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Cultivation of *Pleurotus florida* on Forest and Agricultural Wastes By Leaves of Tree and Wood Waste

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Abstract: Some forest and agricultural wastes of Eastern Black Sea Region of Turkey were subjected to mushroom (*Pleurotus florida*) cultivation in this study. 1:1, 1:3 and 3:1 (w:w) mixtures were prepared mainly by tree leaves wood wastes of timber work shops, cupola of nut trees (NC) and leaves (NL), corn stalks (CS), waste tea leaves (WTL) of tea factories, wheat straw (WS) and waste paper(WP). *P.florida* of which the strain was numbered darmycel by Fungi Perfect co. (USA) was used in inoculations of prepared series of substrates after being sterillized in an autoclave by direct vapor.

Results indicated that wood waste yield highest mushroom production as wood waste, waste tea leaves (WW+WTL) based on dry substrate weight, in a mixture of 3:1 (w:w) with waste tea leaves which reportedly exceeds 10.000 ton and its value as lignocellulosic source, it's importance can be estimated in utilization as substrate of mushroom cultivation for forest villagers. Other regional agricultural and forest wastes were also gave remarkable yield values. *In P.florida* cultivation corn stalk and cupola and nut increased the yield values when used with wood wastes as mixtures presence of wood waste in the prepared mixtures with wheat straw and corn stalks improved the quality of properties of fruit body as cupola of nut resulted in smaller caps in diameter. Further studies are being continued in strain development of different *Pleurotus* species and increasing mushroom yield by many activators and additives for the region.

Orman ve Zirai Atıkları Üzerinde *Pleurotus florida*'nın Kültivasyonu

Özet: Bu çalışmada, Doğu Karadeniz Bölgesi'nin bazı orman ve zirai atıklarının kültür mantarı *Pleurotus florida* üretiminde kültivasyonu gerçekleştirilmiştir. Ağaç yaprakları, odun talaşı, fındık kupulası ve yaprakları, mısır sapı, atık çay yaprakları, buğday sapı ve atık kağıtlar 1:1, 1:3 ve 3:1 ağırlık oranlarında karıştırılarak hazırlandı. Hazırlanan karışımlar direkt buharla steril edildikten sonra Fungi Perfecti (USA) tarafında numaralandırılmış olan *P. florida* ırkı miseller ile aşılanmıştır.

Sonuçlar, kuru ağırlık üzerinden 3:1 oranında odun talaşı ile karıştırılan atık çay yapraklarının en yüksek verimi verdiğini göstermiş olup, atık çay yapraklarının 10.000 tonu aşan bir lignoselülozik kaynak olduğu ifade edilmektedir. Bunun yöre insanı için kültür mantarı üretiminde değerlendirilmesinin önemli olduğu tahmin edilebilir. Ayrıca, diğer orman ve zirai artıklarından da dikkate değer verimler elde edilmiştir. Yapılan çalışmada odun talaşı, mısır sapı ve fındık kupulası ile karışım olarak kullanıldığında verim değerleri artmış olup, buğday sapı ile karışım olarak kullanıldığında ise elde edilen şapkaların kalitesi artmıştır. Fındık kupulası ise şapka çapını düşürmüştür. Bölge için çeşitli aktivatör ve ilave maddelerle farklı *pleurotus* türlerinin geliştirilmesi ve mantar veriminin artırılması için ileri çalışmalar sürdürülmektedir.

Introduction

Cultivation of Pleurotus sp. reaches to the second largest in amount after Agaricus bisporus (Lange) Sıng. in the world (Erkel, 1992; Chang et all, 1991; Günay et all). There recently has also been growing interest to cultivate them on wastes of forest and agricultural plants in Turkey (İlbay et all, 1995; İlbay et all, 1996, Yalınkılıç, 1994). Although, almost every kind of lignocellulosic substances is likely be used as substrate for Pleurotus sp. cultivation, the main and co-substrate differ among countries and even regions on available abundant and cheaper ones (Royse, D.J. 1985; Schmidt, 1986; Yalınkılıç et all., 1989; Oei, P., 1991). Higher yield levels and quality of obtained fruit bodies of Pleurotus sp. were targeted in shorter incubation times in some recent workers (Yıldız and Saya, 1992; Uluer and Özay, 1993). This study dealt with the cultivation of Pleurotus ostreatus (Jacq.ex.Fr.) Kummer Florida type on some untried and available cheaper or obtainable regional forest and agricultural wastes of Eastern Black Sea Region of Turkey with the simplest cultivation technique offered by FAO (Anonymous, 1983) in order to develop mushroom production among forest villagers. In addition Eastern Black Sea Region have suitable climate properties which are especially relative humidity and temperature for the mushroom cultivation.

Materials and Methods

Composting and Pastorization

Cultivation of nut shell of nut trees (Corylus avellena) (CN), corn stalk(CS), beech wood (Fagus orientalis Lipsky) saw mill waste (WW: wood waste) were used as a main substrate and supplemented with waste tea leaves (WTL: waste tea leaves) of tea factories, grass (G), leaves of poplar and linden trees (PL: poplar tree leaves and LL: linden tree leaves), clover (C) and waste news paper(WP) as co- substrate by 1:3, 1:1, 3:1 mixing ratios based on dry weight. Substrate were cut in to 5-6 cm pieces and mixed with some additives according to FAO suggestions (Anonymous, 1983); as 0.5 % ammonium sulfate and 1.0 % lime on dry weight basis prior to moisturizing up to 70-80 % by tap water followed by piling like conical shape and were covered by polyethylene covers. Two days later, piles were uncovered and mixed with 1 % super phosphate and 0.5 % calcium sulfate the same as before for another two days followed by filling into polyethylene bags as 1 kg dry weight basis and sterilized by direct water vapor. After inoculation they left for mycelia development. Mycelium of P.florida was obtained from Faculty of Agriculture of Ankara University. Mycelium development periods, mushroom yields and size account for quality evaluations were recorded. Results evaluated by ANOVA (Analysis of variance) and following Duncan tests to build up homogenity groups which show the significance among differences (95 %).

