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Utilization of Wastes Lemon Grass (*Cymbopogon citratus*) Substrates in the Cultivation of Oyster Mushroom: Modern View and Trends

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Lemon grass wastes are abundant in both rural and urban areas and when carelessly disposed off to the environment by dumping or burning, they lead to environmental pollution, and consequently to health hazards. Growing of edible mushroom on these wastes can contribute to decrease in environment pollution. The aim of this study was conducted to compare the wastes lemon grass (*cymbopogon citratus*) substrates in the cultivation of *Pleurotus sajor-caju* and *Pleurotus florida*. Six substrate, namely, Trt1 (oil extracted lemongrass), Trt 2 (oil extracted lemon grass 40% + wheat straw 30%+ paddy straw 30%), Trt3 (oil extracted lemongrass 70% + wheat straw 30%), Trt4 (oil extracted lemon grass 50% + wheat straw 50%), Trt5 (oil extracted lemongrass 70% + paddy straw 30%) and Trt6 (oil extracted lemongrass 50% +paddy straw 50%) in the cultivation of PSC and PF. The results indicated that different substrate formulas gave a significant difference in complete full

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spawn run and days to pinhead formation were faster in Trt2 (15.5 and 13.70 days) and (18.40 and 17.40 days respectively) while Trt1 recorded the longest days (23.64 and 22.37) and (27.00 and 25.64 respectively) in PF and PSC. Number of fruiting bodies, fresh and dry weights of the mushroom was significantly higher in Trt2 than in the other substrates. The least number of fruiting bodies, fresh and dry weights were recorded in Trt1 of PF and PSC. The treatment Trt2 showed all over best result produce 884.37g.and 856.33g in PSC and PF. but as far as lemon grass (Trt1) alone and its combined effect all other treatments. Combination of lemon grass with wheat straw + paddy straw also showed significant produce while, using oil extracted lemongrass 100% does not show better results.

Keywords: Oyster mushrooms; utilization; substrate, lignocellulosic waste.

1. INRODUCTION

"The mushroom (*Pleurotus sp.*) is a fruiting body of fungi belonging to sub- division Ascomycotina and Basidiomycotina.They dependon organic ma tter for their nutrition and grow saprophytically on various substrates. Mushrooms are also known for their nutritional value of 20-40 % protein, 0.3 to 3.5 % fat, 0.5-1.5% Vitamin B, D, E and K [1] and medicinal values of antineoplastic, antibacterial, antiviral, hypoglycaemic, hypocholesterolemic, anti-inflammatory and anti-oxidative properties" [2]. "Mushroom production represents one of the most commercially important steps towards diversification of agriculture based on microbial technology for large scale recycling of agro wastes in an agricultural country like India [3-5]. The cultivation of *Pleurotus sajor-caju* has a promising future in the country like India, because it requires simple and inexpensive cultivation techniques" [6]. "Therefore, these interesting attributes make it an excellent option for cultivation of Mushrooms. It simple cultivation techniques allows that agro wastes may be used to produce a highly nutritious food and of high commercial value" [7,8]. "Several studies proved that wild grasses (goose grass, kikuyu grass *etc*.) are suitable substrate for the cultivation of oyster mushroom" [9]. "Used cotton straw as a growth substrate for the cultivation of oyster mushrooms and reported that the cotton straw previously unusable as fodder becomes digestible and nutritious feed for cattle , sheep once used for mushroom cultivation" [10]. Pleurotus cultivation in Brazil was established using sugarcane bagasse as substrate" [11]. "However, this agro waste is not abundant in all regions. Thus search for an alternative agro industrial substrate is very important to allow cultivation of this mushroom" [12-14]. Sundaram et. al. [15], "obtained good yield of mushrooms on chopped cotton stalks. Utilized cotton waste and waste paper alone in combination with paddy straw (3:1, 1:1 and 1:3 w/w) for sporophore production of *P. sajor-caju* and *P. citrinopileatus"* [16]. "Reported that the cotton stalks and leaves were the best substrates for cultivation of *P. sajor-caju* as compared to wheat, paddy sorghum and soybean straw under Marathwada condition" [17]. "The aim of this work was to evaluate the potential for utilization of oil extracted lemon grass wastes (*cymbopogon citrates*) as basic raw materials for cultivation of *Pleurotus sajor-caju* and *pleurotus florida*. Presently, in CSIR- Indian institute of Integrative Medicine Jammu the main substrate used for the commercial cultivation of oyster mushroom is oil extracted lemongrass. Using large quantities of lemongrass for mushroom cultivation causes reduction of wooded areas while information on the potential use of other locally available resources is lacking. The potential shortages of SD and high potential of agro-waste residues are the reasons why we need to identify alternatives for sustainable cultivation of oyster mushrooms. The study was conducted to compare the effects of wastes lemongrass on the growth, yield, and nutritional composition of two oyster mushrooms *Pleurotus sajor-caju* and *Pleurotus florida* [18-20]. The final aim is to find the best substrate formulas for effective cultivation of oyster mushrooms. The main objective of this study was proved that lemongrass is suitable substrate for the cultivation of oyster mushroom" [9]. Therefore present work was carried out to evaluate the lemon grass alone and in combinations with different easily available agricultural wastes like wheat straw and paddy straw.

