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ORIGINAL ARTICLE

EVALUATION OF CASING INFLUENCE ON OYSTER MUSHROOM (*PLEUROTUS SAPIDUS*) YIELD AND ITS CHEMICAL COMPOUNDS CONTENT

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Abstract : This study was conducted at the project of Organic fertilizer preparing and mushroom cultivation in Karbala governorate and Satellite to Organic Farming Center of Baghdad, during 2016 and 2017 to study the effect of three factors 1) Substrate type included: Wheat straw (W), Corn cobs (C), Date Palm fronds wastes (P), 50% Wheat straw + 50% Corn cobs (WC), 75% Wheat straw + 25% Corn cobs (WwC), 50% Wheat straw + 50% Date Palm fronds wastes (WP) and 75% Wheat straw + 25% Date Palm fronds wastes (WwP). 2) Supplement type were three: Without Supplement (SU0), 20% wheat bran (SU1) and 20% Grass land cutting wastes (SU2). 3) Spawn level were three levels: 3% (SP1), 5%(SP2) and 7%(SP3), on Growth and Productivity of Oyster mushroom type *Pleurotus sapidus* as an experiment according to Completely Randomized Design (CRD) with three replicates and used three bags for any treatment. All data were analyzed by ANOVA table according to Genstat program and means were tested by Least Significant Difference (LSD) at 0.05 probability level.

Key words : Evaluation, Casing, *Pleurotus sapidus*, Chemical Compounds.

1. Introduction

Oyster mushroom occupies second place only next to white button mushroom, *Agricus bisporus* and its production accounts for 25% of the global production of food fungi [OECD (2008)]. Fruiting bodies of the Oyster mushroom contain high proportion of protein in the range of 20-40% dry weight [Kurtzman (2005)]. Pleurotus contains most essential and non-essential amino acids with high levels of lysine and tryptophan, as well as folic acid, making its nutritional value the highest compared with that of some vegetable crops and cereal crops that lack such acids [Dundar *et al.* (2008)]. Carbohydrates account for 37-69% whereas 3% fat and 8% fiber are present in the dry weight of fruit bodies [Ahmed *et al.* (2009)]. The oyster mushrooms can be grown on a wide range of media such as agricultural wastes and wild plants as substrate although the wheat straw is the ideal substrate for growth and production in the world. But in Iraq, wheat straw is used as animal feed. So, due to high prices, lack of availability throughout the year and high availability of agricultural wastes, wild plants, date palm and other residues. These alternatives can be used in agriculture for the development of different types of oyster mushrooms since it can be grown in different agricultural substrates [Miah *et al.* (2016)]. There is also a possibility of supplementing these substrates by adding a wide variety of materials such as rice bran, wheat bran and many other materials that would improve the quality of fruit bodies of fungi. These materials are left without using grass land cutting from which the wastes are rich in cellulose and other elements [Kumari and Achal (2008)]. On the other hand, the amount of spawn level plays an important role in the determination of different stages of growth, quantity and quality of production. The layer of Casingis, a catalyst for the formation of the fruit bodies in white mushroom *Agaricusbisporus*, is always present since

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without it, there is no fruit body formation. There are two different prerequisites available for the formation of fruit bodies, namely agricultural substrate as a source of growth, and the casing layer, which equips the yarn with appropriate physical, chemical and biological factors and urges the formation of fruit bodies. If there is no such layer present, the fruiting cannot be achieved [Shally (2002) and Farsi *et al.*(2011)]. There is no need to add a casing layer in oyster mushroom as a prerequisite for production, since the fruiting can be obtained without this process. However, if this process is conducted, the fungus may increase its production. So, the aim of the current study is to analyze the effects of Casing on the product Oyster Mushroom, *Pleurotussapidus* and its chemical compounds.

2. Materials and Methods

The study was carried out during the project preparation of organic fertilizers and mushroom cultivation at Husseiniya, Karbala, the holy province of Karbala, Ministry of Agriculture during the period 15/12/2016 to 20/7/2017 using Oyster mushroom. The *Pleurotus sapidus* was procured from the University of Fujian Agriculture and Forestry, Jankao Research Institute, People's Republic of China. National Center for Organic Agriculture and Mushroom Production of the Ministry of Agriculture, Integrated Management Projects for the Production and Protection of Plantations, Baghdad were associated in this project. The process of multiplication of spawn for culturally white line of imported first generation fruit was executed.

2.1 Mother culture

Tissue culture technique was used in the preparation of mother culture. The fruit bodies were taken, wiped with commercial alcohol and parts of it were taken using a special filmy grass land cutting in circles of 1 cm diameter and were planted on Potato Dextrose Agar (PDA) medium in the center of the dish. This was then placed in an incubator at 24^0C for 14 days. After the completion of fungus growth on the dishes, it was kept in an incubator at 4^0C until use [Dundar *et al.* (2008)].

2.2 Spawn

The spawn was grown on wheat grains as per Oei (2005) method. After 3-4 weeks, it was ready for use.

2.3 Substrate culture

Wheat straw, corn cobs and date palm fronds were used as agricultural substrate which were prepared according to the method proposed earlier by AL-Saadawi (2015). Feed additives (wheat bran and grass land cutting wastes) were added to the substrate upto 20% based on dry weight [Hassan (2011)]. The components of the substrates and supplements of pre-agriculture components were analyzed for their basic components (Table 1) as described in the literature [A.O.A.C. (1990)].