In the cultivation of mushroom after completed the composting, the mass of compost should be sterilizated before inoculation. The purpose of sterilization is to remove fungi and bacteria which are present in composts and facilitate the developing of mycelium. Thus, the temperature of pastorization was retained at 60°C and

Table 1. Include the waste types and mixed ratios compose the prepared composts

Trial Code	Substrate	Trial Code	Substrate	Trial Code	Substrate	Mixture as %	Number of bags
111	CN	211	CS	311	WW	100	4
121	CN+WS	221	CS+WS	321	WW+WS	50+50	4
122	CN+WS	222	CS+WS	322	WW+WS	75+25	4
123	CN+WS	223	CS+WS	323	WW+WS	25+75	4
131	CN+CS	231	CS+G	331	WW+CS	50+50	4
132	CN+CS	232	CS+G	332	WW+CS	75+25	4
133	CN+CS	233	CS+G	333	WW+CS	25+75	4
141	CN+G	241	CS+C	341	WW+G	50+50	4
142	CN-G	242	CS+C	342	WW+G	75+25	4
143	CN-G	243	CS+C	343	WW-G	25+75	4
151	CN+C	251	CS+WW	351	WW+C	50+50	4
152	CN+C	252	CS+WW	352	WW+C	75+25	4
153	CN-C	253	CS+WW	353	WW-C	25+75	4
161	CN+WW	261	CS+CN	361	WW+CN	50+50	4
162	CN+WW	262	CS+CN	362	WW+CN	75+25	4
163	CN+WW	263	CS+CN	363	VN+CN	25+75	4
171	CN+NL	271	CS+NL	371	WW+NL	50+50	4
172	CN+NL	272	CS+NL	372	VN+NL	75+25	4
173	CN+NL	273	CS+NL	373	WW+NL	25+75	4
181	CN+PL	281	CS+PL	381	WW+PL	50+50	4
182	CN+PL	282	CS+PL	382	WW+PL	75+25	4
183	CN+PL	283	CS+PL	383	WW+PL	25+75	4
191	CN+LL	291	CS+LL	391	WW+LL	50+50	4
192	CN+LL	292	CS+LL	392	WW+LL	75+25	4
193	CN+LL	293	CS+LL	393	WW+LL	25+75	4
1101	CN+WTL	2101	CS+WTL	3101	WW+WTL	50+50	4
1102	CN+WTL	2102	CS+WTL	3102	WW+WTL	75+25	4
1103	CN+WTL	2103	CS+WTL	3103	WW+WTL	25+75	4
1111	CN+WP	2111	CS+WP	3111	WW+WP	50+50	4
1112	CN+WP	2112	CS+WP	3112	WW+WP	75+25	4
1113	CN+WP	2113	CS+WP	3113	WW+WP	25+75	4

Solve of trial plan :
111 : First trial, first experiment, first mixture, 221 : Second trial, second experiment, first mixture etc.
CN : Nut Cupola, WS : Wheat Straw, CS : Corn Stalks, G : Grass, C : Clover, WW : Wood Waste, NL : Nut Leaves,
PL : Poplar Leaves, WTL : Waste Tea Leaves, WP : Waste Paper

should not be allowed to rise above during two days. At this time in order to removal of CO2 and NH3 and available taken fresh air, the ventillation was made by an apparatus. When temperature is ratios at 24 °C, all of the compost was inoculated. Based on nut cupola composts which of mixtures with other materials and trial codes are shown on Table 1.

Results and Discussion

Cultivation of P.florida on Nut Cupola (CN) based composts

Mycelia development was demonstrated in Figure 1.

As it is followed from the Fig. 1 that CN+WS(25+75), CN+WW(50+50), CN+WW(25+75), CN+NL(50+50),

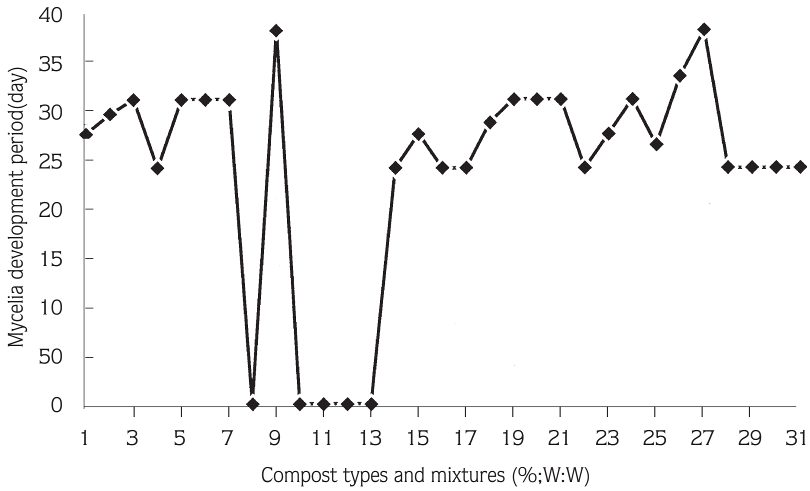

Figure 1. Mycelia development of P.florida on CN based composts 1. CN based composts 1. CN(100). 2. CN+WS(50+50). 3. CN+WS(75+25). 4. CN+WS(25+75). 5. CN+CS(50+50). 6. CN+CS(75+25). 7. CN+CS(25+75). 8. CN+G(50+50). 9. CN+G(75+25). 10. CN+G(25+75). 11. CN+C(50+50). 12. CN+C(75+25). 13. CN+C(25+75). 14. CN+WW(50+50). 15. CN+WW(75+25). 16. CN+WW(25+75). 17. CN+NL(50+50). 18. CN+NL(75+25). 19. CN+NL(25+75). 20. CN+PL (50+50). 21. CN+PL (75+25). 22. CN+PL(25+75). 23. CN+LL(50+50). 24. CN+LL(75+25). 25. CN+LL(25+75). 26. CN+WTL(50+50). 27. CN+WTL(75+25). 28. CN+WTL (25+75). 29. CN+WP (50+50). 30. CN+WP (75+25). 31. CN+WP(25+75)).