2. MATERIALS AND METHODS

The study was to evaluate the suitability of utilization lemon grass waste combination with other substrate, wheat straw and paddy straw waste management of new model for cultivation of *Pleurotus sajor-caju* and *Pleurotus florida* was conducted at CSIR- Indian institute of Integrative Medicine Jammu (Fig. 1). The trial was laid out in

a completely randomized design with 5 replications for each substrate treatment. The substrates used for the cultivation of the oyster mushroom were;

The oil extracted lemon grass was collected from the CSIR- Indian institute of Integrative Medicine in field station chatha Jammu. The oil extracted lemon grass leaves were then chopped into 2-3 cm pieces and wheat straw + paddy straw was then chopped into 1.5-2.5 cm pieces. The wheat straw and paddy straw was collected from SKUAST- Jammu.

2.1 Substrate Preparation

Easily available, cheap and used agro- waste such as lemongrass, wheat straw, paddy straw containing high lignolytic, cellulotic, hemicellulotic, lignocellulotic content were used as a substrate for the cultivation of *Pleurotus* species. The oil extracted lemon grass leaves were used as an additional substrate to support the wheat straw substrate as additional nutrient source in ration of 3:1 as used previously by Hussain et al. [21]. Each substrate was chopped into 2 to 3cm pieces and separately soaked in a solution of carbendazim (75 ppm) and formalin 40 per cent (500ppm) for 16-18 hours. The substrates were then separately dipped in hot water for 30 minutes for sterilization. The partially dried substrate (60-65 per cent moisture) used singly as well as in combination (1:1, 2:1 and 3:1) was mixed with wheat straw and paddy straw in following proportions in Table 1. The substrates were taken out of hot water and squeezed lightly by hands to remove excess of water. After that drained straw was mixed with spawn and spawning was performed by using polypropylene bags of 15 ×20cm and 14 × 28cm. In this stage, substrate moisture contain was 65 to 70%. Two kg (on dry weight basis) of each substrate was used to fill up in each bag. Filling and spawning of substrates was done simultaneously. Filling of substrates in the polythene bags was done in layers. Multi layered spawning technique was adopted for spawning of substrates and 2 per cent spawn was used and then incubated at 22-25^{0}C for spawn run (mycelium growth) inside the cropping room. The spawned bags were kept in a dark room for the completion of spawn run. The corners and lower centre at the base of polythene bags were cut with scissors and holes were made to avoid any accumulation of water in the bags. Each treatment was replicated ten times and the bags were arranged in completely randomized design. In the fruiting house, the bags were hung on horizontal poles; water was sprayed onto the