Each substrate was filled with high-temperature and 40x20 cm high transparent polyproline bags with a plastic ring. The bag nozzles were sealed with clean medical cotton in order to ensure gas exchange between inside and outside the bags. It was packaged by a locally manufactured copy of Dutch machine. The mean amount in bags is 1 kg which was calculated on wet weight (500 g dry weight). The autoclave devices were sterilized at a temperature of 90^0C for five hours [AL-Saadawi (2015)]. The bags were left for 24 hours to cool down in the preparation of vaccination with spawn fungus, *Pleurotus sapidus*.

At the rate of 30, 50 and 70 gms, the spawns were added in each bag from upper nozzles under sterile conditions. The fungus vaccine was added on the basis of dry weight for each substrate, in all of the above-mentioned substrates, by making a hole of 2-3 cm deep in the agricultural substrate. The spawn level was placed inside the hole [Kwon and Kim (2004)]. The bags were placed on racks in the incubation room where the environmental conditions are under control *i.e.*, 24^0C and 70% relative humidity, according to the CRD design. When using three replicates and three bags per treatment, the lighting and ventilation were not needed until the complete growth of mycelium was achieved on all the substrates in order to transfer the bags to the production room.

After complete growth of mycelium on all the substrates, the bag was completely removed and the agricultural substrates alone were arranged from all the three bags in a small plastic box of dimensions 36 × 13 × 28 cm, wrapped inside with pieces of polyethylene to get rid of excess water to form one experimental unit and three replicates. After removing the agricultural substrates, the bags were used in filling the gaps between the moulds of the agricultural circles to achieve the

Table 1 : Chemical composition of each substrate and supplement (nitrogen, phosphorus, protein, carbohydrate, ash, fat and fiber) in % (potassium, calcium and sodium mg. 100 g^{-1}) dry weight, C.O and N/C.

Type of substrate and supplement	N	P	K	Ca	Na	Protein	Carbohydrates	Ash	Fats	Fiber	C.O	N/C
Wheat straw W	0.77	0.03	48.50	17.20	8.30	4.81	52.84	8.75	1.55	32.05	0.53	0.69
Corn Shells	0.46	0.02	22.9	9.80	1.10	2.88	61.47	2.35	1.45	31.85	0.57	1.24
Palm palm P	0.63	0.01	7.50	22.50	2.00	3.94	52.36	6.42	2.20	35.08	0.55	0.87
Wheat bran B	1.70	0.32	34.30	10.10	1.70	10.63	77.57	5.72	2.00	4.08	0.55	0.32
Grassland cutting wastes	0.97	0.09	21.60	18.20	5.60	6.06	71.64	11.01	2.00	9.20	0.52	0.54

Organic matter and organic carbon were estimated based on the percentage of ash and organic substanceaccording to the following equation:

Organic matter = 1 - Percentage of ash

Organic Carbon (O. C) = Organic Substance (O. M) * 0.58

The N / C ratio was calculated [Chu *et al*. (2012)].

stability for casing layer. Peat moss was used in Casing of the surface layer in the agricultural substrate of 2-3 cm thickness. Sterilization was performed using formalin (250 ml formalin per 15 litres of water) and the plastic boxes were arranged on shelves inside the production room at 18-20^{0} C and 90% humidity. The ventilators were operated daily for two hours in order to prevent the accumulation of CO_2 gas upto harmful level in the production room whereas the humidity level was raised using the Humidifier from 80 - 90%. The ventilation was executed using a hollow side located on the wall of the room and was operated for 2-4 hours a day [Oei (2005)].

2.4 Experimental transactions

The experiments included testing the efficiency of various substrates without any supplement as well as testing the efficiency of these substrates with supplement and three spawn levels of oyster. These were analyzed according to full regression design (CRD) and three replicates as a global experiment with three factors after casing

1st factor (plant substrate type)	2nd factor (type supplemented)	3rd factor (the spawn level of oyster)
Wheat straw (W) control	Without the addition of the supplemented (SU0) control	3% (SP1)
Corn Cobs (C)	Wheat Bran (20%) (SU1)	5% (SP2)
Date Palmfronds wastes (P)	Grass land cutting (20%) (SU2)	7% (SP3)
50% wheat straw + 50% corn Cobs(WC)		
75% wheat straw + 25% corn Cobs (WwC)		
50% wheat straw + 50% Date palm fronds wastes (WP)		
75% wheat straw + 25% Date palm fronds wastes (WwP)		

Attributes studied

Weight-based dry

The production was calculated on the basis of dry weight according to the following equation:

$$\text{Production based on dry weight} = \frac{\text{Wet weight} \times \text{Percentage of dry matter}}{100}$$

2.5 Determination of elements (Nitrogen, Potassium, Sodium, Calcium and Phosphorus)

A total of 100 g fruit objects was drained in an electric oven at 60^{0}C until the weight became stable. Then, it was grounded with an electric treadmill and passed through 0.50 mm. diameter sieve. After which it was placed in small-sealed plastic containers for use

[Dundar *et al*. (2008)]. Wet digestion process was then carried out by taking 0.2 g. of the dry sample, which was crushed and digested with concentrated sulfuric acid and concentrated pericloric acid in the ratio of 1:2 [Cresser and Parsons (1979)]. After the digestion process, the elements (Nitrogen, Potassium, Sodium and Calcium) were estimated using Flame-Photometer-UK spectrometer and the nitrogen was measured using Micro Kjeldahl [Jackson (1958)]. The phosphorus component may be estimated in accordance with the method described in the literature [A.O.A.C. (1990)] using spectrophotometry at a wavelength of 880 nm.

