Evaluation of Qualification of Substrates Containing Date Palm Fibers (Leef) and Sawdust on Quality and Productivity of Four Pleurotus spp.

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Abstract:

Effects of used local wastes consist of wheat straw, sawdust and date palm fibers with 5% rock phosphate as substrate of some quality and productivity of four Pleurotus spp., P. ostreatus (Grey Oyster), P. ostreatus (White Oyster), P. cornucopiae var. citrinopileatus (Bright Yellow Oyster) and P. salmoneostramineus (Pink Oyster) was studied. The results showed that using mixture 2 (70% wheat straw, 20% sawdust and 10% date palm fibers) and mixture 3 (50% wheat straw, 30% sawdust and 20% date palm fibers) had significant influence to increase the following: biological efficiency with average 39.21% and 33.58%, number of flushes 2.83 and 2.75 for each bag kg wet weight), total harvest 187.6 and 176.7 g/bag, average of weight one flush 70.21 and 65.90 g and number of fruiting bodies 38.50 and 40.58 body/bag for all Oyster Mushroom species compared to control (100% wheat straw substrate)on 33.54%, 2.50 flush/bag, 154.1 g/2kg, 62.21 g, and 23.83 body/bag respectively, in despite of delay primordia appearance in these mixture, while had not any effect on thickness of cap.

P. ostreatus (Grey) was significant superiority with other species to decrease period primordia appearance to 5.11 days and increase each of biological efficiency of 47.88%, 4 flush/bag, 231.1 g/bag total harvest, 13.89 g average of fruiting body, 14.07 mm stem diameter, 49.78 mm stem length and 85.80 mm cap diameter. P. ostreatus (white strain) increased average weight of flush 75.98 g, while P. salmoneostramineus and P. cornucopiae increased superiority number of fruiting bodiesto 48.67 and 47.89 g, as compared with 22.67 and 18.00 body/bag for white and grey strain (P. ostreatus G and P. ostreatus W) respectively.

تقدير كفاءة الاوساط الزراعية الحاوية على ليف النخيل ونشارة الخشب في الصفات النوعية والانتاجية لأربع أنواع من الفطر المحاري Pleurotus spp.

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الكلمات المفتاحية: Pleurotus spp. , انتاجية , كفاءة حيوية, ليف النخيل, الصخر الفوسفاتي, نشار الخشب.

قيم البحث في المؤتمر العلمي الثاني وارسل الى المقيمين وتم قبوله بعد عرضه على اللجنة العلمية للمجلة

المستخلص:

درست تأثير مخلفات محلية تكونت تبن الحنطة ونشارة الخشب وليف النخيل المدعم بـ 5% صخر فوسفاتي كوسط للزراعة على بعض الصفات النوعية ولإنتاجية لأربع انواع من الفطر المحاري Pleurotus spp. الرصاصي ولأبيض P. ostreatus والاصفر P. co mucopiacb والوردي P. salmoneostramineus وبينت النتائج ان استعمال الخلطتين 2 (تبن الحنطة 70% ونشارة الخشب 20% وليف النخيل10%) و3(تبن الحنطة 50% ونشارة الخشب 30% وليف النخيل20%) اثر معنويا (P>0.05) في زيادة كل من الكفاءة الحيوية بمعدل 39,21% و 33,58% عدد الجنيات بمعدل 2,83 و 2,75 جنية/ كيس (2كغم وزن رطب) والحاصل اكلي بوزن 187,6 و 176,57غم/2كغم وسط رطب ومعدل وزن الجنية الواحدة 70,21 و 65,90غم وعدد الاجسام الثمرية 38,50 و 40,58 جسم/كيس لجميع الفطريات الغذائية مقارنة مع 33,54%

و 2,50جنية/كيس و154,1غم/كيس و 62,21غم و23,83جسم/كيس لوسط تبن الحنطة القياسي على التوالي بالغم من تأخير الخلطات لمدة ظهور الدبابيس في حين لم يظهر استعمال الخلائط اي تأثير على سمك القبة.

وتفوق القطر المحاري الرصاصي .Pleurotus spp معنويا في اختزال مدة ظهور الدبابيس الى 5,11 يوما وارتفاع كل من الكفاءة الحيوية بنسبة 47,88 وعدد الجينات 4 لكل كيس والانتاج الكلي 23,1غم/كيس ومعدل وزن الجسم الثمري 13,89غم وقطر الساق 14,07 ملم وطوله 48,78 ملم وقطر القيمة 85,50 ملم للأجسام الثمرية على بقية الانواع, في حين تفوقت السلالة البيضاء P. ostreatus W في زيادة معدل وزن الجنية الواحد البالغة 75,98 غم بينما بينت انواع الفطر المحاري الوردي P. salmoneostramineus ولأصفر P. cornucopiae بعدد اجسام بلغ 48,67 و 47,89 جسم/كيس على التوالي مقارنة بعدد أجسام العزلتين البيضاء والصفراء البالغ 22,67 و18,00 جسم/كيس على التوالي.