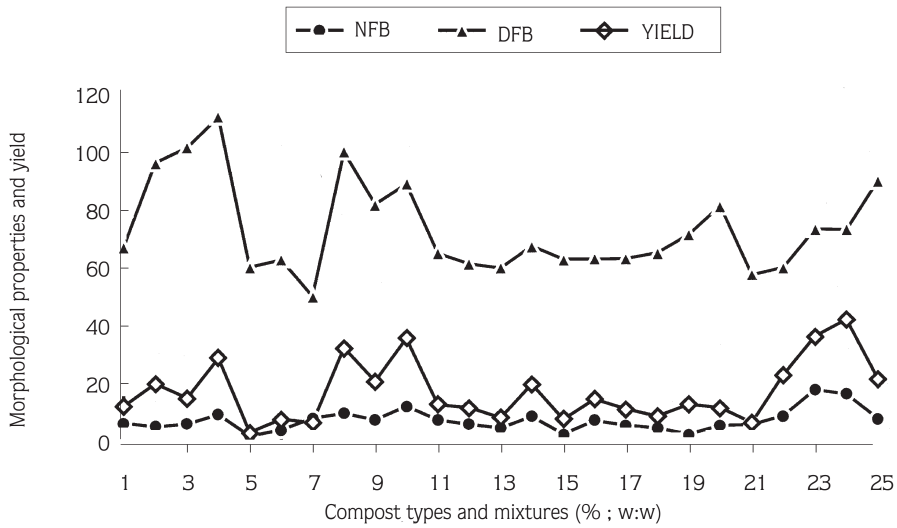

Figure 2. Yield and morphological properties of P.florida on CN based composts. 1. CN(100). 2. CN+WS(50+50). 3. CN+WS(75+25). 4. CN+WS(25+75). 5. CN+CS(50+50). 6. CN+CS(75+25). 7.. CN+G(75+25). 8. CN+WW(50+50). 9. CN+WW(75+25). 10. CN+WW(25+75). 11. CN+NL(50+50). 12. CN+NL(75+25). 13. CN+NL(25+75). 14. CN+PL(50+50). 15. CN+PL(75+25). 16. CN+PL(25+75). 17. CN+LL(50+50). 18. CN+LL(75+25). 19. CN+LL(25+75). 20. CN+WTL (50+50). 21. CN+WTL (75+25). 22. CN+WTL(25+75). 23. CN+WP(50+50). 24. CN+WP(75+25). 25. CN+WP(25+75). Myclia development was not seemed the other bags)

CN+PL(25+75), CN+WTL(25+75) and CN+WP's different mixtures ratios compost types enabled faster mycelia development than the other composts. The slowest mycelium development was observed on CN+C and CN+G based compost ratios. This can be attributed to the co-substrate properties beyond contents of main substrates necessary nutrient elements themselves. Since the suitability of regional substrates was subjected in the present study, the differences among composts regarding cultivation can be studied later.

Mushroom yield percentages which were calculated from the fresh mushroom weights on kg dry compost basis and morphological properties and yield of harvested fruit bodies were demonstrated in Fig 2 and morphological properties were tabulated Table 2. In addition to these, all the results were analyzed statistically and formed homogenity groups given Table 3., from the most succesful trial to the least one.

Referring to the values in the related tables and Figure 2, CN+WS (25+75), CN+OT(50+50) and (25+75), CN+CL(50+50), CN+PL(25+75), CN+WTL(25+75), CN+LL(25+75), CN+WP(50+50), (25+75) and (75+25), CN+WTL(75+25) CN+CL (25+75) mixture ratios composts were more suitable than those of the other

Table 2. Morphological properties of harvested P.florida fruit bodies on Nut Cupola (CN) based composts on P.florida cultivation

Trial Code	Number of Fruit Body (NFB)			Diameters of Fruit Body (DFB) (mm)			Length of Stalk (LS) (mm)		
	Mean	St.E	HG	Mean	St.E	HG	Mean	St.E	HG
111	6.25	2.75	abcd	66.87	9.43	abc	27.81	5.90	ab
121	5.00	3.16	abc	95.62	11.61	cde	57.81	42.45	de
122	6.00	3.82	abcd	100.8	43.23	de	37.08	9.06	abcd
123	9.25	7.41	bcd	111.3	28.68	e	60.00	23.45	e
131	2.00	0.00	a	60.00	0.00	ab	40.00	0.00	abcde
132	4.00	0.00	abc	62.50	0.00	ab	55.00	0.00	de
133	-	-	-	-	-	-	-	-	-
141	-	-	-	-	-	-	-	-	-
142	8.00	0.00	abcd	50.00	0.00	a	50.00	0.00	bcde
143	-	-	-	-	-	-	-	-	-
151	-	-	-	-	-	-	-	-	-
152	-	-	-	-	-	-	-	-	-
153	-	-	-	-	-	-	-	-	-
161	9.75	2.75	cd	99.37	5.81	de	50.62	14.16	bcde
162	7.50	2.08	abcd	81.50	24.21	abcde	48.41	5.96	abcde
163	12.25	6.39	de	88.40	3.95	bcde	36.73	4.30	abcd
171	7.50	4.12	abcd	64.79	7.65	abc	27.81	3.28	ab
172	6.00	2.64	abcd	61.25	10.23	ab	30.83	15.17	abc
173	4.75	2.62	abc	59.79	26.66	ab	26.87	3.75	a
181	8.75	7.13	bcd	67.29	12.86	abc	36.25	7.35	abcd
182	2.66	1.15	ab	62.83	5.66	ab	55.00	20.41	de
183	7.33	5.13	abcd	62.87	9.45	ab	29.50	8.21	abc
191	5.75	1.50	abcd	63.12	16.75	ab	51.91	5.70	cde
192	4.75	2.21	abc	65.00	10.00	abc	28.75	2.50	ab
193	2.66	1.15	ab	71.25	24.60	abcd	30.00	8.16	abc
1101	5.66	5.58	abc	81.00	8.57	abcde	36.75	6.23	abcd
1102	6.00	5.65	abcd	57.50	6.12	ab	26.12	1.76	a
1103	9.00	0.00	bcd	60.00	0.00	ab	40.00	0.00	abcde
1111	18.00	8.48	f	73.08	3.94	abcd	38.35	4.36	abcde
1112	16.50	7.14	ef	72.93	9.28	abcd	37.25	8.38	abcd
1113	8.00	3.36	abcd	89.58	32.15	bcde	45.00	7.07	abcde

Mean : Average St.E.: Standard Error HG : Homogeneity groups

Table 3. Homogenity groups formed statistically for evaluation of Nut Cupola (CN) based composts on *P. florida*

