest value of stake length was found from corn cop substrate which recording the number of 3.18 and 3.60 cm and soybean straw with records of 3.20 and 3.01cm during both seasons respectively, while, the lowest number of stake length was found with wheat straw substrate with records of 2.60 in the first season and berseem straw one with recorded number of 2.81cm during the second season. Regarding to the maximum value of stake diameter was obtained from soybean straw substrate which register number of 0.96 cm in both seasons, while lowest value of stake diameter was obtained from corn cop substrate which register number of 0.69 cm in the first season and wheat straw which rerecording of 0.76 cm during the second season. The largest cap diameter was found from soybean straw substrate with records of 11.40 and 12.26 cm in two seasons, in the contrast the lowest number of cap diameter was obtained from rice straw substrate which rerecord of 7.30 and 7.50cm in the first and second seasons respectively.

These results may be due to the variation in these parameters could be explained by the fact that the texture and substrate formulations as well as nutrients in substrates possibly affected the composition of the final mushroom growth substrate and qualities such as water holding capacity and degree of aeration (**Reyes *et al.*,2009 and Kurtzman 2010).** The worst natural substrates for the nutritional value in oyster mushroom were paddy and berseem straw which may be due to its stiffness and difficult degradation by *P. ostreatus* **(Laborde *et al.*, 1993, Ragunathan and Swaminathan, 2003).**

Table (2): Effect of different substrates on physical characteristics of *Pleurotus ostreatus L.* during 2013/ 2014 and 2014/2015 seasons

Characteristics	Stake length (cm)		Stake diameter (cm)		Cap diameter (cm)	
Substrates	2013/2014	2014/2015	2013/2014	2014/2015	2013/2014	2014/2015
Berseem straw	2.70	2.81	0.76	0.76	7.56	8.13
Wheat straw	2.60	2.87	0.72	0.76	8.60	8.93
Sawdust	2.78	3.06	0.76	0.91	9.33	11.83
Corn cop	3.18	3.60	0.69	0.93	9.15	9.33
Soybean straw	3.20	3.01	0.96	0.96	11.40	12.26
Rice straw	2.88	3.04	0.88	0.87	7.30	7.50
L.S.D. at 5%	0.15	0.25	N.S	N,S	0.33	0.18

T.S.S, ascorbic acid and dry weight are presented in Table (3) which has significant differences between the substrates. The highest value of T.S.S and ascorbic acid was found from soybean substrate which recording the T.S.S content 3.83 and 3.70 % and ascorbic acid 45.13 and 45.03 mg/100g during both seasons respectively, while, the lowest number of T.S.S and ascorbic acid content was found from rice straw substrate which recording the T.S.S content 3.10 and 3.20 % and ascorbic acid 27.36 and 23.80 mg/100g during the first and second seasons respectively. These results due to the highest amounts of TSS were produced by adding the corn (**Mami *et al.*, 2013**). TSS percentage may be increased due to loss in moisture content during storage and this is in agreement with **Barwal *et al.*, (2005).** The rate constant is dependent on inverse absolute temperature by an Arrhenius type relationship **(Bhuiyan *et al.*, 2012).** Regarding to the maximum value of dry weight was obtained from corn cop which record of

11.06g/100g in the first season and soybean straw substrate which register number of 11.97g/100g in the second season, while lowest number of dry weight was obtained from rice straw substrate with records number of 7.93 and 8.77g/100g cm in the first and second season respectively.

Table (3): Effect of different substrates on T.S.S, ascorbic acid and dry weight of *Pleurotus ostreatus* L. during 2013/ 2014 and 2014/2015 seasons

Characteristics	TSS %		Ascorbic acid g/100g		Dry weight g/100g	
Substrates	2013/2014	2014/2015	2013/2014	2014/2015	2013/2014	2014/2015
Berseem straw	3.63	3.80	31.75	29.66	9.83	10.93
Wheat straw	3.30	3.50	30.03	33.50	8.53	9.03
Sawdust	3.36	3.36	33.80	32.76	9.23	8.10
Corn cop	3.60	3.60	42.43	45.50	11.06	11.53
Soybean straw	3.83	3.70	45.13	45.03	9.87	11.97
Rice straw	3.10	3.20	27.36	23.80	7.93	8.77
L.S.D. at 5%	N.S	0.12	1.10	1.35	0.45	0.75