INTRODUCTION

Cultivated members of the genus Pleurotus, the Oyster mushroom, is rapidly increasing, and 875.6 thousand metric tons were produced in 1997. To illustrate the increasing popularity of Pleurotus during the period from 1986 to 1997, the production in the world has increased by a factor of almost 5.2. Oyster mushroom is one of the most commercially important and successfully cultivated and is considered to be a delicacy after Agaricus bisporus and Lentinus edodes. Like Pleurotus ostreatus, many of Pleurotus mushrooms are primary decomposers of hardwood trees found worldwide. Seventy species approximately of Pleurotus were recorded and new species are discovered (Chang and Miles 2004, MushWorld, 2004, Beyer, 2003). Pleurotus is one of 24 mushrooms cultivated commercially in special farm (Thomas and Schumann, 1993). Cultivation of edible mushrooms is a biotechnological process for lingo cellulosic wastes recycling. It might be the only current process that combines the production of protein-rich food with the reduction of environmental pollution (Sanchez, 2010). Pleurotus was cultivated on different agro-wastes such soybean straw, rice straw, paddy straw, coffee pulp, sawdust, cotton waste, cotton seed hulls, corn cobs waste, paper, bean straw, crushed bagasse, molasses wastes, wheat straw and some their combination to determine the effect of these agro waste on yield and other properties (Ahmed et al., 2009; Pandey, 2008; Mush World, 2004; Al-Issawy, 2011). (Kim et al., 2009) determined the highest antioxidant and anticancer activities of Oyster mushrooms with different colors such as dark-grey strain (Pleurotus ostreatus), yellow strain (Pleurotus cornucopiae), and pink strain (Pleurotus salmoneostramineus). The number of date palm tree about 8 millions in Iraq according to Central.

Organization for Statistics (COS) (Ismail et al., 2010). Wheat stubble and date palm leaf used to cultivate P. ostreatus and P. florida in Iran (Kabirifard et al., 2012). The substrates that prepared from date palm wastes have low nitrogen, therefore; (Hassan, 2011) added some nutrients such urea and K2SO4 to date palm wastes such fibers, stalk and base stalk, while (AlIssawy, 2011) improved substrates of Oyster mushroom by adding rock phosphate to increase biological efficiency. The aim of this study to prepare low cost substrates from wheat straw, sawdust and date palm fibers amended with rock phosphates.

MATERIAL AND METHODS

1-Strains and Spawn Preparation

Four Oyster mushrooms species were investigated. Pleurotus ostreatus G (Grey Oyster), Pleurotus ostreatus W (White Oyster), Pleurotus cornucopiae var. citrinopileatus Y (Bright Yellow Oyster) and Pleurotus salmoneostramineus PK (Pink Oyster) are obtained from Mushroom Box Company, Monmouth, UK, in spawn form and sub cultured on Potato Dextrose Agar (PDA) medium at 25 C° for this experiment and stored in 4 C° for future studies (Nasser, 2010). Spawn was prepared on millet grains as described by Stamets and Chilton (1983).

2- Cultivation of Oyster Mushrooms (Pleurotus spp.)

In this experiment, by using locally agro residual wastes available in Heet city in AlAnbar province were wheat straw (1-5) cm, sawdust and date palm tree (Phoenix sp.) fibers (Leef) were first chopped into small pieces (5*5) cm and mixtures prepared astable 1with 5% rock phosphates have properties, table 2. All mixtures soaked in water for 24 hr. Rock phosphate powder was added with well mixing and drained out excess water. Each 2 kg wet weight of substrate packed in polyethylene bags size (30*50) cm and closed. These bags pasteurized at 60-70 C° for 3hr. by the drum method as described by (Kivaisi, 2007) and let to cool to next day. Then transferred to incubation room and mixed with 5% spawn at wet weight base and closed (Beyer, 2003). Ends of bags were cut to drain out any excess water, darkly incubated at 25 C°and a relative humidity of 80-90% for spawn running. The bags were opened when the mycelia had covered the substrateafter 3-4 days and after shock it by 10-20 C° for 2 days, then lighting by fluorescent light for 12 hr. /dayand fresh aeration twice in day (Epogee, 2011). Within different periods of opening, pinheads (primordia) of Oyster mushrooms appeared on all substrate and mixtures, table 3. In all, different numbers of flushes of mushrooms were harvested within a period of about five weeks. Spray watering wasalso given twice a day during the fruiting stage with 90% humidity and lighting. The yields from all the substrates were compared and their biological efficiency was calculated by (Bisaria et al., 1987), and other measurements were detected.