S	HG	MDP	WIF	Y	NFB	DFB	LS
+	1	CN+WS(25+75) CN+WP(50+50) CN+WW(25+75) CN+NL(50+50) CN+PL(25+75) CN+WTL(25+75) CN+WP(50+50) CN+WP(75+25) CN+WP(25+75)	CN+LL(25+75) CN+WP(75+25)	CN+WP(75+25)	CN+WP(50+50)	CN+WS(25+75)	CN+WTL(75+25) CN+NL(25+75)
	2	CN+LL(25+75) CN(100) CN+WW(75+25) CN+LL(50+50) CN+NL(75+25) CN+WS(50+50)	CN+WS(25+75)	CN+WP(50+50) CN+WW(25+75)	CN+WP(75+25)	CN+WS(75+25) CN+WW(50+50)	CN(100) CN+NL(50+50) CN+LL(75+25)
	3	CN+WS(75+25) CN+CN(50+50) CN+CN(75+25) CN+CN(25+75) CN+NL(25+75) CN+PL(50+50) CN+PL(75+25) CN+LL(75+25)	CN+WW(50+50) CN+WS(50+50)	CN+WW(50+50)	CN+WW(25+75)	CN+WS(50+50)	CN+PL(25+75) CN+LL(25+75) CN+NL(75+25)
	4	CN+WTL(50+50)	CN+WP(25+75)	CN+WS(25+75) CN+WTL(25+75) CN+WP(25+75)	CN+WW(50+50)	CN+WP(25+75) CN+WW(25+75)	CN+WP(75+25) CN+WS(75+25) CN+WTL(50+50) CN+WW(25+75) CN+PL(50+50)
	5	CN+G(75+25) CN+WTL(75+25)	CN+WW(25+75)	CN+WW(75+25) CN+PL(50+50) CN+WS(50+50) CN+WS(75+25) CN+PL(25+75)	CN+WS(25+75) CN+WLT(25+75) CN+PL(50+50)	CN+WW(75+25) CN+WTL(50+50)	CN+WP(50+50) CN+CS(50+50) CN+WTL(25+75) CN+WP(25+75) CN+WW(75+25)
	6		CN+WS(75+25) CN+PL(50+50) CN+LL(50+50) CN+WW(75+25) CN+WP(50+50) CN+WTL(25+75) CN+NL(50+50) CN+LL(75+25) CN+WTL(50+50)	CN+LL(25+75) CN+NL(50+50) CN(100) CN+WTL(50+50) CN+NL(75+25) CN+LL(50+50) CN+LL(75+25)	CN+WP(25+75) CN+G(75+25) CN+NL(50+50) CN+WW(75+25) CN+PL(25+75) CN(100) CN+WTL(75+25) CN+NL(75+25) CN+WS(75+25) CN+LL(50+50)	CN+WP(50+50) CN+WP(75+25) CN+PL(25+75)	CN+G(75+25) CN+WW(50+50)
	7		CN+PL(25+75) CN(100) CN+CS(75+25) CN+NL(75+25) CN+WTL(75+25) CN+PL(75+25) CN+NL(25+75) CN+G(75+25) CN+CS(50+50)	CN+NL(25+75) CN+PL(75+25) CN+CS(75+25)	CN+WTL(50+50) CN+WS(50+50) CN+LL(75+25) CN+NL(25+75) CN+CS(75+25)	CN+PL(50+50) CN(100) CN+LL(75+25) CN+NL(50+50)	CN+LL(50+50)
	8			CN+WTL(75+25) CN+G(75+25)	CN+LL(25+75) CN+PL(75+25)	CN+LL(50+50) CN+PL(25+75) CN+PL(75+25) CN+CS(75+25) CN+NL(75+25) CN+CS(50+50) CN+WTL(25+75) CN+NL(25+75) CN+WTL(75+25)	CN+CS(75+25) CN+PL(75+25) CN+WS(50+50)
-	9			CN+CS(50+50)	CN+CS(50+50)	CN+G(75+25)	CN+WS(25+75)

S: Suitability, HG: Homogeneity Groups, MDP: Mycelia Development Period, WIF : Weight of Individual Fruit, Y : Yield, NFB : Number of Fruit Body, DFB : Diameters of Fruit Body, LS : Length of Stalk mixtures, while. CN+G(50+50) and CN+C based composts appeared not so promising for P.florida cultivation. These realized cultivation properties in the present study were somewhat at lower than some previous findings (Yıldız, 1992) and showed better cultivation properties than some previous studies (Uluer and Özay, 1993).

Enormous individual fruit bodies were obtained from CN:LL (1:3) compost while other cultivation properties were not so appropriate. On the other hand, CN:WS mixtures were found superior to the mixtures of WP and WW. Referring to the cultivation results CN:WP and CN:WW composts also appeared very suitable for P.florida which encourages to utilize these two kinds of abundant regional wastes as substrate of mushroom composts.

Cultivation of P.florida on Corn Stalk (CS) based composts

Mycelia development was demonstrated in Figure 3.

As it is followed from the Figure 3, that CS(100), CS+WW(50+50),CS+CN(50+50)CS+NL(50+50), CS+PL(75+25), CS+LL(50+50), CS+WTL(75+25) and CS+WP(50+50), (75+25) and (25+75) different mixture ratios compost types enabled faster mycelia development than the other compost. Mycelium development was not observed on CS+C, CS+G, CS+CN(75+25), CS+LL(75+25) and CS+WTL (75+25; 25+75) based compost mixture ratios. This can be attributed to the co-substrate properties beyond contents of main substrates necessary nutrient elements themselves. Since the suitability of regional substrates were subjected in the present study, the differences among composts regarding cultivation can be studied later. Mushroom yield percentages which were calculated from the fresh mushroom weights on kg dry compost basis and morphological properties of harvested fruit bodies were demonstrated in Fig 4. and morphological properties tabulated Table 4. In addition to these, all the results were analyzed statistically and formed homogenity groups given Table 5, from the most succesful trial to the least one.

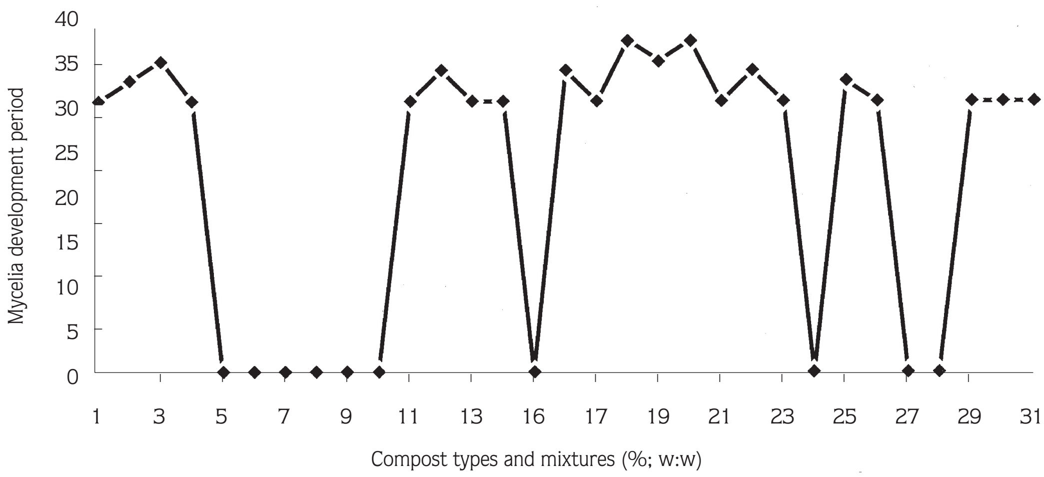

Figure 3. Mycelia development of *P.florida* on CS based composts. 1. CS(100), 2. CS+WS(50+50), 3. CS+WS(75+25), 4. CS+WS(25+75), 5. CS+G(50+50), 6. CS+G(75+25), 7. CS+G(25+75), 8. CS+C(50+50), 9. CS+C(75+25), 10. CS+C(25+75), 11. CS+WW(50+50), 12. CS+WW(75+25), 13. CS+WW(25+75), 14. CS+CN(50+50), 15. CS+CN(75+25), 16. CS+CN(25+75), 17. CS+NL(50+50), 18. CS+NL(75+25), 19. CS+NL(25+75), 20. CS+PL (50+50), 21. CS+PL (75+25), 22. CS+PL(25+75), 23. CS+LL(50+50), 24. CS+LL(75+25), 25. CS+LL(25+75), 26. CS+WTL(50+50), 27. CS+WTL(75+25), 28. CS+WTL(25+75), 29. CS+WP(50+50), 30. CS+WP(75+25), 31. CS+WP(25+75)).

