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Nutritive value of *Pleurotus ostreatus* (Jacq.) P. Kumm. grown on some cellulosic residues

Bazı lokal selülozik atıklar üzerinde kültürü yapılan Pleurotus ostreatus (Jacq.) P. Kumm.'un besin içeriği

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Abstract

In this study, the effects of different cellulosic wastes on the nutritional values of *Pleurotus ostreatus* (Jacq.) P. Kumm. were investigated. Dry matter, moisture, protein, fat and ash contents of *P. ostreatus* were analyzed according to AOAC methods. Crude protein and fat contents were determined by the Kjeldahl method and Soxhlet extraction, using ether as a solvent, respectively. Chemical composition of *P. ostreatus* such as dry matter, moisture, crude protein, fat and organic matter were 93.5-93.7%, 6.3-6.5%, 25.2-33.5%, 1.7-2.5%, 5.3-9.7% and 84.0-88.2% of dry weight, respectvely. There were no significant differences in dry matter and moisture content of *P. ostreatus* grown on various local residues ($p>0.05$), but changeable in other nutrient composition ($p<0.05$). Crude protein, ash, fat and organic matter varied significantly, the lowest protein content was obtained from WS (25.2%), whereas the highest was obtained in the mixture of MS-WS (1:1) (33.5%) and MS-PP (1:1) (33.3%). *P. ostreatus* is highly valued as a good source of protein (25-33%), but low in fat (1.7-2.5%). It was observed that the type of substrate used for cultivation of *P. ostreatus* could influence the crude protein content of the fruit bodies.

Özet

Bu çalışmada, farklı selülozik atıkların *Pleurotus ostreatus* (Jacq.) P. Kumm.'un besin değerleri üzerine etkileri araştırılmıştır. *P. ostreatus*'un kuru madde, nem, ham protein, yağ ve kül içerikleri AOAC yöntemlerine göre analiz edildi. Ham protein içeriği Kjeldahl yöntemi ile ham yağ ise Soxhlet ekstraksiyonu ile belirlenmiştir. *P. ostreatus*'un kuru madde, nem, ham protein, yağ ve organik madde içerikleri kuru ağırlığın % 93.5-93.7, % 6.3-6.5, % 25.2-33.5, % 1.7-2.5, % 5.3-9.7 ve % 84.0-88.2 olarak bulunmuştur. Değişik lokal atıklar üzerinde yetiştirilen *P. ostreatus*'un kuru madde ve nem içeriklerinde istatistiksel olarak önemli bir fark bulunmadığı ($p>0.05$), fakat diğer besin öğeleri ise değişkenlik göstermektedir ($p<0.05$). Ham protein, kül, yağ ve organik madde miktarları önemli ölçüde değişiklik gösterirken, en düşük ham protein içeriği BS'de (% 25.2), en yüksek ise YS-BS (1:1) (% 33.5) ve YS-PA (1:1) (% 33.3) ortamlarında elde edilmiştir. *P. ostreatus* iyi bir protein kaynağı olarak oldukça değerli, yağ içerikleri bakımından ise oldukça düşüktür (% 1.7-2.5). *P.ostreatus* kültüründe kullanılan substrat ürünlerin, mantarın ham protein gibi besin bileşimini etkileyebileceği gözlemlendi.

INTRODUCTION

Edible mushrooms are considered as mycotherapeutics, cosmeceuticals, nutraceuticals, and useful for the production of functional foods. Their cultivation allows for the sustainable management of lignocellulosic wastes and provides a good income with low inputs, creating a good opportunity for the development of economically distressed rural areas (Kibar 2019, Ferraro et al. 2020). Currently, the number of edible and/or medicinal mushroom, is approximately 3.000 species (ca. 230 genera edible mushrooms and 700 medicinal mushrooms). Among them, only 25 species are cultivated for commercial use as food or medicine (Marshall & Nair 2009, Reis et al. 2012, Chang & Wasser 2017).

The genus *Pleurotus* spp., commonly known as oyster mushrooms, is one of the most commercially produced edible mushrooms in the world with gastronomic and nutritional importance and as well as the latest findings revealed strong bioactivities such as immunomodulatory effects, hypolipidemic, antiinflammatory, antihyperglycemic, antiviral, antitumor, antioxidant, anticancer, hypocholesterolemic, antidiabetic and antimicrobial (Carrasco-González et al. 2017, Barbosa et al. 2020, Krakowska et al. 2020).