% Biological Efficiency =
(Weight of wet mushrooms harvested/ Weight of dry substrate taken)*100.

Table -1: Agro-residual wastes and their mixtures for cultivation Oyster Mushroom

Substrates Mixture 3	Wheat Straw (Control)	Mixture 2	Mixture 1
Wheat Straw	100%	70%	50%
Sawdust	0%	20%	30%
Date Palm Fibers (Leef)	0%	10%	20%

Table -2: Properties of rock phosphates (Al-Issawy, 2011)

Mesh Particular	Lime%	Silicate%	S%	F%	%P	Mg ppm	Zn Ppm	Fe ppm
50.00	30.00	2.38	1.55	0.50	8.86	762	385	1460

3. Statistical Analysis

Experimental values are given as means. Statistical significance was determined by two variance (Two Ways) analysis (ANOVA) by using GenStat Discovery Edition computer program version 7 DE3(VSN International Ltd., UK). Differences at P> 0.05 were considered to be significant. The experiments were used three replicates.

RESULTS:

Primordia (Pins) Appearance:

(Table-3) showed that using of mixture 2 (70% wheat straw, 20% sawdust and 10% date palm fibers) and 3 (50% wheat straw, 30% sawdust and 20% date palm fibers) delayed in pins appearance for 6 and 4 days respectively, compared with wheat straw substrate treatment (control) appearance of pins after 9.42 days of the heat shock, was recorded. The results showed the different among species of Oyster mushroom in the pins start, P. ostreatus G significantly (P> 0.05), as compared with all species and pins observed after 5.11 days followed by P. ostreatus W and P. salmoneostramineus duration 11.67 and 15.33 days respectively, whereas P. cornucopiae had the longest period 18.78 days after the heat shock. The treatments showed that mixture

3 reduced period of pins appearance for P. ostreatus G and P. ostreatus W 2.33 and 9.33 days respectively, while the period increased to 7 and 14.33 days when development on substrate 2 comparison with the control that recorded 6 and 11.33 days for the same strains respectively, while all mixtures were significantly increased (P> 0.05) the time of pins emergence of P. cornucopiae 23.33 and 26.33 days and P. salmoneostramineus 16.33 and 16.00 days for mixture 2 and 3,as compared with wheat straw substrate 6.67 and 13.67 days respectively

Table-3: Primordia appearing of Oyster mushrooms after heat shock (Days)

Substrate (S)	(Pleurotus Oyster Mushroom (OM				Mean S
	P.ostreatusG	P. streatus W	P.cornucopiaeY	P.salmoneostramineusPK	
S1	6.00	11.33	6.67	13.67	9.42
S2	7.00	14.33	23.33	16.33	15.25
S3	2.33	9.33	26.33	16.00	13.50
Mean OM	5.11	11.67	18.78	15.33	12.72
LSD P> 0.05	S=1.003 , OM=1.158 , S* OM=2.006				

S1: 100% Wheat Straw Substrate (Control), S2: (70% wheat straw, 20% sawdust and 10% date palm (fibers), S3: (50% wheat straw, 30% sawdust and 20% date palm fibers
OM: Oyster Mushroom, G: Grey Oyster Mushroom, W: White Oyster Mushroom, Y: Bright Yellow Oyster Mushroom, PK, Pink Oyster Mushroom.

Number of Flushes per Bag (Table-4) showed that using of mixtures had significant affect to increase flushes number 2.83 and 2.75 flush/bag (2kg wet weight) for mixture 2 and 3, as compared with average 2.50 flush/bag by wheat straw substrate (control). Oyster mushroom species showed the highest significant superiority (P> 0.05) average 4.00 flush/bag by P. ostreatus G than 2.44, 2.33 and 2.00 flush/bag by P. salmoneostramineus, P. cornucopiae and P. ostreatus W respectively. The best rate was achieved 5.00 flush/bag for flushes number of P. ostreatus G on mixture 2, while decreased significantly (P> 0.05) 3.00 flush/bag with mixture 3, as compared with the control 4.00 flush/bag for same strain. Mixture 3 increased number of flushes significantly (P> 0.05) 3.00 flush/bag for each P. salmoneostramineus and P. cornucopiae, compared with 2.00 flush/bag for the other mixtures, the mixtures 2 and 3 did not record any significant deference on flushes number of P. ostreatus W which reached to 2.00 flush/bag in all substrates.