3. Results and Discussion

3.1 Evaluation of casing influence on dry yield of Oyster mushroom, *Pleurotus sapidus*

The results shown in Table 2 infers that there was a significant effect of different substrates on the average yield of fruit objects on the basis of dry weight. The WC substrate attained the highest dry yield of 22.07 g. Kg^{-1} from the agricultural substrate which did not differ statistically from what was achieved by mean C *i.e.*, 21.52 g. Kg^{-1} from the agricultural substrate. When compared to mean W, it achieved the lowest dry yield of 14.09 g. Kg^{-1} from the agricultural sector.

The results showed that the addition of supplements to different agricultural substrates significantly affected the amount of dry weight based on the type of supplement added *i.e.*, for wheat bran SU1, the dry yield was 21.93 g. Kg^{-1} from agricultural substrate followed by the SU2 second place where a dry yield of 18.37 g.Kg^{-1} was achieved from the same agricultural substrate compared to SU0 comparison, which yielded the lowest dry weight 13.34 g. Kg^{-1} from the agricultural substrate. Statistical analysis showed that the level of spawn in addition to different agricultural substrates had a significant impact on the quantity obtained on the basis of dry weight. The SP3 level gave the highest dry yield of 21.65 g.Kg^{-1} from the tumor substrate followed by the vaccine SP2 second level with dry yield of 17.89 g. Kg^{-1} from the agricultural substrate whereas the vaccine SP1 level achieved the lowest dry yield of 14.11 g.Kg^{-1} from the agricultural substrate.

The effect of the binary interaction between the type of agricultural substrate M and the type of SUP supplemented was significant in the quantity obtained on the basis of dry weight. The dry yield was in the range of 10.10 - 30.51 g.Kg^{-1} in agricultural substrate whereas C + SU1 gave the highest dry yield of 30.51 g. Kg^{-1} from the agricultural substrate. In case of combination of W + SU0, the lowest dry yield 10.10 g.Kg^{-1} was achieved from the agricultural substrate without significant difference with WwC + SU0 and WwP + SU0, both of which yielded a dry yield of 11.35 and 12.05 g. Kg^{-1} of the agro-substrate, respectively.

The double interaction between the substrate type M and the level of the SP vaccine had a significant effect on the amount of dry weight. The dry yield was in the range of 11.00 to 25.41 g.Kg^{-1} from the agricultural substrate. The combination of WC + SP3 achieved the highest dry yield of 25.41 g.Kg^{-1} from tumor substrate, which was not statistically significant for the combinations of C + SP3, WC + SP2 and WP + SP3 which respectively yielded a dry yield of 25.40, 23.79 and 23.39 g.Kg^{-1}. The W + SP1 combination yielded the lowest dry content of 11.00 g.Kg^{-1} from the mean though it was not statistically significant for dry score in the combinations of P + SP1, WwC + SP1, WwP + SP1 and W + SP2 which yielded dry yields of 12.30, 11.88, 12.16 and 12.77 g.Kg^{-1}, respectively. The overlap between SU and SP showed a significant effect on dry weight, with SU1 + SP3 achieving a dry yield of 26.12 g. Kg^{-1} from the center, while the combination SU0 + SP1 recorded the lowest average production *i.e.*, 9.41 g. Kg^{-1} from the center.

The results of the statistical analysis of the Table 2 showed that the triple interference of the studied factors had a significant impact on the quantity of dry yield, as the treatment C + SU1 + SP3 gave the highest average production *i.e.*, 33.70 g. Kg^{-1} from the center whereas the comparison treatment W + SU0 + SP1 gave the average production of 6.68 g.Kg^{-1} from the center.

3.2 Evaluation of casing influence on nitrogen content of Oyster mushroom, *Pleurotus sapidus*

The statistical analysis results are tabulated in Table 3 showed a significant effect of various agricultural substrates on the percentage of nitrogen. Wheat substrate attained the highest percentage of nitrogen *i.e.*, 3.80%, while WwP achieved the lowest percentage of 2.02%. The superiority of the nitrogen content present in the fruit bodies grown in wheat straw may be due to high wheat content (Table 1). The results showed that there was a significant effect in the

Table 2 : Evaluation of casing influence on dry yield of Oyster mushroom, *Pleurotus sapidus*.

SU	SP	M							SP *SU
		W	C	P	WC	WwC	WP	WwP	
SU0	SP1	6.68	7.94	10.30	9.19	8.46	12.98	10.03	9.41
	SP2	8.35	13.10	13.93	16.70	11.67	19.34	12.92	13.71
	SP3	14.98	17.62	17.39	21.76	13.93	19.43	13.19	16.90
SU1	SP1	12.35	27.91	15.54	20.57	11.85	20.39	14.18	17.54
	SP2	16.17	29.92	17.65	30.34	22.52	22.64	15.67	22.13
	SP3	22.51	33.70	23.98	29.38	22.77	29.17	21.29	26.12
SU2	SP1	13.65	17.38	11.05	21.21	15.33	16.74	12.28	15.38
	SP2	13.79	21.25	15.47	24.35	16.00	20.37	13.49	17.82
	SP3	18.04	24.88	22.72	25.11	20.71	21.58	20.43	21.92
M		14.09	21.52	16.45	22.07	15.91	20.29	14.83	
M*SU*SP = 4.34SU*SP= 1.64M= 1.45									LSD 0.05
SU	SU * M								
M * SU	SU0	10.10	12.89	13.87	15.88	11.35	17.25	12.05	13.34
	SU1	17.01	30.51	19.06	26.76	19.04	24.07	17.05	21.93
	SU2	15.16	21.17	16.41	23.56	17.35	19.56	15.40	18.37
M*SU= 2.50SU=0.95									LSD 0.05
SP	SP * M								
M * SP	SP1	11.00	17.74	12.30	16.99	11.88	16.70	12.16	14.11
	SP2	12.77	21.42	15.68	23.79	16.73	20.78	14.03	17.89
	SP3	18.51	25.40	21.36	25.41	19.14	23.39	18.31	21.65
M*SP = 2.50SP=0.95									LSD 0.05