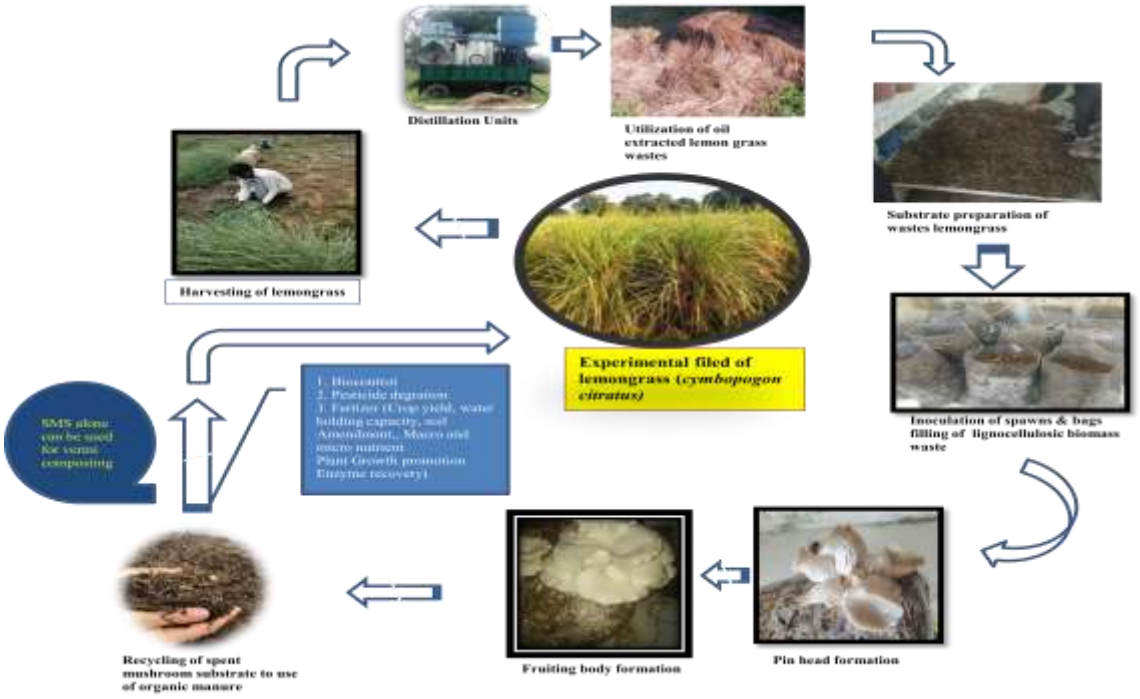

Fig. 1. Flow of utilization of lemongrass waste management according to a new model at the CSIR-Indian Institute of Integrative Medicine in the cultivation of Pleurotus sajor-caju and *Pleurotus florida*

Table 1. Base substrates and their composition as used in this experiment as substrate material

Treatment	Composition by weight
Trt_1	Oil extracted lemon grass 100%
Trt_2	Oil extracted lemon grass 40% + Wheat straw 30%+ Paddy straw 30%
Trt_3	Oil extracted lemon grass 70% + Wheat straw 30%
Trt_4	Oil extracted lemon grass 50% + Wheat straw 50%
Trt_5	Oil extracted lemon grass 70% + Paddy straw 30%
Trt_6	Oil extracted lemon grass 50% +Paddy straw 50%

bags to keep them moist, the floors were also wetted to help increase the humidity to not less than 75-85 %, and temperature was maintained in the range of 14–18°C. Harvesting was done by cutting the bigger mushrooms at the base to allow the base itself and smaller mushrooms to continue growing.