Table-4: Number of flushes per bag of Oyster mushrooms

Substrate (S)	(Pleurotus Oyster Mushroom (OM				Mean S
	P.ostreatus G	P. streatus W	P.cornucopiaeY	P.salmoneostramineusPK	
S1	4.00	2.00	2.00	2.00	2.50
S2	5.00	2.00	2.00	2.33	2.83
S3	3.00	2.00	3.00	3.00	2.75
Mean OM	4.00	2.00	2.33	2.44	2.69
LSD P> 0.05	S=0.1404 , OM=0.1622, S* OM=0.2809				

S1: 100% Wheat Straw Substrate (Control), S2: (70% wheat straw, 20% sawdust and 10% date palm (fibers), S3: (50% wheat straw, 30% sawdust and 20% date palm fibers
OM: Oyster Mushroom, G: Grey Oyster Mushroom, W: White Oyster Mushroom, Y: Bright Yellow Oyster Mushroom, PK, Pink Oyster Mushroom.

Total Yield:

In (table-5), treatment showed mixtures 2 and 3 were significantly increased (P> 0.05) totalyield of 187.6 and 176.7 g/bag (2kg wet weight substrate) respectively, as compared with 154.1 g/bag by wheat straw (control). Species of Oyster mushroom showed that P. ostreatus G significant

superiorly (P> 0.05) on all other species in production, which reached to 231.1 g/bag, as compared with 164.0 and 152.0 and 144.1 g/bag by P. salmoneostramineus, P. ostreatus W and P. cornucopiae respectively.Treatments showed significant affect (P> 0.05) for mixture 2 to increase production of P. ostreatus G and P. salmoneostramineus of 279.5 and 185.1 g/bag, as compared with 237.3 and 156.1g/bag with control and give 176.6 and 150.6 g/bag when development on the mixture 3 respectively. Mixture 3 improved productivity of P. ostreatus W and P. cornucopiae to 54.14% and 25.08% compared with wheat straw with significant deference (P> 0.05), which reached to 211.3 and 168.2 g/bag compared with wheat straw of 96.9 and 126.0g/bag respectively

Table -5: Total Yield for each bag of Oyster mushrooms (g/bag = g/2kg wet weight)

Substrate (S)	(Pleurotus Oyster Mushroom (OM				Mean S
	P.ostreatus G	P. streatus W	P.cornucopiaeY	P.salmoneostramineusPK	
S1	237.3	126.0	96.9	156.1	154.1
S2	279.6	161.7	124.0	185.1	187.6
S3	176.6	168.2	211.3	150.6	167.7
Mean OM	231.1	152.0	144.1	146.0	172.8
LSD P> 0.05	S=6.54 , OM=7.55 S* OM=13.08				

S1: 100% Wheat Straw Substrate (Control), S2: (70% wheat straw, 20% sawdust and 10% date palm fibers), S3: (50% wheat straw, 30% sawdust and 20% date palm fibers).
OM: Oyster Mushroom, G: Grey Oyster Mushroom, W: White Oyster Mushroom, Y: Bright Yellow Oyster Mushroom, PK, Pink Oyster Mushroom.

Average Weight of Each Flush:

The results in (table-6): showed higher significant average weight of each flush (P>0.05) when development on the mixture 2 of 70.21 g than mixture 3 and wheat straw were 65.90 and 62.21 g respectively. Species of mushroom showed significant superiority (P>0.05) for P. ostreatus W of 75.98 g followed by P. salmoneostramineus, P. cornucopiae and P. ostreatus G of 70.11, 60.31 and 58.02 g per flush respectively. Treatments showed that mixture 3 and 2 increased average weight of flushes and P. ostreatus W and P. cornucopiae, as compared with the other species. P. ostreatus W gave the highest weight on mixture 3 reached 84.07 g followed 80.87 g on mixture 2 compared with wheat straw of 63.00 g, while P. cornucopiae on mixture 3 and 2 gave weight rate of 70.43 and 62.02 g, as compared with 48.47 g on control which the lowest weight achieved.

Table - 6: Average weight of each flush of Oyster mushrooms (g)

Substrate (S)	(Pleurotus Oyster Mushroom (OM				Mean S
	P.ostreatus G	P. streatus W	P.cornucopiae Y	P.salmoneostramineus PK	
S1	59.32	63.00	48.47	78.06	62.21
S2	55.89	80.87	62.02	82.05	70.21
S3	58.87	84.07	70.43	50.21	65.90
Mean OM	58.02	75.98	60.31	70.11	66.10
LSD P> 0.05	S=4.868 , OM=5.621 S* OM=9.737				

S1: 100% Wheat Straw Substrate (Control), S2: (70% wheat straw, 20% sawdust and 10% date palm (fibers), S3: (50% wheat straw, 30% sawdust and 20% date palm fibers.
OM: Oyster Mushroom, G: Grey Oyster Mushroom, W: White Oyster Mushroom, Y: Bright Yellow Oyster Mushroom, PK, Pink Oyster Mushroom.