Over the past two decades, edible mushroom have gained importance as health promoters and environmental enhancers causing an increase in research and development activities. *Pleurotus ostreatus* (Jacq.) P. Kumm. (Pleurotaceae, Basidiomycetes higher) is the

second most cultivated edible mushroom worldwide after *A. bisporus* (Sánchez 2010, Royse et al. 2017). It can be easily grown on various agricultural and industrial wastes, also is widely marketed and sold well in many other countries. It has an outstanding reputation as an edible mushroom that has been used as food for centuries due to its highly desirable taste qualities and unique aroma (Patel et al. 2012, Sardar et al. 2017, Naim et al. 2020).

In this study, it was aimed to determine the nutritional values of the *P. ostreatus* by evaluating the wheat straw, *Medicago sativa* L. residues and *Prangos pabularia* Lindl. wastes, which can be provided abundantly and cheaply in Eastern Region Turkey, and to spread the production of this species as a cultivated mushroom and to establish a market share.

MATERIAL AND METHODS

Mushroom cultivation

The primary inocula of *P. ostreatus* was obtained from the Department of Biology, Science Faculty, Fırat University, Elazığ-Turkey and maintained on potato dextrose agar medium at 4°C. For inocula multiplication, propagation of spawn, cultivation process such as substrate preparation, inoculation of substrates, maintenance of beds and for harvest, the methods proposed by Zadrazil (1978) were followed.

For the formation of basidiocarp, Wheat straw (WS), *M. sativa* straw (MS) and *P. pabularia* residues (PP) were used as culture media. These local lignocellulosic residues were obtained from the vicinity of Bitlis, Turkey. Four types of compost were prepared, consisting of a mixture of MS-WS (1:1), MS-PS (1:1), MS and WS. The mushroom culture process was accomplished in the Bitlis Eren University, Science and Technology Application and Research Center (Bitlis-Turkey) in which the relative humidity, illumination, ventilation and temperature were controlled. After sterilization (at 121ºC for 30 min), the substrate-filled bags (one kg) were inoculated by spreading spawn grains on the surface of the substrate with a weight percentage of about 1% of the wet weight of substrate and the lids of the bags were tied up and taken into incubation room at 25±1^{o}C in the dark for 15 days. After opening the bags, for the temperature (18±1°C), humidity (80-90%), aeration (2 h daily), light intensity (500 lux for 12 h a day) of the culture room were maintained by sprinkling water regularly in the morning and afternoon. Fruiting bodies developed after a period of 3 weeks (total harvest: 60 days) and thereafter were harvested in 2 flushes from each bag (Figure 1a). The mushroom fructification obtained were dried at room temperature for 15 days (Figure 1b). It was stored in labeled bags for analysis.

Biochemical analyses

The nutrient contents were performed in the Faculty of Veterinary Medicine, Fırat University, Turkey. Selected biochemical properties were determined with appropriate methods, as described below: crude protein, ash, dry matter, fat, moisture were analysed according to AOAC methods (1990). Protein content was determined by the Kjeldahl method using 6.25 as converting factor to protein. Crude fat was determined by Soxhlet extraction, using ether as a solvent, and the crude ash by incineration at 550°C. Organic matter and moisture were calculated as dry matter − % ash, and 100 – dry matter, respectively.

a b

Figure 1. Cultivation of *P. ostreatus* grown on various lignocellulosic wastes (a: cultivation, b:samples dried at room temperature for analysis)

RESULTS AND DISCUSSION

The nutritional values of *P. ostreatus* grown on various agricultural wastes are shown in Table 1. The chemical constituents of *P. ostreatus* revealed variations in their values depending on the substrates (see Table 1). The fruit body of *P. ostreatus* cultivated in the present study, contained 93.5-93.7% dry matter, 6.3-6.5% moisture, 25.2-33.5% crude protein, 1.7-2.5% crude fat, 5.3-9.7% crude ash and 84.0-88.2% organic matter of dry weight, respectively (see Table 1). The dry matter and moisture contents of fruiting bodies were not significantly different among substrates (p>0.05), but changeable in other nutrient composition such as crude protein, fat, ash and organic matter (p<0.05) as shown in Table 1.