2.2 Data Collection

The data was collected and observations were made on the following parameters number of days from spawning to complete spawn run was recorded, and after two weeks of spawning, the spawned bags were checked daily. Days took from complete spawn run to pinhead formation, time taken from pin formation to pin maturation and the number of days from spawning to the first harvest were recorded in days. The total number of pins (TNP) formed during the first and four flashes were recorded based on the total number of pins formed. Total number of flushes and yield of each bag and total yield (g) of the mushroom were calculated after the completion of cropping period. The yield was measured in terms of the fresh weight (kg) of the oyster mushrooms. The effectiveness of a mushroom species and substrate was measured. The biological efficiency (Yield of mushroom per kg substrate on dry wt. basis) was calculated by the following formula Chang et al. [22].

Biological efficiency, BE (%) = (Fresh weight of mushroom / Dry weight of substrate)* 100

2.3 Data Analysis

The economic analysis of the different substrate treatments was determined by calculating the benefit: cost ratio of each treatment. Statistical evaluations of the abovementioned parameters were done by one-way ANOVA using Gestate statistical software package and the mean comparisons were done using Fisher's protected CD at $p < 0.05$.

3. RESULTS AND DISCUSSION

3.1 Days from Spawning to Complete – Spawn Run (S-CSR)

There was a significant difference ($p < 0.05$) in the number of days taken from spawning to complete spawn run (Table 2 and Fig 2.). Among the two species PSC and PF based on their fast and vigorous mycelial growth rate were selected and consequently evaluated for the cultivation parameters of *Pluratus sp.* In case of *Pleurotus sajor-caju* substrate (Trt2) took the least number of days (14.66) to complete the spawn run followed by a combination of substrate (Trt6) and Trt4 with 15.33 and 16.10 days, respectively. However, maximum spawn run period of 23.04 days was observed in Trt1 substrate alone. In *Pleurotus florida* the minimum earliest days for spawn run (12.51 days) was observed with (Trt2) substrate followed by a combination of substrate Trt6 13.70 days, and Trt4 substrate 14.06 days. Maximum spawn run period of 22.37 days in (Trt2) oil extended lemon grass alone. This is comparable with other similar studies elsewhere. Biswas and Biswas (2015) reported the completion of spawn running on wheat straw waste to be 14 days, while, Lalithadevi et al. [23] recorded between 16-25 days on paddy straw.

3.2 Days from Spawning to First Pinhead Formation (S-PF)

Data patterning time taken from spawning to first pinhead formation is shown in Table 2 and Fig. 2. The data reveal that there was a significant difference ($p < 0.05$) in the time taken from spawning to first pinhead formation among the different substrates. In case of *Pleurotus florida* all the substrates were significant to each other. The minimum (earliest) days for pinhead formation (17.40 days) were observed with *Pleurotus sajor-caju* on wheat straw (control) Trt1 substrate followed by Trt6 (18.66 days).

However, maximum pinhead formation period of 25.64 days was observed in (Trt2) lemongrass substrate alone. The time required for the formation of pinheads is comparable with other similar studies. Ahmed [24] reported pinhead formation of oyster mushroom cultivated in different substrates to be between 23 and 27 days from spawning, while Fan et al. [25] reported it to be 20-23 days. Tan (1981) recorded 23-26 days for the appearance of pinheads. Patra and Pani [26] recorded 20-24 days on paddy straw. In *Pleurotus florida* the minimum earliest days for pinhead formation (18.40days) was observed with wheat straw followed by Trt6 19.66 days. Maximum pinhead formation period of 27.00 days (Trt2) oil extracted lemon grass alone.

3.3 Days for Fruiting Body Formation (after pinhead formation) (F-PF)

In Table 2 and Fig. 2 indicates that the *Pleurotus sajor-caju* and *Pleurotus florida* were non-significant in regard to days taken for fruiting body formation (after pinhead formation) in case of different substrates. Minimum number of days recorded for fruiting body formation by *Pleurotus florida* were (25.70 days) in substrate Trt2 followed by 26.66 days in case of substrate (Trt6). However, maximum days for fruiting body formation (35.73 days) were observed with Trt1 substrate with *Pleurotus florida*. In case of *Pleurotus sajor-caju,* minimum days for fruiting body formation (27.24 days) were recorded in Trt2 substrate followed by 28.46 days for substrate (Trt6) alone. Maximum days for fruiting body formation (37.22 days) were observed in (Trt1) substrate.