Number of Fruiting Bodies per Bag:

(Table-7) seen that type of mixture influenced significantly (P> 0.05) on fruiting bodies number were reached 40.58 body/bag followed by mixture 2 and wheat straw of 38.50 and 23.83 body/bag respectively. Mushroom species appeared that P. salmoneostramineus and P. cornucopiae had a number 48.67 and 47.89 body/bag respectively compared to the fruiting bodies number of P. ostreatus W and P ostreatus G was 22.67 and 18.00 body/bag respectively. Generally, treatments showed that mixture 2 and 3 increased the number of fruiting for all species studied with significant deference (P> 0.05), the lowest number 12.00 body/bag by P. ostreatus G onwheat straw substrate followed on mixture 3 and 2 by same strain 16.00 and 26.00 body/bag, while the highest number achieved was 68.00 then 55.00 body/bag by P. cornucopiae and P. salmoneostramineus on mixture 3, then average 51.00 body/bag for each of the same strains on mixture 2.

Table-7: Number of fruiting bodies of Oyster mushrooms

Substrate (S)	(Pleurotus Oyster Mushroom (OM				Mean S
	P.ostreatus G	P. streatus W	P.cornucopiae Y	P.salmoneostramineus PK	
S1	12.00	18.67	24.67	40.00	23.83
S2	26.00	26.00	51.00	51.00	38.50
S3	16.00	23.67	68.00	55.00	40.58
Mean OM	18.00	22.67	47.89	48.67	34.31
LSD P> 0.05	S=2.358, OM=2.723 S* OM=9.716				

S1: 100% Wheat Straw Substrate (Control), S2: (70% wheat straw, 20% sawdust and 10% date palm fibers), S3: (50% wheat straw, 30% sawdust and 20% date palm fibers).
OM: Oyster Mushroom, G: Grey Oyster Mushroom, W: White Oyster Mushroom, Y: Bright Yellow Oyster Mushroom, PK, Pink Oyster Mushroom.

Weight Average of Fruiting Body:

The results in (table – 8) decreased rate of fruiting body weight when using mixture 2 and 3of 5.75 g and 6.04 g respectively compared to wheat straw substrate 8.62 g. Species of mushrooms were effected in the rate of weight fruiting body of P. ostreatus Gwith significant superiority (P> 0.05) reached 13.89 g followed by rates weight of P. ostreatus W, P. salmoneostramineus and P. cornucopiae were 6.74 and 3.42 and 3.17 g respectively. Generally, treatments showed low levels of body weight for all strains with mixture 2 and 3 except P. ostreatus W which cultivated on mixture 3 compared to control, whereas achieved the highest rate 19.86 g by P. ostreatus G with control, followed by the same fungus on mixture 2 and 3 of weight reached 11.08 and 10.74 g, then came P. ostreatus W onmixture 3 of 7.24 g, the lowest rateswere on mixture 2 by P. cornucopiae and mixture 3 by P. salmoneostramineus of 2.42 g and 2.74 g respectively

Table-8: Weight average of fruiting bodies of Oyster mushrooms

Substrate (S)	(Pleurotus Oyster Mushroom (OM				Mean S
	P.ostreatus G	P. streatus W	P.cornucopiae Y	P.salmoneostramineus PK	
S1	19.86	6.75	3.98	3.90	8.62
S2	10.74	6.23	2.42	3.63	5.75
S3	11.08	7.24	3.12	2.74	6.04
Mean OM	13.89	6.74	3.17	3.42	6.80
LSD P> 0.05	S=0.4814, OM=0.5558 S* OM=0.9628				

S1: 100% Wheat Straw Substrate (Control), S2: (70% wheat straw, 20% sawdust and 10% date palm fibers), S3: (50% wheat straw, 30% sawdust and 20% date palm fibers).
OM: Oyster Mushroom, G: Grey Oyster Mushroom, W: White Oyster Mushroom, Y: Bright Yellow Oyster Mushroom, PK, Pink Oyster Mushroom.