Referring to the values in the related tables and Figure 4, CS(100), CS+WS(25+75), CS+WW(25+75), (75+25) and (50+50), CS+CN(50+50), CS+NL(50+50), (27+75), CS+PL(75+25), CS+LL(50+50), CS+WTL(50+50), CS+WP(50+50), (75+25) and (25+75) compost ratios were more suitable than those of the other mixtures, while. CS+G, CS+C CS+CN(50+50), CS+LL(75+25) and CS+WTL(75+25), (25+75) based composts appeared not so promising for P.florida cultivation. These results are very similar to the previous findings with the same fungi (Erkel and Işık, 1992). However, obtained mushroom yields with the

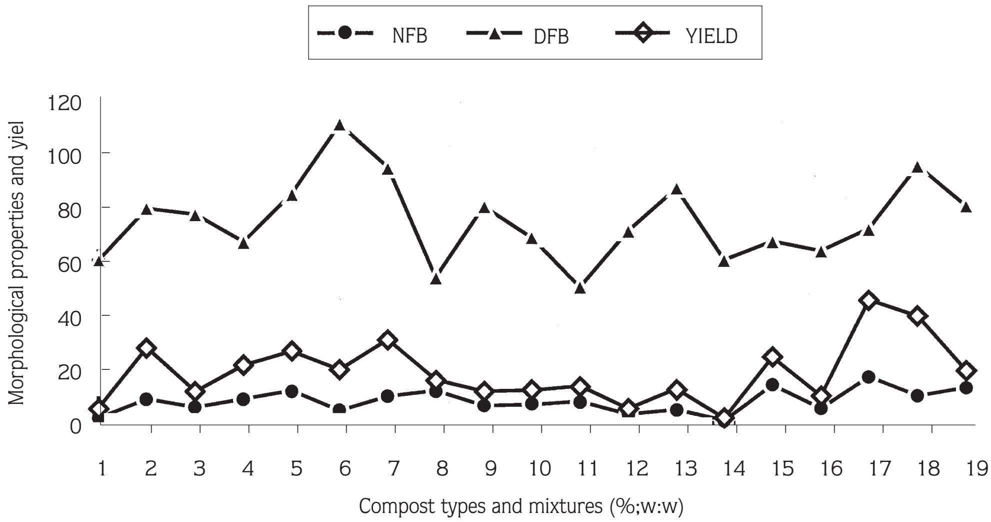

Figure 4. Yield and morphological properties of *P.florida* on Corn Stalk (CS) based composts. 1. CS;(100), 2. (CS+WS;50+50), 3. (CS+WS;75+25), 4. CS+WS;25+75), 5.(CS+WW;50+50), 6. (CS+WW;75+25), 7. (CS+WW;25+75), 8. (CS+CN;50+50), 9. (CS+CN(25+75), 10. (CS+NL;50+50), 11. (CS+NL;75+25), 12. (CS+NL;25+75), 13. (CS+PL;75+25), 14. (CS+PL;25+75), 15. (CS+LL;50+50), 16. (CS+LL;25+75), 17. (CS+WP;50+50), 18. (CS+WP;75+25), 19. (CS+WP;(25+75), (Mycelia development was not seemed the other bags)

Table 4. .Morphological properties of *P.florida* on the substrate of Corn Stalk (CS) basis

Trial Code	Number of Fruit Body (NFB)			Diameters of Fruit Body (DFB) (cm)			Length of Stalk (LS) (cm)		
	Mean	St.E	HG	Mean	St.E	HG	Mean	St.E	HG
211	2.00	0.00	ab	60.00	0.00	abc	50.00	0.00	e
221	9.00	0.00	defg	79.37	0.51	efg	38.75	5.10	bcd
222	6.00	6.37	bcde	77.08	22.64	defg	31.87	8.58	ab
223	9.00	1.41	defg	66.87	1.53	bcde	44.50	7.75	cde
231	-	-	-	-	-	-	-	-	-
232	-	-	-	-	-	-	-	-	-
233	-	-	-	-	-	-	-	-	-
241	-	-	-	-	-	-	-	-	-
242	-	-	-	-	-	-	-	-	-
243									
251	12.00	7.16	fgh	84.84	11.99	fghı	47.48	9.72	de
252	4.75	2.85	abcd	110.8	7.48	j	35.00	4.08	bc
253	10.00	4.76	efgh	94.58	22.08	hı	49.25	14.22	e
261	12.00	0.00	fgh	53.75	0.00	ab	32.50	0.00	ab
262	-	-	-	-	-	-	-	-	-
263	6.50	0.40	bcde	80.00	12.24	efgh	32.50	2.04	ab
271	7.00	2.44	cde	68.33	5.44	cdef	38.33	5.44	bcd
272	8.00	0.00	cdef	50.00	0.00	a	46.66	0.00	de
273	3.33	0.57	abc	70.83	8.24	cdef	23.33	9.42	a
281	-	-	-	-	-	-	-	-	-
282	5.00	0.00	abcd	86.66	0.00	ghı	50.00	0.00	e
283	1.00	0.00	a	60.00	0.00	abc	30.00	0.00	ab
291	14.00	0.00	hı	67.00	0.00	bcde	33.00	0.00	ab
292	-	-	-	-	-	-	-	-	-
293	5.50	2.12	abcde	63.33	10.88	abcd	39.16	4.76	bcd
2101	-	-	-	-	-	-	-	-	-
2102	-	-	-	-	-	-	-	-	-
2103	-	-	-	-	-	-	-	-	-
2111	17.00	0.00	l	71.66	0.00	cdefg	51.66	0.00	e
2112	10.00	0.00	efgh	95.00	0.00	h	37.50	0.00	bcd
2113	13.00	5.71	ghı	80.00	8.16	efgh	46.87	9.69	de