3.4 Number of Fruit Bodies of *Pleurotus sajor-caju* and *Pleurotus florida*

Table 3 indicates mean ± SD for each flush and the overall mean of fruit bodies of *Pleurotus sajor-caju* and *Pleurotus florida*. Maturity was not significantly different ($p > 0.05$) among the flush of each treatment, while among the treatments in case of *Pleurotus sajor-caju*, maximum average of fruit bodies (41.35) was recorded in Trt1 followed by 34.60 in Trt6, whereas minimum average of fruit bodies (20.87) were recorded in Trt2. In case of *Pleurotus florida*, maximum average of fruit bodies (39.99) were observed in Trt1 followed by 32.38 in Trt6. whereas minimum number of fruit bodies (17.41) was observed in Trt2.

3.5 Average of Fresh Weight of Fruiting Body

Table 4 indicates mean ± SD for each flush and the overall mean of fruit bodies of *Pleurotus sajor-caju* and *Pleurotus florida*. Maturity was not significantly different ($p > 0.05$) among the flush of each treatment, Maximum average of fresh weight of fruit bodies (27.39g) was observed on Trt1 followed by Trt6 (25.35g); 23.73g on Trt4, while minimum average weight of 15.32g was obtained on Trt2. In case of *Pleurotus florida*, maximum average of fresh weight of fruit bodies (22.98 g) was observed on Trt1 followed by Trt6 (21.16g), while minimum average weight of 13.07g was obtained on Trt2.

3.6 Total Yield of Pleurotus Sajor-caju and Pleurotus florida

Table 5 indicates the effect of the treatment groups with varying substrate composition on yield (g) and BE (%).of PSC and PF. Among the various substrates, wheat straw (control) (Trt1) proved to be the best producing maximum total yield of 1219.04g of dry substrates for PSC, followed by Trt4, Trt6 with total yield of 925.21g, 884.37g. The least effective substrate proved to be Trt2 with minimum total yield of 316.65g substrates. Similar trend was observed in case of PF in which Trt1 proved to be best with maximum total yield of 1117.60g of dry substrates whereas total yield of 806.26g, and 719.26g were recorded in Trt4 and Trt6, respectively. The least effective substrate was Trt2 with minimum total yield of 292.83g of dry substrates.

3.7 Biological Efficiency of PSC and PF

Table 5 reveals that the biological efficiency of PSC and PF was significantly affected by the selected substrates. In PSC maximum biological efficiency of 98.56 percent was recorded on Trt1, followed by 73.56, and 71.63 percent by Trt4 and Trt6, respectively. Minimum biological efficiency of 47.36 per cent was recorded in Trt2. In case of PF, maximum biological efficiency of 95.12 per cent was recorded in Trt1 which was followed by 70.36 per cent in Trt4 and 69.56 per cent in Trt6. Minimum biological efficiency of 45.20 per cent was recorded in Trt2. The main purpose of several studies have also demonstrated the need to oil extracted lemon grass leaves wastes substrate with combination via., wheat straw and paddy straw for two species PF and PSC