Diameter of Stipe (Stem)

Table 9 showing that the type of mixtures was significantly (P> 0.05) reduced the stipe diameter of fruiting body to 8.88 mm by mixture 2 followed by mixture 3 of 9.25 mm and wheat straw substrate of 9.65 mm. Mushroom species showed significant superiority (P> 0.05) by *P. ostreatus* G of 14.07 mm followed by *P. ostreatus* W, *P. salmoneostramineus* and *P. cornucopiae* of 12.31, 5.69 and 4.97 mm respectively. Generally, treatments showed the lowest stipe diameter for all mushrooms on mixture 2 and 3 except *P. ostreatus* W which recorded 14.00 and 13.17 mm on the mixture 3 and 2 as compared with 9.77 mm with control, recorded higher stipe diameter was 17.17 mm by *P. ostreatus* G on control and lower diameter reached to4.50 and 5.03 mm for *P. cornucopiae* and *P. salmoneostramineus* on mixture 2 respectively.

Table - 9: Diameter of stipe of fruiting bodies of Oyster mushrooms (mm)

Substrate (S)	(Pleurotus Oyster Mushroom (OM				Mean S
	P.ostreatus G	P. streatus W	P.cornucopiae Y	P.salmoneostramineus PK	
S1	9.65	6.43	5.23	9.77	17.17
S2	8.88	5.03	4.50	13.17	12.80
S3	9.25	5.60	5.17	14.00	12.23
Mean OM	9.26	5.69	4.97	12.31	14.07
LSD P> 0.05	S=0.717, OM=0.828, S* OM=1.435				

S1: 100% Wheat Straw Substrate (Control), S2: (70% wheat straw, 20% sawdust and 10% date palm (fibers), S3: (50% wheat straw, 30% sawdust and 20% date palm fibers.

OM: Oyster Mushroom, G: Grey Oyster Mushroom, W: White Oyster Mushroom, Y: Bright Yellow Oyster Mushroom, PK, Pink Oyster Mushroom.

Length of Stipe

Type of mixtures gave significant increase (P> 0.05) in stipe length was 31.94 mm by mixture 2 followed by control and mixture3 of 29.42 and30.04 mm, (table – 10). Strains showed longer stipe achieved 49.78 mm of *P. ostreatus* Gand decreased significantly (P> 0.05) to 32.50, 24.41 and 15.18 mm by *P. cornucopiae*,8

Table -10: Length of stipe of fruiting bodies of Oyster mushrooms (mm)

Substrate (S)	(Pleurotus Oyster Mushroom (OM				Mean S
	P.ostreatus G	P. streatus W	P.cornucopiae Y	P.salmoneostramineus PK	
S1	29.42	15.70	31.83	27.30	42.83
S2	31.94	16.00	34.00	20.60	57.17
S3	30.04	13.83	31.67	25.33	49.33
Mean OM	30.47	15.18	32.50	24.41	49.78
LSD P> 0.05	S=1.147, OM=1.325, S* OM=2.294				

S1: 100% Wheat Straw Substrate (Control), S2: (70% wheat straw, 20% sawdust and 10% date palm fibers), S3: (50% wheat straw, 30% sawdust and 20% date palm fibers).
OM: Oyster Mushroom, G: Grey Oyster Mushroom, W: White Oyster Mushroom, Y: Bright Yellow Oyster Mushroom, PK, Pink Oyster Mushroom.

Diameter of Pileus (Cap)

Types of substrates (Table -11) had significant affect (P>0.05) on cap diameter, which decreased to 68.12 and 60.08 mm with mixture 2 and 3 compared to wheat straw substrate of 71.89 mm. Strains of mushroom had significant affect (P> 0.05) on diameter reached 85.50 mm by *P. ostreatus* G, followed by mushroom *P. ostreatus* W, *P. salmoneostramineus* and *P. cornucopiae* of 68.89, 59.47 and

52.94 mm respectively. Treatments *P. ostreatus* W and *P. salmoneostramineus* respectively.Treatments showed that mixture 2 increased stem length of mushroom strains except *P. ostreatus* W which decreased compared to control of each strains, the highest significant length of stem (P> 0.05) recorded 57.17 and 49.33 mm by *P. ostreatus* G on mixture 2 and 3, while the lowest length were 13.83,15.70 showed that the diameter reduced on mixture 2 and 3 by all mushrooms except *P. ostreatus* W of 77.00 mm and 73.67 mm compared to control 56.00 mm, while the biggest diameter was 96.00 mm by *P. ostreatus* G development on wheat straw substrate, then decreased to 91.00 and 69.50 on mixture 2 and 3 respectively for the same strain with significant deference (P> 0.05), the lowest diameter was 42.83 mm by *P. cornucopiae* on mixture 2, followed by *P. cornucopiae* and *P. salmoneostramineus* of 50.67 and 53.83 mm on mixture 3.