percentage of nitrogen by the additives, which were added to different agricultural substrates. The wheat bran gave SU1 the highest nitrogen ratio of 3.14%, followed by SU2 grass land cutting with 2.75%, compared to SU0 which achieved the lowest nitrogen ratio of 2.50%. It was also found that the level of spawn in addition to different agricultural substrates had a significant effect on the percentage of nitrogen which exceeds SP2 level by giving the highest percentage of nitrogen being 2.89%. The SP3 level achieved the lowest percentage of nitrogen amounted to 2.65%.

The double correlation between the substrate type M and type SU was significant in terms of nitrogen percentage. W + SU1 gave the highest nitrogen concentration *i.e.*, 4.56%, while WwP + SU0 attained the lowest nitrogen ratio *i.e.*, 1.78%.The double interaction between the substrate (M) and the spawn level (SP) led to a significant effect on the percentage of nitrogen. The combination of W + SP1 gave the highest nitrogen ratio of 4.05%, while the WwP + SP1 gave the lowest nitrogen ratio of 1.83%.

The effect of SU overlapping between SU and SP was significant in nitrogen percentage, with SU1 + SP2 giving the highest nitrogen ratio of 3.31%, while SU0 + SP3 gave the lowest nitrogen ratio of 2.30%.

The statistical analysis results of the same Table 3 shows the effect of triple interference of the studied factors which seemed to be significant in the percentage of nitrogen. W + SU1 + SP2 gave the highest nitrogen percentage of 4.63%, while WP + SU0 + SP2 gave the lowest percentage of nitrogen 1.71%.

3.3 Assessment of influence of casing on potassium content in Oyster mushroom, *Pleurotus sapidus*

The statistical analysis results shown in Table 4 inferred a significant effect of different agricultural substrates in the concentration of potassium. Wheat

Table 3 : Evaluation of casing influence on Nitrogen content of Oyster mushroom, *Pleurotus sapidus.*

SU	SP	M							SP *SU
		W	C	P	WC	WwC	WP	WwP	
SU0	SP1	3.47	3.35	2.84	2.71	2.45	2.26	1.80	2.70
	SP2	3.63	2.56	2.70	2.56	2.54	1.71	1.79	2.50
	SP3	2.47	2.44	2.55	2.58	2.52	1.79	1.76	2.30
SU1	SP1	4.59	2.32	3.57	3.46	3.17	2.52	1.84	3.07
	SP2	4.63	4.47	2.50	3.68	3.02	2.74	2.11	3.31
	SP3	4.45	2.45	2.87	3.65	2.55	2.88	2.51	3.05
SU2	SP1	4.08	3.27	2.50	2.33	2.57	2.78	1.87	2.77
	SP2	3.64	2.52	3.36	2.58	2.24	3.29	2.46	2.87
	SP3	3.25	3.40	2.66	2.47	2.18	2.23	2.06	2.61
M		3.80	2.98	2.84	2.89	2.58	2.47	2.02	
M*SU*SP = 0.45SU*SP= 0.17M=0.15									LSD 0.05
SU	SU * M								
M * SU	SU0	3.19	2.79	2.70	2.62	2.50	1.92	1.78	2.50
	SU1	4.56	3.08	2.98	3.60	2.91	2.71	2.15	3.14
	SU2	3.66	3.06	2.84	2.46	2.33	2.77	2.13	2.75
M*SU= 0.26SU=0.10									LSD 0.05
SP	SP * M								
M * SP	SP1	4.05	2.98	2.97	2.83	2.73	2.52	1.83	2.85
	SP2	3.97	3.18	2.85	2.94	2.60	2.58	2.12	2.89
	SP3	3.39	2.76	2.69	2.90	2.42	2.30	2.11	2.65
M*SP= 0.26SP=0.10									LSD 0.05

substrate achieved the highest concentration of potassium with 118.47 mg/100g^{-1} dry weight, while WwP yielded the lowest concentration of 82.30 mg^{-1} of dry weight. This was not statistically different from that of C, WwC and WP, which yielded potassium concentrations of 85.20, 85.35 and 84.41 mg per 100 gm^{-1} of dry weight, respectively. The results showed that there was a significant effect of additives added to different agricultural substrates in the concentration of potassium. The wheat bran gave SU1 the highest concentration of potassium *i.e.*, 93.70 mg, 100 g $^{-1}$ of the dry weight, followed by SU2 grass land cutting with a concentration of 88.73 mg^{-1}.

The dry weight, which was not statistically different from SU0 (without the addition of the supplement), gave the lowest potassium concentration of 88.59 mg.

The results also indicate that the level of spawn addition to different agricultural substrates has a significant effect in the concentration of potassium, when SP3 level achieved the highest concentration of potassium *i.e.*, 92.07 mg.100 g^{-1} dry weight, compared to what was achieved in the level of SP1, which achieved the lowest concentration of potassium *i.e.*, 88.14 mg.100 g^{-1} dry weight.