The highest value of the nitrogen 1.21 and 120 g/100g and phosphorus 3.32 and 3.21g/100g content was found from soybean substrates which reach the significant differences during both seasons respectively (Table 4). In the contrast the lowest number of the nitrogen and phosphorus content was found from corn cop substrate which recording the nitrogen content 0.29 and 0.30 and phosphorus 1.45 and 1.40 g/100g during the two seasons. These results may be due to the soybean straw substrate consists of maximum nitrogen content before cultivation, subsequently was highest spent the oyster mushroom cultivars with soybean straw nitrogen content in fruit body in the both seasons. On the other side the lowest nitrogen content in soybean straw was found after oyster mushroom cultivation in both seasons (Table 7). Regarding to the maximum value of potassium content was obtained from sawdust which recording of 3.17 and 3.18 g/100g in the first and second season, while lowest number of potassium was obtained from wheat straw substrates which register number of 1.12 and 1.13g/100g in the first and second season respectively (Table 4).

The highest results of protein was 7.57 and 7.48 g/100g and fat content 0.25 and 0.24 g/100g was found from soybean substrate and reach the significant level during both seasons respectively (Table 5). On the other side the lowest value of protein content (1.81 and 1.87 g/100g) was found from corn cop substrate during both seasons respectively. The changes in protein contents in the fruit bodies and substrates were depended on the C/N ratio in the cultivation substrate **(Yehia 2012).** These results may be due to the protein consumption from raw materials. The protein content of raw soybean straw substrate was 5.62 g/100g before cultivation and 1.62 and 1.68 g/100g after cultivation in both seasons respectively (Table 7).

Regarding to the maximum value of fiber content (Table 5) was obtained from sawdust which recording of 7.39 and 7.60 g/100g in the first and second season, while lowest number of fat and fiber content was obtained from wheat straw substrate which register fat of 0.17 and 0.18 g/100g and fiber 3.42 and 3.60 g/100g in the first and second season respectively. The variation in fiber content might be due to the quality and quantity of fiber available in substrates **(Patil 2012).** Concerning to discussing the fat, the fat content on dry weight basis lower than that of earlier report by **Wang *et al.*, (2001)** and much depends on the nature of substrate. These results may be due to the sawdust substrate consists of 4.50 0.23 g/100g fiber before cultivation and contents of 0.20 and 0.23 g/100g fiber in both seasons respectively after cultivation (Table 7).

Table (4): Effect of different substrates on N. P. and K. of *Pleurotus ostreatus* L. during 2013/2014 and 2014/2015 seasons

Characteristics	Nitrogen g/100g		Phosphorus g/100g		Potassium g/100g	
Substrates	2013/2014	2014/2015	2013/2014	2014/2015	2013/2014	2014/2015
Berseem straw	0.45	0.47	1.00	1.01	2.09	2.04
Wheat straw	0.42	0.44	1.84	1.82	1.12	1.13
Sawdust	0.41	0.24	2.74	2.68	3.17	3.18
Corn cop	0.29	0.30	1.45	1.40	2.53	2.50
Soybean straw	1.21	1.20	3.32	3.21	0.98	1.04
Rice straw	0.77	0.76	2.70	2.00	1.18	1.25
L.S.D. at 5%	0.27	0.18	0.26	0.13	0.21	0.31

Table (5): Effect of different substrates on protein, fat and fiber of *Pleurotus ostreatus* L.during 2013/ 2014 and 2014/2015 seasons

Characteristics	Protein g/100g		Fat g/100g		Fiber g/100g	
Substrates	2013/2014	2014/2015	2013/2014	2014/2015	2013/2014	2014/2015
Berseem straw	2.81	2.93	0.21	0.23	5.43	5.59
Wheat straw	2.62	2.68	0.17	0.18	3.42	3.60
Sawdust	2.56	2.62	0.21	0.21	7.39	7.60
Corn cop	1.81	1.87	0.19	0.20	5.03	5.55
Soybean straw	7.57	7.48	0.25	0.24	7.09	7.60
Rice straw	4.81	4.74	0.22	0.23	7.00	7.30
L.S.D. at 5%	0.32	0.58	N.S	N.S	0.27	0.19