Cultivation. The current study the results of Table 4 showed that in the all four flushes in the yield and biological registered that highest yield, as well as the highest BE wheras results from Trt2 registered the lowest yield as well as the lowest BE values. The work of Girommay et al. [27] also reported a 74.20 biological efficiency in cotton waste and also Islam and Riaz et al. [28], recorded a 92.9 % BE for the same substrate. In our recent studies, the substrate treatment Trt1 for this purpose and its combination with wheat straw, and paddy straw can also best combination for PF and PSC cultivation. However, our results are similar to studies conducted by Long 1978.Cotton waste was best for mushroom as compare to rice husk .Cotton waste showed best performance because it contains plenty of cellulose and hemi cellulose and digestion of cellulose. Sapit [29]. Described the oyster mushroom cultivation on different substrates which were peat of coconut husk, sawdust, narrow leaf cattails and bagasses. The wheat straw high production and this was signifiently different to those found from other substrates. Ibekwe et al. [30], reported the cultivation of oyster mushroom on different agriculture wastes like corn, millet, rye and rice, millet gave the maximum yield ,while rye gave the lowest Khan et al. [31],reported different strains of oyster mushroom on commonly available (WC-536) and *P. flabellatus dijamoe* gave the minimun yield .But in results of PF and PSC gave the higher yield on wheat straw and minimum on Trt1. Recently, Shalinee Prasad et al. [32] reported that the use of perennial grass as the sole source, showed low yield and B.E of 197 g/Kg (B.E 26 %) to 240 g/Kg (B.E 32%) but in the combination of wheat straw and perennial grass where grass is used as an additional substrate for the cultivation of *P. florida.* the biological yield was found to be 513.43 g/Kg and B.E as 68.45%. In the current studies, we report that our combination substrates show higher biological yield and biological efficiency v on Trt2 for the PF and PSC. The previously used combination of wheat straw with lemon grass substrate for the cultivation of *P. sajor-caju, and P. flabellatus* showed higher production compared to solely used wheat straw where *it* showed 18.5 % increase in yield over control in ration of 3:1 for lemon grass to wheat straw combination as reported by Hussain et al. [21]. In these studies, we added the organic combination of substrate for the different variety of Pleurotus species such as *P. florida, P.* and *P. sajor-caju.* The time duration was found to be low for harvesting of fruiting bodies, with satisfactory biological yield and notably high biological efficiency, making the oil extracted lemon grass leaves with wheat straw and paddy straw as suitable and efficient combinatorial medium for the cultivation of *Pleurotus sajor-caju and Pleurotus florida.*

3.8 Cost: Benefit Ratio

To find out the substrate which has maximum economic feasibility, Cost: Benefit ratio of different treatments was calculated and data presented in Table 6 shows that maximum cost: benefit ratio for *Pleurotus sajor-caju* was observed in Trt1 (4.84) followed by Trt4 (4.47), and minimum cost: benefit ratio was found in Trt2 (2.49). In case of *Pleurotus florida* Species maximum cost: benefit ratio was found in Trt1 (3.84) followed by Trt4 (3.47) and minimum cost: benefit ratio was found in Trt2 (2.08).

Table 2. The oil extracted lemon grass wastes substrate treatments on mushroom growth parameters investigated of *Pleurotus sajor-caju* and *Pleurotus florida*

Substrate	S-CSR		S-PF		F-PF	
	Species		Species		Species	
	PSC	PF	PSC	PF	PSC	PF
Trt1	23.04	22.30	27.00	25.64	37.22	35.73
Trt2	14.66	12.51	18.40	17.40	27.24	25.70
Trt3	20.70	20.41	24.44	22.66	33.17	32.03
Trt4	16.10	14.06	20.33	19.66	29.99	28.18
Trt5	18.00	17.11	22.81	22.03	32.45	30.45
Trt6	15.33	13.70	19.66	18.66	28.46	26.66
CD	2.61	2.50	3.30	3.45	1.31	1.80
S Em (±)	0.82	0.52	1.03	1.08	0.41	0.56

**Mean of five replications; *PSC- Pleurotus sajor-caju, *PF- Pleurotus florida, *S-CSR- Spawning to Complete – Spawn Run, *S-PF -Spawning to First Pinhead Formation, *F-PF fruiting body formation*