The effect of the dual interactions between substrate type M and supplement type SU was significant in potassium concentration. W + SU1 gave the highest concentration of potassium *i.e.*, 128.43 mg in 100 g^{-1} of dry weight, while WwP + SU0 gave the lowest potassium concentration of 74.27 mg in 100 g^{-1} dry weight.

The combination of substrate (M) and spawn level (SP) had a significant effect on potassium concentration with W + SP1 achieving the highest potassium concentration *i.e.*, 120.88 mg in 100 g^{-1} dry weight while the WwP + SP1 achieved the lowest potassium

Table 4 : Evaluation of casing influence on potassium content of oyster mushroom, *Pleurotus sapidus.*

SU	SP	M							SP *SU
		W	C	P	WC	WwC	WP	WwP	
SU0	SP1	113.00	87.17	81.37	81.37	78.67	73.97	63.00	82.65
	SP2	118.50	88.13	85.90	85.90	78.20	76.83	78.87	87.48
	SP3	121.33	93.10	102.60	112.93	78.30	80.23	80.93	95.63
SU1	SP1	121.33	78.80	77.93	77.93	83.80	81.27	85.30	86.62
	SP2	127.83	96.07	89.30	89.30	89.97	89.30	94.43	96.90
	SP3	136.13	73.33	96.57	95.23	93.23	91.60	99.13	97.89
SU2	SP1	128.30	84.90	88.00	88.00	97.10	96.10	83.60	95.14
	SP2	115.80	79.73	83.80	83.80	86.30	89.80	79.47	88.39
	SP3	84.03	85.60	85.80	84.13	82.60	80.63	75.93	82.68
M		118.47	85.20	87.92	88.73	85.35	84.41	82.30	
M*SU*SP = 12.31SU*SP= 4.65M= 4.10									LSD 0.05
SU	SU * M								
M * SU	SU0	117.61	89.47	89.96	93.40	78.39	77.01	74.27	88..59
	SU1	128.43	82.73	87.93	87.49	89.00	87.39	92.96	93.70
	SU2	109.38	83.41	85.87	85.31	88.67	88.84	79.67	88.73
M*SU= 7.11SU= 2.69									LSD=0.05
SP	SP * M								
M * SP	SP1	120.88	83.62	82.43	82.43	86.52	83.78	77.30	88.14
	SP2	120.71	87.98	86.33	86.33	84.82	85.31	84.26	90.82
	SP3	113.83	84.01	94.99	97.43	84.71	84.16	85.33	92.07
M*SP= 7.11SP= 2.69									LSD=0.05

concentration of 77.30mg.100 g^{-1} of dry weight.

The SU-SP3 combination gave the highest potassium concentration of 97.89 mg.100 g^{-1} dry weight, which was not statistically different from that of the three combinations such as SU0 + SP3, SU1 + SP2 and SU2 + SP1 which yielded the concentrations of 95.63, 96.90 and 95.14 mg per 100 gm^{-1} dry weight, respectively. The SU0 + SP1 gave the lowest potassium concentration of 82.65 mg. The SU1 + SP1 and SU2 + SP3 had a statistical similarity of 86.62 and 82.68 mg per 100 gm^{-1} dry weight, respectively.

The statistical analysis results of the above Table 4 showed that the effect of tri-interactions interference of the studied factors was significant in the concentration of potassium. W + SU1 + SP3 gave the highest potassium concentration of 136.13 mg per 100 gm of dry weight, while WwP + SU0 + SP1 attained the lowest concentration of potassium *i.e.*, 63.00 mg.

3.4 Evaluation of casing influence on sodium content in oyster mushroom,*Pleurotussapidus*

The statistical analysis results showed in Table 5 inferred a significant effect of different agricultural substrates in the concentration of sodium. Wheat straw achieved the highest concentration of sodium with 4.07 mg per 100 gm dry weight, while the corn cobsachieved a mean concentration of 1.39 mg.100 g^{-1} dry weight. The results showed no effect on the type of supplement added to different agricultural substrates with statistical differences in the sodium content of fruit bodies. SU0, SU1 and SU2 achieved the sodium concentrations of 2.49, 2.50 and 2.62 mg. 100 g^{-1} dry weight, respectively. The results showed that there was no significant effect of spawn addition in the sodium content of fruit bodies. The parameters SP1, SP2 and SP3 achieved the sodium concentrations of 2.47, 2.59 and 2.55 mg per 100 gm^{-1} of dry weight, respectively.

The double overlap between the substrate type M and supplement type SU was significant in sodium concentration with W + SU1 and W + SU0 attained the highest concentrations of sodium (4.33 and 4.06mg. 100 g^{-1}) of dry weight in two combinations, respectively. The combination C + SU0 achieved the lowest sodium concentration of 1.11 mg per 100 gm dry weight, which was not statistically different from that of C + SU1 and P + SU1 combinations at a concentration of 1.27 and 1.43 mg, respectively.

The effect of Di-interaction between substrate M and the spawn level SP was significant in the sodium content of fruit. Among the combinations, W + SP3 gave the highest sodium concentration of 4.38 mg. 100 g^{-1} of dry weight, while the C + for sodium achieved 1.23 mg.100 gm^{-1} of dry weight which was not statistically significant for C + SP2 and P + SP3 at 1.52 and 1.42 mg per 100 gm^{-1} dry weight, respectively.