Mean : Average St.E.:Standard error HG: Homogeneity groups

Table 5. Homogeneity groups formed statistically for evoluation of Corn Stalk (CS) based composts on *P.florida*

S	HG	MDP	WIF	Y	NFB	DFB	LS
+	1	CS(100) CS+WS(25+75) CS+WW(50+50) CS+WW(25+75) CS+CN(50+50) CS+NL(50+50) CS+PL(75+25) CS+LL(50+50) CS+WTL(50+50) CS+WP(50+50) CS+WP(75+25) CS+WP(25+75)	CS+WP(50+50)	CS+WP(50+50) CS+WP(75+25)	CS+WP(50+50)	CS+WW(75+25)	CS+NL(25+75)
	2	CS+WS(50+50) CS+LL(25+75)	CS+WW(25+75) CS+WP(75+25) CS+WW(75+25) CS+WS(50+50) CS+WP(25+75)	CS+WW(25+75)	CS+LL(50+50)	CS+WP(75+25)	CS+PL(25+75) CS+WS(25+75) CS+CN(50+50) CS+CN(25+75) CS+LL(50+50)
	3	CS+WW(75+25) CS+CN(25+75) CS+PL(25+75)	CS+CN(25+75) CS(100) CS+NL(50+50) CS+WW(50+50)	CS+WS(50+50)	CS+WP(25+75)	CS+WW(25+75)	CS+WW(75+25)
	4	CS+WS(75+25) CS+NL(25+75)	CS+WS(75+25) CS+LL(50+50) CS+WS(25+75) CS+NL(75+25) CS+NL(25+75) CS+PL(75+25)	CS+WW(50+50) CS+LL(50+50)	CS+WW(50+50) CS+CN(50+50)	CS+PL(75+25)	CS+WP(75+25) CS+NL(50+50) CS+WS(50+50) CS+LL(25+75) CS+LL(25+75)
	5	CS+NL(75+25) CS+PL(50+50)	CS+CN(50+50) CS+LL(25+75)	CS+WS(25+75)	CS+WW(25+75) CS+WP(75+25)	CS+WW(50+50)	CS+WP(25+75)
	6	CS+PL(25+75)	CS+WW(75+25)	CS+WS(50+50) CS+WS(25+75)	CS+CN(25+75) CS+WP(25+75)	CS+CN(25+75) CS+WP(25+75)	CS+NL(75+25) CS+WP(25+75) CS+WW(50+50)
	7			CS+WP(25+75)	CS+NL(75+25)	CS+WS(50+50)	CS+WW(25+75) CS(100) CS+PL(75+25) CS+WP(50+50)
	8			CS+CN(50+50)	CS+NL(50+50)	CS+WS(75+25)	
	9			CS+NL(75+25)	CS+CN(25+75)	CS+WP(50+50)	
	10			CS+PL(75+25) CS+NL(50+50)	CS+WS(75+25) CS+LL(25+75)	CS+NL(25+75) CS+NL(50+50)	
	11			CS+CN(25+75) CS+WS(75+25)	CS+PL(75+25) CS+WW(75+25)	CS+LL(50+50) CS+WS(25+75)	
	12			CS+LL(25+75)	CS+NL(25+75)	CS+LL(25+75)	
	13			CS(100) CS+NL(25+75)	CS(100)	CS(100) CS+PL(25+75)	
	14			CS+PL(25+75)	CS+PL(25+75)	CS+CN(50+50)	
	15					CS+NL(75+25)	

CS+WP(50+50) and (75+25) very higher than those of above mentioned authors. CS:WP(1:1) mixture yielded better cultivation results than another composts in this series. WW apparently induced morphological quality properties. The fact that the increasing of ratio of WW was has and advantage of yield. On the other hand, CS was found better to be supplemented by co-substrates such as WP and WW, instead of use as sole CS substrate, referring to the statistical evaluations based on homogenity groups (Table 5). Tree leaves from poplar and linden could not in prove mushroom yield and quality properties of CS based substrata.

As it is followed from the Figure 5, that WW+LL(50+50) mixture ratious were observed the fastest mycelium development, in addition to these WW(100), WW+WS(50+50), WW+CN(75+25) and (50+50), WW+CL (50+50) WW+PL(50+50), WW+LL(50+50) and (25+75), WW+WTL (75+25) and WW+WP's all mixtures enabled faster mycelia development than the other composts. Mycelium development was not observed on WW + CS (50+50), WW+G(25+75), WW+C WW+WTL(25+75) baed compost mixture ratios. This can be attributed to the co-substrate properties beyond contents of main substrates necessary nutrient elements themselves. Since

Cultivation of P. florida on wood waste (ww) based compasts

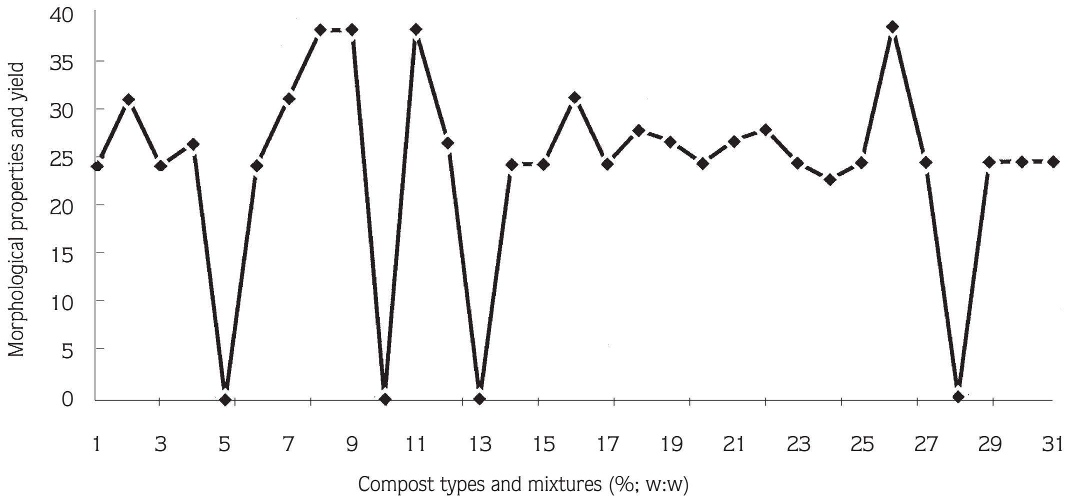

Figure 5. Mycelia development of P.florida on Wood Waste (WW) based composts. 1. WW;(100), 2. WW+WS(50+50), 3. WW+WS(75+25), 4. WW+WS(25+75), 5. WW+CS(50+50), 6. WW+CS(75+25), 7. WW+CS(25+75), 8. WW+G(50+50), 9. WW+G(75+25), 10. WW+G(25+75), 11. WW+C(50+50), 12. WW+C(75+25), 13. WW+C(25+75), 14. WW+CN(50+50), 15. WW+CN(75+25), 16. WW+CN(25+75), 17. WW+NL(50+50), 18. WW+NL(75+25), 19. WW+NL(25+75), 20. WW+PL(50+50), 21. WW+PL(75+25), 22. (WW+PL(25+75), 23. WW+LL(50+50), 24. WW+LL(75+25), 25. WW+LL(25+75), 26. WW+WTL(50+50), 27. WW+WTL(75+25), 28. WW+WTL(25+75), 29. WW+WP(50+50), 30. WW+WP(75+25), 31. WW+WP(25+75)).