Table (6): Effect of different substrates on protein, fat and fiber of *Pleurotus ostreatus* L.during 2013/ 2014 and 2014/2015 seasons

Characteristics	Carbohydrates g/100g		Ash g/100g		Energy	
Substrates	2013/2014	2014/2015	2013/2014	2014/2015	2013/2014	2014/2015
Berseem straw	27.99	29.39	9.70	9.70	124.96	130.20
Wheat straw	24.14	24.88	9.40	9.50	108.58	111.87
Sawdust	27.91	27.83	8.40	8.60	123.91	122.76
Corn cop	27.36	28.36	9.20	9.20	118.22	122.75
Soybean straw	33.88	36.18	8.93	9.13	168.06	176.87
Rice straw	29.00	30.37	9.18	9.26	137.62	142.56
L.S.D. at 5%	1.12	0.89	N.S	N.S	0.77	0,56

Table (7): The chemical analysis of raw and spent substrates before and after *Pleurotus ostreatus* L. cultivation during the two season of 2013/2014 and 2014/2015.

Substrates	Berseem straw			Wheat straw			Sawdust		
Characteristics	Raw	Spent 1	Spent 2	Raw	Spent 1	Spent 2	Raw	Spent 1	Spent 2
Nitrogen	0.89	0.43	0.44	0.73	0.57	0.55	0.13	0.08	0.11
Phosphorus	1.32	1.75	1.80	1.26	2.23	2.32	0.89	1.95	1.99
Potassium	0.37	0.20	0.22	0.29	0.13	0.15	0.32	0.22	0.24
Protein	5.56	2.68	2.78	4.56	3.56	3.45	0.81	0.50	0.70
Fat	0.62	0.61	0.60	0.22	0.32	0.30	0.73	0.32	0.33
Fiber	3.80	1.20	1.40	3.50	0.90	1.00	4.50	0.20	0.23
Carbohydrates	67.8	79.0	79.52	74.6	81.3	81.73	68.4	82.2	82.33
Ash	7.80	8.00	8.11	8.20	6.80	6.90	8.90	8.90	9.30
Substrates	Corn cop			Soybean straw			Rice straw		
Characteristics	Raw	Spent 1	Spent 2	Raw	Spent 1	Spent 2	Raw	Spent 1	Spent 2
Nitrogen	0.29	0.28	0.28	0.90	0.26	0.26	0.85	0.39	0.39
Phosphorus	1.24	2.48	2.40	1.66	1.00	1.20	2.37	2.09	1.98
Potassium	0.25	0.83	0.85	0.64	0.61	0.58	0.14	0.36	0.31
Protein	1.81	1.75	1.79	5.62	1.62	1.68	5.31	2.43	2.48
Fat	0.46	0.28	0.26	0.33	0.69	0.65	0.46	0.25	0.26
Fiber	1.70	1.3	1.4	4.3	2.4	2.44	2.10	1.30	1.50
Carbohydrates	75.3	81.7	81.4	71.0	77.6	77.75	67.4	75.2	74.92
Ash	8.80	7.60	7.40	8.40	9.00	9.12	8.50	9.60	9.30

Raw = Raw straw contents before cultivation
Spent 1 = spent straw contents after cultivation in the first season
Spent 2 = spent straw contents after cultivation in the second season

The highest values of carbohydrates 33.88 and 36.18 g/100g and energy content 168.06 and 167.87 kcal/100g were found from soybean substrate during both seasons respectively (Table 6). In the contrast,

the lowest values of carbohydrates and energy content was found from wheat straw substrate which recording the carbohydrates of 24.14 and 24.88 g/100g and energy content of 108.58and 111.87 kcal/100g during both seasons respectively. These results may be due to the nutritional composition of each substrate which may contribute immensely in the nutritional composition of mushroom **(Ogundele *et al.*, 2014).** Nitrogen and protein contents were decreased in the substrates after cultivation and increased the fruits body, whereas carbohydrates and phosphorus contents were increased in the substrates after cultivation (Table 7). Regarding to the maximum value of ash content was obtained from berseem straw which recording of 9.70 g/100g in the first and second season, while lowest number of ash was obtained from sawdust substrates which register number of 8.40 and 8.60 g/100g in the first and second season respectively (Table 6).

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