The SU2 + SP1 combination gave the highest sodium concentration of 2.73 mg. 100 gm^{-1} of dry weight, with no statistical differences on the combinations such as SU0 + SP2 and SU0 + SP3, SU1 + SP2, SU1 + SP3, SU2 + SP2, and SU2 + SP3 which yielded the concentrations of 2.57, 2.51, 2.59, 2.62, 2.61, and 2.53 mg per 100 gm^{-1} dry weight, respectively. The SU1 + SP1 achieved the lowest sodium concentration of 2.28 mg, 100 gm^{-1} of dry weight with no statistical differences on the combinations of SU0 + SP1, SU0 + SP3 and SU2 + SP3 at a concentration of 2.39, 2.51 and 2.53 mg.100 g^{-1} of dry weight for each of them, respectively.

The statistical analysis results of the same table showed that the effect of tri-interactions interference of the studied factors was significant in terms of sodium concentration. The W + SU1 + SP3 achieved the highest sodium concentration *i.e.*, 5.33 mg per 100 g dry weight, while the combination C + SU0 + SP1 achieved the lowest sodium concentration being 1.10 mg.100g^{-1} dry weight.

Table 5 : Evaluation of casing influence on the sodium content in oyster mushroom, *Pleurotus sapidu*s.

SU	SP	M							SP *SU
		W	C	P	WC	WwC	WP	WwP	
SU0	SP1	4.00	1.10	2.20	2.60	2.60	2.13	2.10	2.39
	SP2	4.03	1.27	1.73	3.00	2.87	2.37	2.70	2.57
	SP3	4.13	0.97	1.60	3.13	2.77	1.83	3.10	2.51
SU1	SP1	3.53	1.20	1.30	2.23	2.67	1.67	3.37	2.28
	SP2	4.13	1.33	1.53	2.57	3.23	2.27	3.03	2.59
	SP3	5.33	1.27	1.47	2.50	2.80	2.13	2.83	2.62
SU2	SP1	4.30	1.40	1.70	2.63	3.30	2.40	3.40	2.73
	SP2	3.53	1.97	2.00	2.73	3.17	2.33	2.50	2.61
	SP3	3.67	2.03	1.90	2.83	2.83	1.93	2.50	2.53
M		4.07	1.39	1.72	2.69	2.92	2.12	2.84	
M*SU*SP = 0.68SU*SP= 0.26M= 0.23									LSD 0.05
SU	SU * M								
M * SU	SU0	4.06	1.11	1.84	2.91	2.74	2.11	2.63	2.49
	SU1	4.33	1.27	1.43	2.43	2.90	2.02	3.08	2.50
	SU2	3.83	1.80	1.87	2.73	3.10	2.22	2.80	2.62
M*SU= 0.39SU= 0.15									LSD 0.05
SP	SP * M								
M * SP	SP1	3.94	1.23	1.73	2.49	2.86	2.07	2.96	2.47
	SP2	3.90	1.52	1.76	2.77	3.09	2.32	2.64	2.59
	SP3	4.38	1.42	1.66	2.82	2.80	1.97	2.81	2.55
M*SP= 0.39SP= 0.15									LSD 0.05

3.5 Evaluation of casing influence on calcium content in oyster mushroom, *Pleurotus sapidus*

The statistical analysis results shown in Table 6 inferred a significant effect of different substrates in the calcium content of fruit bodies. The center of wheat straw achieved the highest concentration of calcium *i.e.*, 13.72 mg. 100 g^{-1} of the dry weight, while the Corn cobs attained the lowest percentage of calcium *i.e.*, 6.56 mg. 100 g^{-1} of dry weight. The results did not show significant statistical differences in calcium content of fermented fruit with that of the type of supplement added to different agricultural substrates. SU0, SU1 and SU2 achieved the calcium concentrations of 10.47, 10.67 and 10.48mg, respectively. The results also indicated that there were no statistical differences in calcium content in fruit bodies with different oyster spawn levels as the treatments SP1, SP2 and SP3 gave the calcium concentrations amounted to 10.37, 10.57 and 10.68 mg. 100 g^{-1} dry weight, respectively.

The effect of di-interaction between substrate type M and supplement type SU was significant in calcium content of fruit bodies. The combination W + SU1 achieved the highest calcium concentration *i.e.*, 15.30 mg. 100 g^{-1} dry weight, while the C + SU1 achieved the lowest calcium concentration *i.e.*, 5.61 mg.100 g^{-1} dry weight.

The combination of substrate M and the spawn level SP had a significant effect on calcium content of fruit bodies. W + SP3 achieved the highest calcium concentration *i.e.*, 13.99 mg.100 g^{-1} dry weight and there was no significant difference with that of W + SP1 and W + SP2 at 13.78 and 13.39 mg per 100 gm^{-1} of dry weight respectively. However, the C + SP3 gave the lowest calcium concentration of 6.34 mg.100 g^{-1} dry weight without statistical differences on the performance of C + SP1 and P + SP2 at concentrations of 6.81 and 6.52 mg per 100 gm^{-1} of dry weight,

Table 6 : Evaluation of casing influence on calcium content in oyster mushroom, *Pleurotus sapidus*.