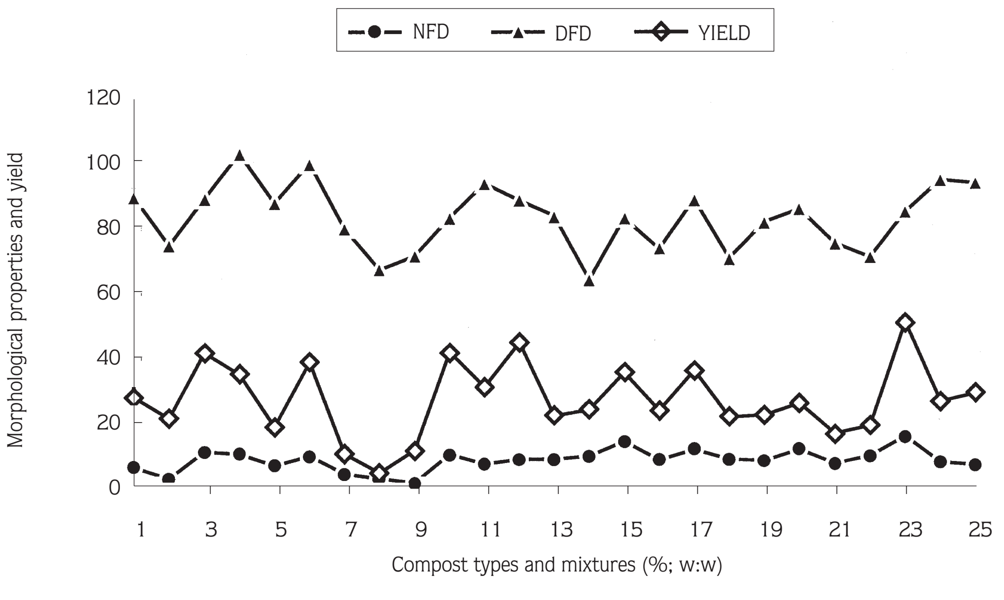

Figure 6. Yield and morphological properties of P.florida on Wood Waste (WW) based composts. 1. WW;(100), 2. WW+WS(50+50), 3. WW+WS(75+25), 4. WW+WS(25+75), 5. WW+CS(75+25), 6. WW+CS(25+75), 7. WW+G(75+25), 8. WW+C(50+50), 9. WW+C(75+25), 10. WW+CN(50+50), 11. WW+CN(75+25), 12. WW+CN(25+75), 13. WW+NL(50+50), 14. WW+NL(75+25), 15. WW+NL(25+75), 16. WW+PL(50+50), 17. WW+PL(75+25), 18. WW+PL(25+75), 19. WW+LL(50+50), 20. WW+LL(75+25), 21. WW+LL(25+75), 22. (WW+WTL(50+50), 23. WW+WTL(25+75), 24. WW+WP(50+50), 25. WW+WP(25+75), (Mycelia development was not seemed other the bags).

the suitability of regional substrates was subjected in the present study, the differences among composts regarding cultivation can be studied later. Mushroom yield percentages which were calculated from the fresh mushroom weights on kg dry compost basis and morphological properties of harvested fruit bodies were demonstrated in Fig 6. and morphological properties tabulated Table 6. In addition to these, all the results were analyzed statistically and formed homogenity groups given Table 7, from the most succesful trial to the least one.

Referring to the values in the related tables and Figure 6; WW+LL(75+25), WW+WS (50+50), WW+WTL (75+25), WW+WS (25+75), WW+CS (25+75) and WW+WTL (50+50) compost ratious were more suitable than those of the other mixtures, while. WW+CS (50+50), WW+G(25+75), WW+C(25+75) and WW+WTL(25+75) based composts appeared not so promising for P.florida cultivation. These results realized cultivation relevant values in the present study were somewhat at lower levels than some previous findings (Yalınkılıç et. all, 1994). However, obtained mushroom yields with the WW+CN mixture based compost types are very near to that of wood waste (WW) based compost

Table 6. Morphological propertiaes of P.florida on the substrate of Wood Waste basis.

Trial Code	Number of Fruit Body (NFB)			Diameters of Fruit Body (DFB) (mm)			Length of Stalk (LS) (mm)		
	Mean	St.E	HG	Mean	St.E	HG	Mean	St.E	HG
311	6.50	3.20	cdef	89.81	13.29	abc	47.39	11.30	cdefg
321	3.00	0.00	ef	75.00	19.39	bcd	75.00	12.24	a
322	11.25	5.56	abc	89.13	11.84	abc	56.73	2.15	bcd
323	10.66	2.49	abc	103.1	3.21	a	49.44	9.06	bcdefg
331	-	-	-	-	-	-	-	-	-
332	7.00	4.69	cdef	87.91	19.56	abcd	46.20	12.74	cdefg
333	10.00	0.00	bcd	100.0	0.00	a	53.33	0.00	bcdef
341	-	-	-	-	-	-	-	-	-
342	4.50	1.22	def	80.00	16.32	abcd	52.50	10.60	bcdef
343	-	-	-	-	-	-	-	-	-
351	3.00	0.81	ef	67.50	22.45	cd	35.00	4.08	gh
352	1.66	1.29	f	71.66	23.21	bcd	56.66	7.72	bcd
353	-	-	-	-	-	-	-	-	-
361	10.50	2.04	abcd	83.33	5.44	abcd	60.41	20.07	bc
362	7.50	2.88	cdef	93.77	26.63	ab	51.04	5.24	bcdef
363	9.00	2.44	bcde	88.57	5.25	abc	43.57	5.25	defg
371	9.00	4.54	bcde	83.95	10.87	abcd	40.10	9.09	efgh
372	10.00	0.00	bcd	64.50	20.00	d	35.25	6.32	gh
373	14.50	5.30	ab	83.19	0.56	abcd	38.05	2.49	fgh
381	8.75	1.89	bcde	73.87	10.53	bcd	45.43	3.90	cdefg
382	12.00	2.16	abc	89.00	2.48	abc	45.50	5.02	cdefg
383	9.00	6.27	bcde	71.06	8.77	bcd	40.52	4.29	efgh
391	8.50	5.80	bcde	82.08	15.47	abcd	50.52	18.84	bcdefg
392	12.00	6.21	abc	85.86	10.33	abcd	43.85	8.53	defg
393	7.66	3.09	cde	75.55	18.38	bcd	42.50	6.12	defg
3101	10.00	2.44	bcd	71.25	5.10	bcd	26.25	5.10	h
3102	16.00	3.55	a	84.94	8.67	abcd	44.21	2.92	defg
3103	-	-	-	-	-	-	-	-	-
3111	8.00	4.32	cde	94.66	17.59	ab	55.70	14.78	bcde
3112	7.25	3.20	cdef	93.74	12.35	ab	63.74	9.85	ab
3113	-	-	-	-	-	-	-	-	-