Table 1. Nutritive value of *P. ostreatus* grown on some lignocellulosic residues (%, air-dried basis)

Materials	Dry Matter	Moisture	Crude Protein	Crude Fat	Crude Ash	Organic Matter
WS	93.7±0.1[a]	6.3±0.1[a]	25.2±0.2[a]	2.5±0.4[b]	9.7±0.1[d]	84.0±0.1[a]
MS	93.7±0.2[a]	6.3±0.2[a]	32.5±0.1[b]	1.8±0.1[a]	6.8±0.1[c]	86.9±0.2[b]
MS-WS (1:1)	93.6±0.1[a]	6.4±0.1[a]	33.5±0.2[c]	1.7±0.1[a]	5.8±0.1[b]	87.8±0.1[c]
MS-PP (1:1)	93.5±0.1[a]	6.5±0.1[a]	33.3±0.1[c]	1.7±0.1[a]	5.3±0.1[a]	88.2±0.2[d]
F value	**1.889**	**1.889**	**1959.575**	**10.370**	**1393.700**	**693.947**
***p* value**	**0.210**	**0.210**	**0.000**	**0.004**	**0.000**	**0.000**

WS: Wheat straw, ***MS: Medicago sativa*** L., PP: *Prangos pabularia* Lindl..
Value is expressed as mean ± SD (n=3, p< 0.05)).
[a.b.c] : Comparison in different culture medium
Organic matter: % dry matter − % ash
Moisture: 100 – dry matter

There were no significant differences in dry matter (93.5-93.7%) and moisture (6.3-6.5%) contents for *P. ostreatus* grown on various cellulosic residues (see Table 1). Those results are in agreement with a previous work (Manzi et al. 1999, Ragunathan & Swaminathan 2003, Patil et al. 2010, Kırbağ & Korkmaz 2014, Tolera & Abera 2017, Jin et al. 2018) analysis of *Pleurotus* species which also most wet mushrooms have about 90% moisture and 10% dry matter and that dried mushrooms have about 90% dry matter and 10% moisture.

Minimum organic matters was 84.0% on WS and maximum was 88.2% on MS-PP (1:1) as seen in Table 1. The highest value of crude ash contents was obtained from WS (9.7%), while lowest value was obtained from MS-PP (1:1) substrate (5.3%) show Table 1. The reported ash contents were 4.4-10.91% in *Agaricus* spp., *Pleurotus* spp., and *L. edodes* (Mau et al. 1998, Manzi et al. 1999, Ragunathan & Swaminathan 2003, Kırbağ & Korkmaz 2014, Tolera & Abera 2017, Jin et al. 2018, Kibar 2019). These values are similar to that reported by other mentioned studies.

Fat content ranged from 1.7% to 2.5% in *P. ostreatus* as shown in Table 1. The reported fat contents were 0.95-3.16 in *Pleurotus* spp. (Ragunathan & Swaminathan 2003), 2.18-4.5% in *Pleurotus* spp. (Patil et al. 2010, Kırbağ & Korkmaz 2014, Tolera & Abera 2017, Jin et al. 2018, Kibar 2019), 4.36-6.4% in *P. ostreatus* (Rashad & Abdou, 2002), 4.30-5.42% in *Pleurotus* spp.. *A. bisporus* ve *L. edodes* (Furlani & Godoy 2007). Crude oil values are similar to that reported in previous work (Ragunathan & Swaminathan 2003, Patil et al. 2010, Kırbağ & Korkmaz, 2014, Tolera & Abera, 2017, Jin et al. 2018, Kibar 2019), and some values lower than that reported earlier (Ragunathan & Swaminathan 2003, Rashad & Abdou 2002, Furlani & Godoy 2007, Kırbağ & Korkmaz 2014).

The highest crude protein (33.3% and 33.5%) was obtained from MS-PP (1:1) and MS-WS (1:1), while the lowest (25.2%) was obtained from WS and was found to be significantly different (p<0.05, see Table 1). The reported protein contents were 25.6-44.3% in *Pleurotus* spp. (Ragunathan & Swaminathan 2003), 26.3-39.3% in *Pleurotus* spp. (Kırbağ & Korkmaz 2014), 41-53% in *P. ostreatus* (Wang et al. 2001), and 18.35-28.45% in *Pleurotus* spp., *A. bisporus* and *L. edodes* (Furlani & Godoy 2007, Tolera & Abera 2017, Jin et al. 2018, Kibar 2019). It seems that the quantity of crude proteins are changeable to that reported by previously (Wang et al. 2001, Ragunathan & Swaminathan 2003, Furlani & Godoy 2007, Kırbağ & Korkmaz 2014, Tolera & Abera 2017, Jin et al. 2018, Kibar 2019). Protein contents of edible mushrooms were reported to vary according to genetic structure of species, and physical and chemical differences in growing medium as stated by mentioned research.

CONCLUSION

In the present study, *P. ostreatus* excellent food that can be used in well balanced diet for low fat content, and other nutritional values. It was observed that the type of substrate used for cultivation of *P. ostreatus* could influence the crude protein of the fruit bodies.

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