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The Effect of Ferrum ($FeSO_4$) on Culture Mushroom: *Pleurotus ostreatus* (Jacq.) Kumm.

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Abstract: This study was conducted on the growth, ratio of protein and cultivation of *Pleurotus ostreatus* on local celluosic wastes in different concentrations of the ferrous (Fe^{++}). It was observed that Fe^{++} had effect on the formation and growth of the basidiocarps. The shortest and longest period of basidiocarps formation and growth were obtained in 100 ppm and 300 ppm Fe^{++}, respectively. The higher total amount of yield was found for 100 ppm Fe^{++} when compared with control, 200 and 300 ppm Fe^{++}. Significant ($P < 0.05$) difference was found between the control and 100 ppm Fe^{++}, but the best yield was obtained. Mushroom protein ratio of all concentrations of ferrous (Fe^{++}) were found to be lower than control.

Key Words: *Pleurotus ostreatus*, growth, yield, ferrous (Fe^{++}), protein ratio

Demir ($FeSO_4$)'in Kültür Mantarı Üzerine Etkisi: *Pleurotus ostreatus* (Jacq.) P. Kumm.

Özet: Bu çalışma, yerel selülozik atıklarda, Demir (Fe^{++})' in farklı konsantrasyonlarının *Pleurotus ostreatus*' un yetiştiriciliği ve gelişimi üzerine yapılmıştır. Fe^{++} in bazidiokarp oluşumu ve gelişimi üzerine etkili olduğu gözlenmiştir. En kısa ve en uzun bazidiocarp oluşum ve gelişim süresi, yaklaşık olarak 100 ppm ve 300 ppm Fe^{++} dozlarında elde edilmiştir. 200 ve 300 ppm Fe^{++} ile karşılaştırıldığında; en yüksek toplam ürün miktarı, kontrol grubu ve 100 ppm Fe^{++} de bulunmuştur. En iyi ürün elde edilen 100 ppm' lik doz ile kontrol grubu arasında büyük bir istatistiksel fark ($P < 0.05$) bulunmuştur. Protein oranı; tüm (Fe^{++}) konsantrasyonlarında, kontrol grubuna göre daha düşük tespit edilmiştir.

Anahtar Sözcükler: *Pleurotus ostreatus*, gelişme, ürün, demir (Fe^{++}), protein oranı

Introduction

In world mushroom production, *Pleurotus* rate second, after *Agaricus bisporus*. In 1986, *Pleurotus* sp. production accounted for approximately 7 % of the total world production of edible mushroom; by 1990, production of *Pleurotus* sp. reached one million metric tones and accounted for 24 % of the total mushroom production (1). Unlike other mushrooms, *Pleurotus* spp. has much diversity the in their adaptation to the varying agro climatic condition as the locality available lignocellulosic substrates (2). Commercial cultivation of *Pleurotus* sp. has not been performed in Turkey. The cultivation of *Pleurotus* has been evaluated in the Laboratory.

Cultivated mushrooms, especially the white button mushrooms, are highly perishable and tend to loose the quality attributes which otherwise make then highly appealing to consumers, thereby reducing the market value (3). Mushrooms are an important source of edible protein for human consumption (4, 5). More than 2000 species of mushroom exist in nature but only approximately 22 species are intensively cultivated for commercial purposes, on soil or wood and utilizing particular environmental and nutritional conditions (6). Mushrooms have also been reported as therapeutic foods, useful in preventing diseases such as hypertension, hyper cholesterolemia and cancer (7).

In nature, thirty-nine *Pleurotus* species exist and about 7 to 9 species have been artificially cultivated on various lignocellulosic materials (2, 8).

The role of ferrous iron in stimulating fruiting was reported for *Agaricus bisporus* (9), for *Pleurotus* flabillatus (10) and *Pleurotus* florida (11). Fe^{++} plays a role in fungus physiology that it activating enzymes such as cytocrome and cytocrome oxidase catalyses (12).

In this study, the effect of different concentrations of Fe^{++} (obtained the sülphat) on the amount and period of yield and on nutritional content of P.ostreatus were investigated.

Materials and Methods

Inoculum preparation

This study was carried out in a disinfected mushroom culture laboratory. Naturally occurring P. ostreatus growing in Diyarbakir Hevsel Gardens was obtained for the culture (13).

Condition of cultivation

In this study, as additive substance, 30 g dose of lentil straw was added to 100 g soybean to obtain in the culture media for *Pleurotus ostreatus*. The 0.75 % N contents of waste materials were used as culture media. Material for each trial was placed in plastic buckets and kept for 48 h in water, until the compost reached a humidity of 70-75 %. In order to obtain the desired pH values (5, 5-6, 5), 7 g of lime ($CaCO_3$) and 7 g of gypsium ($CaSO_4$) were added to the 130 g dry compost (14, 15). The compost was sprayed with 1 % of formaldehyde containing 2 % g benlate 250 mlt per 2 kg compost so as to eliminate microorganisms (16). It was then mixed thoroughly. The compost was left in closed buckets for 24 hours in the laboratory conditions, emptied into plastic bowls, and then mixed until the formaldehyde was completely evaporated. The spawn additive on 100 g wheat was used for 2 kg (humidity of 70-75 %) compost as inoculation material. Into each of transparent polyethylene bags of 40 cm diameter, 1 kg mycelium compost was put, and the bags were tied up and taken into the incubation room. For aeration of the mycelium, 15 holes of 0.5 cm diameter were opened in each bag using a sterilized nail.