Table - 11: Diameter of pileus (Cap) of fruiting bodies of Oyster mushrooms (mm)

Substrate (S)	(Pleurotus Oyster Mushroom (OM				Mean S
	P.ostreatus G	P. streatus W	P.cornucopiae Y	P.salmoneostramineus PK	
S1	71.89	70.23	65.33	56.00	96.00
S2	60.08	54.33	42.83	73.67	69.50
S3	68.12	53.83	50.67	77.00	91.00
Mean OM	66.70	59.47	52.94	68.89	85.50
LSD P> 0.05	S=1.553, OM=1.794, S* OM=3.107				

S1: 100% Wheat Straw Substrate (Control), S2: (70% wheat straw, 20% sawdust and 10% date palm (fibers), S3: (50% wheat straw, 30% sawdust and 20% date palm fibers.
OM: Oyster Mushroom, G: Grey Oyster Mushroom, W: White Oyster Mushroom, Y: Bright Yellow Oyster Mushroom, PK, Pink Oyster Mushroom.

Thickness of Pileus (Cap)

The evaluated substrates did not significantly effect on the thickness of pileus but the strains effected and the highest significant thickness (P> 0.05) achieved was 5.75 mm by *P. ostreatus* W followed by *P. ostreatus* G, *P. salmoneostramineus* and *P.* cornucopiae of 4.21 and 3.52 and 3.11 mm respectively ,(table - 12).

Table - 12: Thickness of pileus (Cap) of fruiting bodies of Oyster mushrooms (mm)

Substrate (S)	(Pleurotus Oyster Mushroom (OM				Mean S
	P.ostreatus G	P. streatus W	P.cornucopiae Y	P.salmoneostramineus PK	
S1	4.26	3.67	2.80	6.10	4.50
S2	4.06	3.47	3.67	4.90	4.23
S3	4.11	3.43	2.87	6.27	3.90
Mean OM	4.14	3.52	3.11	5.75	4.21
LSD P> 0.05	S=0.4029, OM=0.4652, S* OM=0.8057				

S1: 100% Wheat Straw Substrate (Control), S2: (70% wheat straw, 20% sawdust and 10% date palm (fibers), S3: (50% wheat straw, 30% sawdust and 20% date palm fibers.

OM: Oyster Mushroom, G: Grey Oyster Mushroom, W: White Oyster Mushroom, Y: Bright Yellow Oyster Mushroom, PK, Pink Oyster Mushroom.

Diameter of Pileus (Cap) / Length of Stipe Ratio (DP/LS Ratio)

Using of the mixture 3 was reduced DP/LS ratioto 2.36 followed 2.59 by mixture 2 as compared to wheat straw substrate (control) of 2.70. Species of Oyster mushrooms gave higher DP/LS ratio achieved 3.92 by *P. Salmoneostramineus* than *P. ostreatus* W, *P. ostreatus* G and *P. cornucopiae* of 2.89,

1.76 and 1.63 respectively, (table -13). Especially, treatments appeared DP/LS ratio 4.49 by *P. salmoneostramineus* on wheat straw substrate and mixture 3 respectively, followed by *P. ostreatus* W on mixture 2 of 3.59, the ratio was significantly (P> 0.05) decreased to 1.21 and 1.25 for *P. ostreatus* G and *P. cornucopiae* when development on mixture 2.

Table - 13: Diameter of pileus (Cap) / length of stipe ratio (DP/LS ratio)

Substrate (S)	(Pleurotus Oyster Mushroom (OM				Mean S
	P.ostreatus G	P. streatus W	P.cornucopiae Y	P.salmoneostramineus PK	
S1	2.70	4.49	2.05	2.05	2.24
S2	2.36	3.39	1.25	3.59	1.21
S3	2.59	3.89	1.59	3.04	1.85
Mean OM	2.55	3.92	1.63	2.89	1.76
LSD P> 0.05	S=0.2331, OM=0.2692, S* OM=0.4662				

S1: 100% Wheat Straw Substrate (Control), S2: (70% wheat straw, 20% sawdust and 10% date palm (fibers), S3: (50% wheat straw, 30% sawdust and 20% date palm fibers.
OM: Oyster Mushroom, G: Grey Oyster Mushroom, W: White Oyster Mushroom, Y: Bright Yellow Oyster Mushroom, PK, Pink Oyster Mushroom.

Biological Efficiency:

Using of the mixture 3 was significantly increased the efficiency 39.21% as compared with 33.54% on the control, mixture 2was the nearest to control of 33.58%, (table - 14). Cultivated Oyster mushroom species showed that best biological efficiency was 47.88% by *P. ostreatus* G, the lowest efficiency for other species about 32.06%-33.77%. Best biological efficiency achieved by treatments was 58.41% by *P. ostreatus* G on mixture 2, whereas the lowest efficiencies was 21.10% and 25.92% by *P. cornucopiae* on control and mixture 2, but noted increasing of biological efficiency for all cultivated Oyster mushrooms strains on mixture 2 comparedto the wheat straw substrate.