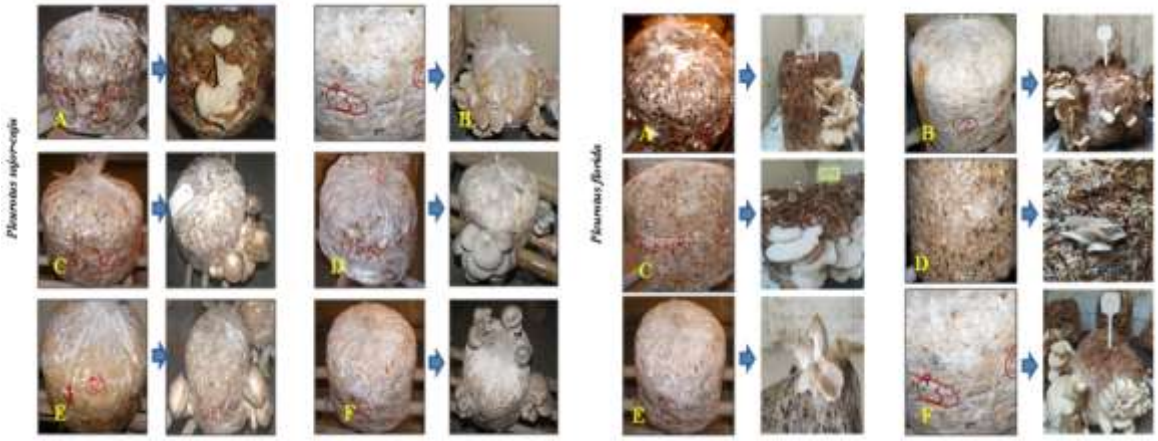

***Fig* 2. Oyster mushroom *Pleurotus florida* and *Pleurotus sajor caju* showing different stages on the substrate**

(A) Trt1 (Oil extracted lemon grass 100%), (B).Trt2. Oil extracted lemon grass 40% + Wheat straw 30%+ Paddy straw 30% ,(C) Trt3 Oil extracted lemon grass 70% + wheat straw 30%(D) Trt4 Oil extracted lemon grass 50% + wheat straw 50% (E) Trt5 Oil extracted lemon grass 70% + Paddy straw 30% (F) Trt6 Oil extracted lemon grass 50% +Paddy straw 50%) in spawn run and pinhead formation

Table 3. Effects of wastes lemongrass substrate of fresh weight of fruiting body of *Pleurotus sajor-caju* and *Pleurotus florida*

Substrate	No. of fruit bodies								Average of fruit bodies	
	1 flush		2 flush		3 flush		4 flush			
	Species		Species		Species		Species		Species	
	PSC	PF	PSC	PF	PSC	PF	PSC	PF	PSC	PF
Trt1	18.12	15.25	12.00	13.85	8.11	9.03	3.12	1.86	41.35	39.99
Trt2	8.33	7.74	5.83	4.66	4.36	4.00	2.35	1.01	20.87	17.41
Trt3	14.23	12.23	9.56	7.66	4.63	5.00	2.03	2.45	30.45	27.34
Trt4	15.78	11.55	12.56	9.22	7.11	6.96	1.10	3.62	36.55	31.35
Trt5	11.00	10.33	9.12	6.11	6.12	5.66	2.14	3.00	28.38	25.10
Trt6	14.63	12.59	9.43	8.66	7.03	6.36	3.51	2.65	34.60	32.38
C.D (< p 0.05)	2.35	2.11	1.63	1.40	1.23	1.10	1.15	1.45		

Table 4. Effects of wastes lemongrass substrate of fresh weight of fruiting body of *Pleurotus sajor-caju* and *Pleurotus florida*