SU	SP	M							SP *SU
		W	C	P	WC	WwC	WP	WwP	
SU0	SP1	12.70	7.20	10.67	9.77	10.77	8.97	9.40	9.92
	SP2	12.63	7.03	10.27	10.67	11.03	10.20	11.37	10.46
	SP3	12.87	5.90	12.70	12.13	11.20	8.70	13.63	11.02
SU1	SP1	12.63	5.97	10.57	10.00	11.07	8.10	13.77	10.30
	SP2	15.63	5.53	8.23	11.30	12.60	9.93	13.07	10.90
	SP3	17.63	5.33	6.43	11.00	12.33	10.53	12.43	10.81
SU2	SP1	16.00	7.27	6.80	11.90	11.67	10.20	12.33	10.88
	SP2	11.90	7.00	9.00	11.37	11.50	11.00	10.77	10.36
	SP3	11.47	7.80	9.10	11.50	11.10	9.77	10.63	10.20
M		13.72	6.56	9.31	11.07	11.47	9.71	11.93	
M*SU*SP = 1.63SU*SP= 0.62M= 0.54									LSD 0.05
SU	SU * M								
M * SU	SU0	12.73	6.71	11.21	10.86	11.00	9.29	11.47	10.47
	SU1	15.30	5.61	8.41	10.77	12.00	9.52	13.09	10.67
	SU2	13.12	7.36	8.30	11.59	11.42	10.32	11.24	10.48
M*SU= 0.94SU= 0.36									LSD 0.05
SP	SP * M								
M * SP	SP1	13.78	6.81	9.34	10.56	11.17	9.09	11.83	10.37
	SP2	13.39	6.52	9.17	11.11	11.71	10.38	11.73	10.57
	SP3	13.99	6.34	9.41	11.54	11.54	9.67	12.23	10.68
M*SP= 0.94SP= 0.36									LSD 0.05

respectively.

The SU-SP3 combination achieved the highest calcium concentration of 11.02 mg. 100 g^{-1} dry weight and did not differ statistically from SU0 + SP2 and SU1 + SP2 combinations. SU1 + SP3 and SU2 + SP1 achieved the concentrations of 10.46, 10.90, 10.81 and 10.88 mg per 100 gm^{-1} of dry weight respectively while SU0 + SP1 achieved the lowest calcium concentration of 9.92 mg.100 gm^{-1} dry weight. There was no significant difference in the SU0 + SP2, SU1 + SP1, SU2 + SP2 and SU2 + SP3 concentrations of 10.46, 10.30, 10.36 and 10.20 mg per 100 gm^{-1} dry weight, respectively.

The statistical analysis results of the Table 6 showed that the effect of tri-interactions interference of the studied factors was significant in calcium concentration. The combination W + SU1 + SP3 achieved the highest concentration of calcium at 17.63 mg.100 g^{-1} of dry weight while the combination C + SU1 + SP3 attained the lowest concentration of calcium being 5.33 mg. 100 g^{-1} dry weight.

3.6 Evaluation of casing influence on phosphorous content in oyster mushroom, *Pleurotus sapidus*

The statistical analysis results shown in Table 7 inferred a significant effect of different substrates in the percentage of phosphorus, which was higher among wheat straw at 0.32%, while the WwP achieved the lowest percentage of 0.23%, which was not statistically significant phosphorous content in C, WwC and WP (0.24, 0.24 and 0.24%, respectively). The results showed that there was a significant effect in the percentage of phosphorus with regard to the type of supplement added to different agricultural substrates. The wheat bran SU1 achieved the highest percentage of phosphorus at 0.30%, followed by SU2 grass land cutting *i.e.*, 0.25% in comparison with SU0 treatment which gave the lowest phosphorus value *i.e.*, 0.22%.

Table 7 : Evaluation of casing influence on phosphorous content in oyster mushroom, *Pleurotus sapidus.*

SU	**SP**	**M**							**SP *SU**
		W	**C**	**P**	**WC**	**WwC**	**WP**	**WwP**	
SU0	SP1	0.27	0.20	0.27	0.19	0.18	0.18	0.15	0.21
	SP2	0.38	0.25	0.25	0.16	0.16	0.20	0.19	0.23
	SP3	0.28	0.25	0.25	0.37	0.18	0.17	0.19	0.24
SU1	SP1	0.38	0.25	0.27	0.28	0.29	0.26	0.28	0.29
	SP2	0.35	0.27	0.34	0.30	0.30	0.28	0.29	0.30
	SP3	0.39	0.24	0.28	0.29	0.30	0.29	0.32	0.30
SU2	SP1	0.32	0.24	0.24	0.29	0.30	0.22	0.22	0.26
	SP2	0.30	0.25	0.28	0.27	0.24	0.29	0.23	0.27
	SP3	0.23	0.25	0.24	0.22	0.25	0.23	0.21	0.23
M		.320	0.24	0.27	0.26	0.24	0.24	0.23	
M*SU*SP = 0.09SU*SP= 0.04M= 0.03									LSD 0.05
SU	SU * M								
M * SU	SU0	0.31	0.23	0.25	0.24	0.17	0.19	0.18	0.22
	SU1	0.38	0.25	0.30	0.29	0.29	0.28	0.30	0.30
	SU2	0.28	0.25	0.26	0.26	0.26	0.25	0.22	0.25
M*SU= 0.05SU= 0.02									LSD 0.05
SP	SP * M								
M * SP	SP1	0.33	0.23	0.26	0.25	0.25	0.22	0.21	0.25
	SP2	0.34	0.25	0.29	0.25	0.23	0.26	0.23	0.27
	SP3	0.30	0.24	0.26	0.29	0.24	0.23	0.24	0.26
M*SP= 0.05SP= 0.02									LSD 0.05

The results showed no statistically significant differences in phosphorus content with regard to the effect of spawn level. The levels of SP1, SP2 and SP3 achieved the phosphorus levels to be 0.25, 0.27 and 0.26%, respectively.