Table - 14: Biological efficiency of Oyster mushrooms

Substrate (S)	(Pleurotus Oyster Mushroom (OM				Mean S
	P.ostreatus G	P. streatus W	P.cornucopiae Y	P.salmoneostramineus PK	
S1	51.67	27.42	21.10	33.98	33.54
S2	58.41	33.80	25.92	38.69	39.21
S3	33.57	31.96	40.17	28.63	33.58
Mean OM	47.88	31.06	29.06	33.77	35.44
LSD P> 0.05	S=1.315, OM=1.519, S* OM=2.631				

S1: 100% Wheat Straw Substrate (Control), S2: (70% wheat straw, 20% sawdust and 10% date palm (fibers), S3: (50% wheat straw, 30% sawdust and 20% date palm fibers.
OM: Oyster Mushroom, G: Grey Oyster Mushroom, W: White Oyster Mushroom, Y: Bright Yellow Oyster Mushroom, PK, Pink Oyster Mushroom.

DISCUSSION:

The reason of the different mushrooms in yield returned to composite substrates of nutrient and environment requirements. Mixture 2 (70% wheat straw, 20% sawdust and 10% date palm fibers) and mixture 3 (50% wheat straw, 30% sawdust and 20% date palm fibers) showed high biological efficiency compared to wheat straw alone may be return to use rock phosphate with these combinations, which achieved with (Al-Issawy, 2011) and to use date palm wastes in mixture 2 and 3 which appeared with (Hassan, 2011), biological efficiency

was increased by positive correlation with all properties except primordia appearance and diameter of pileus / length of stipe ratio (DP/LS Ratio), table 15.High production may be returned for the mixtures contained from cellulose, hemicellulose and lignin (Edit *et al.*, 2006; Kuhad *et al.*, 1997).But the number of fruiting bodies of Oyster mushroom species increased with low levels of rate of fruiting bodies, that explained by negative correlation between these properties (Table 15) and may be to size and type of wastes of substrates as compared with wheat straw substrate alone that led to speed biodegradation for these wastes (wheat straw, sawdust and date palm fibers) by *Pleurotus* mycelia which grew through substrates (Hamad, 2005).The parameters of pileus diameter, stipe diameter and stipe length increased with positive correlation of weight average of flush (Table 15) duration available nutrients of mixtures. The pins were quickly appeared with control and delayed with mixture 2 and 3 may be reason of small size of fruiting bodies the high number of fruiting bodieson control as compared with mixtures which delayed pins appearance, give large in size and small in number, which achieved with (Hamad, 2005). The low levels of numbers of fruiting bodies led to increased weight of each body that illustrated in (table -15) with negative correlation between number of fruiting bodies and average weight of it.Finally, different species of Oyster mushroom in properties go back to genetic factors related with force the strain in production and ability to grow in these mixtures (MushWorld, 2004).

Table -15 : Correlation relationship among properties of Oyster mushrooms species

Correlation	Primordia Appearing	Number of Flushes / bag	Total Harvest	Weight Average of Flush	Fruiting Bodies Number	Weight of Fruiting Body	Diameter of Stipe	Length of Stipe	Diameter of Pileus	Thickness of Pileus	DP/LS Ratio
Primordia Appearing	1.000										
Number of Flushes / bag	-0.288	1.000									
Total Harvest	-0.145	0.860	1.000								
Weight Average of Flush	0.254	-0.439	0.073	1.000							
Fruiting Bodies Number	0.875	-0.141	-0.058	0.136	1.000						
Weight of Fruiting Body	-0.652	0.611	0.583	-0.172	-0.720	1.000					
Diameter of Stipe	-0.633	0.419	0.499	0.087	-0.771	0.854	1.000				
Length of Stipe	-0.458	0.697	0.536	-0.445	-0.448	0.627	0.470	1.000			
Diameter of Pileus	-0.793	0.330	0.365	0.009	-0.770	0.822	0.815	0.424	1.000		
Thickness of Pileus	-0.313	-0.110	0.025	0.306	-0.541	0.311	0.588	0.006	0.289	1.000	
DP/LS Ratio	0.030	-0.398	-0.235	0.434	0.121	-0.254	-0.099	-0.797	0.077	0.068	1.000
Biological Efficiency %	-0.188	0.853	0.981	0.059	-0.132	0.634	0.519	0.534	0.385	0.041	-0.220

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