Substrate	Fresh weight of fruiting body								Average number of fresh weight of fruiting body	
	1 flush		2 flush		3 flush		4 flush			
	Species		Species		Species		Species		Species	
	PSC	PF	PSC	PF	PSC	PF	PSC	PF	PSC	PF
Trt1	21.33	19.44	20.63	17.33	10.01	7.87	9.33	7.63	15.32	13.07
Trt2	33.75	29.37	31.33	27.63	23.37	19.21	21.11	15.69	27.39	22.98
Trt3	25.1	22.22	23.77	20.14	18.77	10.00	12.89	9.87	20.13	15.56
Trt4	29.29	24.66	27.37	21.63	19.63	12.66	18.65	12.99	23.73	17.99
Trt5	27.58	22.36	26.92	21.12	17.55	11.45	14.63	10.36	21.67	16.32
Trt6	31.39	29.33	29.99	26.45	20.33	15.62	19.69	13.23	25.35	21.16
C.D (< p 0.05)	5.24	5.18	5.09	5.00	4.94	5.12	5.14	4.05	-	-

Table 5. Effects of wastes lemongrass substrate composition on yield and biological efficiency of oyster mushroom *Pleurotus sajor-caju* and *Pleurotus florida*

Substrate	1flush		2 flush		3flush		4 flush		Total Yield (g)		Biological efficiency (%)	
	PSC	PF	PSC	PF	PSC	PF	PSC	PF	PSC	PF	PSC	PF
Trt1	176.25	150.36	125.45	94.21	48..45	38.96	15.00	9.3	360.26	343.23	47.36	45.20
Trt2	592.45	447.45	386.12	429.36	174.69	198.65	65.78	42.14	1219.04	1117.6	98.56	95.12
Trt3	356.78	298.63	225.45	176	91.25	95.36	44.56	28.5	718.04	598.49	68.63	66.96
Trt4	460.86	330.66	322.45	248.44	120.45	145.36	21.45	81.8	925.21	806.26	73.56	70.36
Trt5	302.56	285.3	236.12	158.23	103.78	65.89	29.33	34.98	671.79	544.4	66.23	64.55
Trt6	460.26	328.71	275.11	242.63	124.00	99.36	25.00	48.56	884.37	719.26	71.63	69.56
C.D ($p < 0.05$)	4.56	6.36	8.36	9.46	3.25	2.58	2.77	1.56	34.67	31.54	2.10	2.35

Table 6. Cost: Benefit ratio of cultivation of *Pleurotus sajor-caju* and *Pleurotus florida* on different substrates

Substrate	Total Expenditure /bag(Rs)		Total income /bag(Rs)		Benefit /bag(Rs)		Benefit : Cost ratio	
	PSC	PF	PSC	PF	PSC	PF	PSC	PF
Trt1	14.61	14.61	51.11	45.00	36.50	30.39	2.49	2.08
Trt2	30.87	30.87	180.37	165.00	149.50	118.63	4.84	3.84
Trt3	21.50	21.50	105.00	90.00	83.50	62.00	3.88	2.88
Trt4	24.01	24.01	131.47	121.41	107.46	83.45	4.47	3.47
Trt5	20.36	20.36	95.00	81.47	74.64	54.28	3.66	2.66
Trt6	22.80	22.80	123.48	109.11	100.68	77.88	4.41	3.41

4. CONCLUSION

It may be concluded from the study that Pleurotus genus is among the most cultivated mushrooms in the world. Among the oil extracted lemon grass are not only proved as the alternative substrate for *Pleurotus sajor-caju* and *Pleurotus florida* cultivation, they also can significantly increase the protein content and reduce the production time. In the present investigation oil extracted lemon grass wastes and in combination with different supplements substracts for the cultivation of *Pleurotus sajor-caju* and *Pleurotus florida* mushroom, in combination of oil extracted lemon grass 40% + wheat straw 30%+ paddy straw 30% proved to be the best substrate followed by oil extracted lemon grass 50% + wheat straw 50% for commercial cultivation of *Pleurotus sajor-caju* and *Pleurotus florida* with respect to the total yield and biological efficiency. Therefore oyster mushroom cultivation proves to be a highly efficient method for disposing of lemongrass leave as well as producing protein rich food. It helps in recycling oil extracted lemon grass wastes and their conversion into protein-rich food.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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