The inoculation was performed in a room at 25±1 ºC and then the temperature was reduced to about 15±1 ºC, with an air conditioning system. An air cooler was used an hour a day to provide aeration to avoid the accumulation of CO_2. In order to supply a homogenous condition in the incubation room, a ventilator was used for an hour for once a day. After 13 days inoculation, all the samples were shocked (18), the culture was kept in a fridge at 5 ºC for 48 hours. After 2 days shocked, 200 ml solution which containing 100, 200 and 300 ppm Fe^{++} (FeSO4) was sprayed to the 1 kg compost containing each test, and the same amount of water was added to the control group (11).

The culture room was subjected to light for 12 hours a day with a light (fluorescent in bulbs) intensity of 150 to 200 lux (17) after mycelium had been developed on the compost. The culture room was constantly bathed to maintain the relative humidity (75-90%).

Organic Elements

The Carbon and Nitrogen (N) were analyzed by using Carlo-Erba Element Analysis Instrument (Model EA 1108) for basidiocarp. The technique used for the determination of C and N is based on the quantitative "dynamic flash combustion" that converts all organic and inorganic substances into combustion products. The resulting combustion gases pass through a reduction furnace and are swept into the chromatographic column by the carrier gas (helium) where they are separated and detected by thermal conductivity detector (TCD), which gives an output signal proportional to the concentration of the individual components of the mixture (5).

Protein ratio was calculated by multiple ratio of N with 6.25.

Proximate Composition

The moisture content of each sample was determined by drying in an oven at 100°C and crude fibre was determined according to the standard method of A. O. A. C. (Association of Official Agricultural Chemist, 1950).

Statistical Analysis

The data obtained were analyzed by ANOVA and using Duncan's multiple range of significance. All results are averages of five replicates.

Results and Discussion

First harvesting was made after 4 days basidiocarp formation, the shortest and longest period of basidiocarp formation were determined as 28 and 32 days for 100 ppm Fe^{++} and control groups, respectively (Table 1). The shortest and longest total harvesting period were obtained as 59 days for 100 ppm Fe^{++} and 71 days for 300 ppm Fe^{++}, respectively (Table 1). As seen in Table 2, it was seen that the highest amount of yield was 99 g for 100 ppm Fe^{++} and the lowest was 90 g for 300 ppm Fe^{++}. The highest amount of protein was found in control group and lowest in 300 ppm Fe^{++}. Also, it was determined that the amount and period of yield increased by 100 ppm doses of Fe^{++}, and that this result is consistent with those in the others (9, 10, 11). According to others results (9, 10, 11) it was obtained to have stimulated Fe^{++} the formation of basidiocarps. However, we found that Fe^{++} decreased the protein ratio of P. ostreatus (Table 2).

For the cultivation of *Pleurotus* species, the compost containing 0.66 % (19) and 0.7- 0.9 % N (15) as dry weight was recommended.

The yield period, amount and protein content of mushroom were found to vary according to different nitrogen source variety and dose (17, 10, 19, 20, 21, 22).

As a result, although the yield period and amount were found to be close to the results determined previously, we can recommend the compost obtained with 100 g soybean straw and 30 g lentil straw and containing 0.75 % N for the calculation of P. ostreatus of the examined doses, only ferrous, Fe^{++} at 100 ppm significantly increased yield compared with the control. However, its ability to utilize waste soybean and lentil straw may be of particular commercial interest where these commodities exist in excess.

Table 1. The effect of different doses of Fe^{++} on *Pleurotus ostreatus* growing period (days).*

ppm Fe^{++}	Formation of Basidiocarp	First Harvest	Second Harvest	Third Harvest	Fourth Harvest
	X ± SD	X ± SD	X ± SD	X ± SD	X ± SD
100	24± 1[a]	28 ± 2[a]	38 ± 3[a]	48 ± 4[a]	59 ± 2[a]
200	26 ± 1[a]	30 ± 1[a]	43 ± 1[b]	56 ± 1[b]	68 ± 4[c]
300	26 ± 2[a]	30 ± 2[a]	44 ± 1[b]	58 ±1[b]	71 ± 2[c]
0. 0	28 ± 3[a]	32 ± 4[a]	41 ± 2[ab]	53 ± 4[ab]	63 ± 4[b]

*: Means having the same superscript letter(s) are not significantly different ($P < 0.05$) by Duncan's Multiple range test.

Table 2. The effect of different doses of Fe^{++} on *Pleurotus ostreatus* product yield of fresh mushrooms (yield / 100 g waste 70 % moisture) and protein content of mushrooms.*

Yield(g)→	The amount of first harvest	The amount of secon harvest	The amount of third harvest	The amount of fourth harvest	The amount of total yield	Protein (N X 6, 25) (dry weight %)
ppm Fe^{++}	X ± SD	X ± SD	X ± SD	X ± SD	X ± SD	X ± SD
100	36 ±4[a]	19± 2[a]	26 ± 3[a]	16 ± 5[a]	97± 5[a]	49.21 ± 3.12
200	31 ± 3[b]	20 ±5[a]	23 ±5[ab]	17 ± 1[a]	91 ±1[b]	41.90 ± 2.36
300	30 ± 2[b]	22 ±2[a]	20 ± 1[b]	17 ± 0[a]	89 ± 2[b]	41.17 ± 2.63
0. 0	28 ± 2[b]	26 ± 3[b]	18 ± 4[a]	15 ± 2[a]	87 ± 3[a]	51.87 ± 3.85

*: Means having the same superscript letter (s) are not significantly different ($P < 0.05$) by Duncan's Multiple range test.

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