Mean : Average St.E.:Standard error HG: Homogeneity groups

Table 7. Homogenity groups formed statistically for evaluation of Wood Waste (WW) based composts on *P.florida* cultivation

S	HG	MDP	WIF	Y	NFB	DFB	LS
+	1	WW+LL(75+25)	WW+WS(50+50)	WW+WTL(75+25)	WW+WTL(75+25)	WW+WS(25+75) WW+CS(25+75)	WW+WTL(50+50)
	2	WW(100) WW+WS(75+25) WW+CS(75+25) WW+CN(50+50) WW+CN(75+25) WW+NL(50+50) WW+PL(50+50) WW+LL(50+50) WW+LL(25+75) WW+WTL(75+25) WW+WP(50+50) WW+WP(75+25) WW+WP(25+75)	WW+CS(25+75)	WW+CN(25+75)	WW+NL(25+75)	WW+WP(50+50) WW+CN(75+25) WW+WP(75+25)	WW+C(50+50) WW+NL(75+25)
	3	WW+WS(25+75) WW+C(75+25) WW+NL(25+75) WW+PL(75+25)	WW+G(75+25)	WW+CN(50+50) WW+WS(75+25)	WW+PL(75+25) WW+LL(75+25) WW+WS(75+25) WW+WS(25+75)	WW(100) WW+WS(75+25) WW+PL(75+25) WW+CN(25+75)	WW+NL(25+75)
	4	WW+NL(75+25) WW+PL(25+75)	WW+WP(75+25) WW+CN(50+50) WW(100) WW+WS(25+75)	WW+CS(25+75)	WW+CN(50+50)	WW+CS(75+25) WW+LL(75+25) WW+WTL(75+25) WW+LL(50+50) WW+CN(50+50) WW+NL(25+75) WW+LL(50+50) WW+G(75+25)	WW+NL(50+50) WW+PL(25+75)
	5	WW+WS(50+50) WW+CS(25+75) WW+CN(25+75)	WW+WP(50+50)	WW+PL(75+25)	WW+CS(25+75) WW+NL(75+25) WW+WTL(50+50)	WW+LL(25+75) WW+WS(50+50) WW+PL(50+50) WW+C(75+25) WW+PL(25+75)	WW+LL(25+75) WW+CN(25+75) WW+LL(75+25) WW+WTL(75+25)
	6	WW+G(50+50) WW+G(75+25) WW+C(50+50) WW+WTL(50+50)	WW+PL(75+25)	WW+NL(25+75) WW+WS(25+75)	WW+CN(25+75) WW+NL(50+50) WW+PL(25+75) WW+PL(50+50) WW+LL(50+50)	WW+C(50+50)	WW+PL(50+50) WW+PL(75+25) WW+CS(75+25) WW(100)
	7		WW+WTL(75+25) WW+CN(75+25) WW+WS(75+25) WW+NL(50+50)	WW+CN(75+25)	WW+WP(50+50) WW+LL(25+75)	WW+NL(75+25)	WW+WS(25+75) WW+LL(50+50)
	8		WW+CN(25+75) WW+CS(75+25) WW+LL(75+25) WW+C(75+25) WW+LL(50+50) WW+PL(25+75) WW+LL(25+75)	WW+WP(75+25) WW(100)	WW+CN(75+25) WW+WP(75+25) WW+CS(75+25) WW(100)		WW+CN(75+25) WW+G(75+25) WW+CS(75+25)
	9		WW+NL(25+75) WW+PL(50+50)	WW+WP(50+50) WW+LL(75+25)	WW+G(75+25)		WW+WP(50+50)
	10		WW+NL(75+25) WW+LL(50+50) WW+WTL(50+50)	WW+NL(75+25) WW+PL(50+50) WW+LL(50+50) WW+NL(50+50)	WW+WS(50+50) WW+C(50+50)		WW+C(75+25) WW+WS(75+25)
	11			WW+PL(25+75) WW+WS(50+50)	WW+C(75+25)		WW+CN(50+50)
	12			WW+WTL(50+50) WW+CS(75+25)			WW+WP(75+25)
	13			WW+LL(25+75)			WW+WS(50+50)
	14			WW+C(75+25) WW+G(75+25)			
	15			WW+C(50+50)			

types. Other differences are likely to do composting procedure and additives used as well as substrate and co-substrate properties

Co-substrate used in this series of the study, as WTL, CN, WS and CS, improved cultivation properties of WW based composts. Most appropriate mixtures evidently appeared as WW:WS and WW:CS by mushroom quality while WW:WTL(3:1) was obtained the most hihg yield.

The mushroom yields for each trial was compared and the Biological Efficiency was calculated as indicated below (Royse, D.J.).

$$B.E.\% = \frac{\text{Weight of fresh mushroom harvested}}{\text{Weight of dry substrate used}} \times 100$$

Conclussions

P.florida was cultivated on some regionally available wastes aimed at highlighting mixtures, saw mill waste of beech wood was distinguished very appropriate as main substrate with some mixtures of WTL, WS, PL and CS, etc. as co-substrata. Great potential of WW of timber mils of Eastern Black Sea region offers as a unique chance for mushroom growers.

Climatical conditions are also very suitable for continuous harvest through the seasons by some simple non-costly equipment which enable economical cultivation. In conclusion, this study confirmed the previous assessment in TOAG-985 Coded project supported by Scientific and Technical Council of Turkey made on Pleurotus sp. cultivation and opened a further area for growing the Florida type Pleurotus sp. in the Region. Investigation of compost properties, constituent elements and nutritional values of obtained fruit bodies and improvement of mushroom yield and quality of P.florida by some additional measures are still underway in our laboratory.

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