The effect of Di-interaction between the substrate type (M) and supplement type (SU) was significant in the percentage of phosphorus. W + SU1 achieved the highest phosphorus percentage *i.e.*, 0.38%, while the WwC + SU0 achieved the lowest phosphorous ratio *i.e.*, 0.17% without statistical differences. The values of WP + SU0 and WwP + SU0 were 0.19% and 0.18%, respectively. The combination of substrate (M) and the spawn level (SP) achieved a significant effect on the percentage of phosphorus. W + SP2 achieved the highest phosphorus yield *i.e.*, 0.34%, which was not statistically significant in case of W + SP1 and W + SP3 combinations for which the values were 0.33% and 0.30%, respectively. However, the WwP + SP1 achieved the lowest phosphorous ratio of 0.21%. The results showed that the SU-+ SP2 and SU1 + SP3 were higher than 0.60% phosphorus whereas the SU0 + SP1 gave the lowest phosphorous ratio *i.e.*, 0.21%. The statistical analysis results of the Table 7 showed the effect of Tri-interaction interference of the studied factors which was significant in terms of phosphorous percentage. The combination W + SU1 + SP3 achieved the highest percentage of phosphorus being 0.39%, while WwP + SU0 + SP1 achieved the lowest phosphorus ratio of 0.15%.

4. Conclusion

The results revealed that Oyster mushroom type Pleurotus sapidus showed a clear response to the Peat moss Casing, The higher of fruit bodies obtained by (WP) substrate was 81.83g.kg^{-1} of substrate, while the (W) substrate given lower quantity of yield was 47.13 g.kg^{-1} of substrate.

References

A.O.A.C. (1990). *Official Methods of Analysis*. 15th ed., Association ofOfficial Analytical Chemists, Artington, Virginia, USA.

Ahmed, S.A., J.A. Kadam, V.P. Mane, S.S. Patil and M.M.V. Baig (2009). Biological efficiency and nutritional contents of *Pleurotus florida* cultivated on Different agro-waste. *Nature. Sci*., **7(1)**, 44-48.

AL-Sadaawwy, A.K.A. (2015). Evaluation the Efficiency of Substrate and Casing in Quantities and Qualities Characteristics of *Flammulina velutipes* and *Pleurotus eryngii* and their effect in Control of Some Plant Pathogenes. *Ph.D. Thesis*, Dept. of Plant Pathology Sci., Coll. of Agric., Univ. of Baghdad, ,Iraq .

Chu, J.N., C.C. Young, C.C. Tan, S.P. Wu and L.S. Young (2012). Improvement of productivity and polysaccharide - protein complex in *Agaricus blazei*. *Pesquisa Agropecuaria Brasileira*, **47(1)**, 96-102.

Cresser, M.S. and J.W. Parsons (1979). Sulphuric, perchloric and digestion of plant material for magnesium. *Analytic. Chemic. Acta*., **109**, 431-436.

Dundar, A., H. Acay and A. Yildiz (2008). Yield performances and nutritional contents of three oyster mushroom species cultivated on wheat stalk. *Afric. J. of Biotec*., **7(19)**, 3497-3501.

Farsi, M., K. Malekzadeh and B. Jalazadeh (2011). Recycling of Mushroom peat casing soil through a plastic mesh. Proceeding of the 7th International Conference on Mushroom Products, Arcachon, France, 4 - 7 October.

Hassan, I.A. (2011). Effect of Sterilization Method and Supplementation on the Yield and Storage life of Oyster Mushroom Cultivated on Date Palm Byproducts. *M.Sc.Thesis*, Dept. of Horticulture and Sci., Coll. of Agric., Univ. of Baghdad, Iraq.

Jackson, M.L. (1958). *Soil Chemical Analysis*. Prentice Hall Inc Englewood, Cliffs, N.J., USA.

Kumari, D. and V. Achal (2008). Effect of different substrates on the production and non-enzymatic antioxidant activity of *Pleurotus ostreatus* (Oyster mushroom). *Life Sci. J*., **5(3)**, 73-76.

Kurtzman, R.H.J.R. (2005). Mushroom: Sources for modern western medicine. *Micolo. Apli. Inter*., **17(2)**, 21-33.

Kwon, H. and B.S. Kim (2004). Mushroom Growers' Handbook: Shiitake Cultivation, 260. Mushworld, Korea.

Miah, Md. Nuruddin, Akikun Nesa Brinti and Kamal Uddin Ahmed (2016). Effect of Different Sawdust on the Growth, Yield and Proximate Composition of *Pleurotus Sajor-Caju*. *J. Agricult. Vet. Sci*. (IOSR-JAVS), **9 (1)**, 40-52.

OECD-Organisatio for Economic Co-operation and Development (2008). Oyster mushroom *Pleurotus* Spp., Source: OECD Agri. and food. *2006*, **21**, 319 -338.

Oei, P. (2005). *Small-scale mushroom cultivation (oyster, shiitake and wood ear mushrooms)*. Digigrafi, no 40 Wageningen, The Netherlands.

Shally, A.A.K. (2002). Studies on white buttons mushroom, *Agaricuis bisporus* (lange) sing and *Agaricuis compestris* (fries). *M.Sc. Thesis*, College of Science, University of Sulaimani.