ECOLOGICAL CHEMISTRY AND ENGINEERING A

Vol. 18, No. 1 2011

Marek SIWULSKI[1], Agnieszka JASIŃSKA[1],
Krzysztof SOBIERALSKI[1] and Iwona SAS-GOLAK[1]

COMPARISON OF CHEMICAL COMPOSITION OF FRUITING BODIES OF SOME EDIBLE MUSHROOMS CULTIVATED ON SAWDUST

PORÓWNANIE SKŁADU CHEMICZNEGO OWOCNIKÓW WYBRANYCH GRZYBÓW UPRAWIANYCH NA PODŁOŻU Z TROCIN

Abstract: In the present research the chemical compositions of fruiting bodies of two strains of *Lentinula edodes*, two strains of *Pleurotus eryngii*, *Auricularia auricula-judae* and *A. polytricha* were assessed. Above-mentioned mushrooms were cultivated on birch and beech sawdust. The content of protein, fat, carbohydrates and ash in fruiting bodies was assessed.

The results obtained show that the cultivation substrate influenced the chemical compositions of fruiting bodies of examined mushroom species and strains. The highest amount of protein was found in fruiting bodies of *P. eryngii;* but fruiting bodies of *L. edodes* contained the highest amount of fat and ash. Fruiting bodies of the genus *Auricularia* was characterized by the highest content of carbohydrates.

Keywords: *Lentinula edodes*, *Pleurotus eryngii*, *Auricularia auricula-judae*, *Auricularia polytricha*, fruiting bodies, chemical composition, sawdust

Pleurotus eryngii and *Lentinula edodes* are commonly cultivated edible mushrooms all over the world and gather more attention within Polish mushroom growers. Although both, *Auricularia auricula-judae* and *Auricularia polytricha* are species less known on the Polish market, similar way of cultivation as *Lentinula edodes*, together with their tasty fruiting bodies and spectacular medical properties are highly recommended for commercial cultivation [1]. Mushrooms are rich in protein, minerals and vitamins [2]. For the reason that part of the harvested fruiting bodies is designated for processing main emphasis is placed on their chemical composition. Many authors show significant differences in chemical composition among different species and strains of cultivated mushrooms [3–6]. The latest reports show growing interest in the new edible mushrooms available for commercial cultivation in Europe [7].

[1] Department of Vegetable Crops, Poznan University of Life Sciences, ul. Dąbrowskiego 159, 60–594 Poznań, Poland, phone: +48 61 848 7974, email: fungus@up.poznan.pl

The aim of this study was to evaluate the chemical composition ie water, protein, fat, carbohydrates and ash values, of fruiting bodies of different edible mushrooms cultivated on two sawdust substrates.

Materials and methods

The investigation was carried out at the Department of Vegetable Crops of Poznan University of Life Sciences in 2008. The subjects of the study were four species of edible mushrooms cultivated on two sawdust substrates.

Investigated species and strains were as follows:

– *Lentinula edodes* 'SH 37' and 'SH 27',
– *Pleurotus eryngii* 'B124' and 'B127,'
– *Auricularia auricula-judae*,
– *Auricularia polytricha*.

Sawdust of beech and birch were used as a growing substrate, supplemented with 20 % (w/w) of wheat bran and 0.2 % $CaCO_3$. After mixing the components, the substrates were watered up with tap water to the moisture content of 65 %.

In the experiment substrates were packed into PP foil bags with filter (0.02 μm). Each bag contained 2.5 kg of substrate. Bags with the substrates were sterilized at 121 ^{o}C for 2 h. After cooling to the room temperature (ca 21 ^{o}C) the substrates were inoculated with the spawn of tested mushroom strains in the amount equal to 3 % of substrates dry weight. Next, substrates were incubated at 25 ^{o}C and 80–90 % RH until all the substrates volume was grown through by the mycelium. After incubation bags were transferred into cultivation room with temperature of 13–15 ^{o}C, for *A. auricula--judae* and *A. polytricha* the temperature was increased up to 22 ^{o}C after appearance of primordial. The humidity in case of all mushrooms was similar and valued from 85 to 90 %. Cultures were lighted with fluorescent light (Day-Light) of 500 lx intensity for 12 h a day. Fruiting bodies were set on the upper surface of the substrate. The cultivation was conducted in two cycles.

After harvesting the fruiting bodies were dried in 50 ^{o}C for 8 hours and then dried at 80 ^{o}C to constant weight and ground to powder.

Contents of water, protein, fat, carbohydrates and ash were determined using analytical methods described by Rutkowska [8].

Data obtained were evaluated by analysis of variance (ANOVA) and Tukey's mean homogeneity test were used to indicate the significant differences between the means values ($p < 0.01$). Each value was the average of three replicates from both cycles of cultivation.

Results and discussion

According to various authors, nutrient values of the mushrooms differ between the species. Chang and Miles [9] note that moisture of fruiting bodies can rate from 73 to 91 % of fresh mass and carbohydrates from 57 to 82 % of dry mass. Protein content in mushroom normally ranges between 20 and 40 % and it is digested easier than the protein from many legume sources like soybeans and peanuts. The mushrooms fruiting bodies are low in fat which makes them good component of dietary products (3.7–10.0 %) [10, 11].

In presented study, different cultivation substrates influenced the chemical composition of evaluated mushrooms. However, moisture content did not vary among studied dried mushrooms and was similar in all investigated fruiting bodies, regardless the cultivation substrate.

Two different substrates used for cultivation influenced especially the content of protein and carbohydrates in all investigated mushrooms.

Fruiting bodies of all investigated mushrooms contained higher amount of protein when cultivated on beech sawdust compared with birch sawdust (Table 1). The 'SH37' strain of *L. edodes* contained higher amount of protein than 'SH27'one regardless the substrate. Furthermore, in *P. eryngii* 'B127' and 'B124' the protein content was higher in fruiting bodies obtained from cultivation on beech sawdust (18.35 % and 17.87 %, respectively). In *A. auricula-judae* the highest amount of protein was found in fruiting bodies grown on beech sawdust (10.24 %). Furthermore, surprisingly on the same substrate *A. polytricha* showed the lowest its amount (6.30 %). This can be explained by individual character of the species. *A. auricula-judae* cultivated on birch sawdust contained second highest amount of protein (8.99 %).

Amount of carbohydrates in fruiting bodies in both strains of *L. edodes* was higher when cultivated on birch sawdust compared with beech sawdust (68.54 and 68.41 %, respectively), as well as in *P. eryngii* 'B127', simultaneously this amount was the highest amount among the strains (62.03 %). Regarding genus *Auricularia*, content of carbohydrates was higher in mushrooms grown on birch sawdust, and was higher in carpophores of *A. polytricha* (83.30 %) than in *A. auricula-judae* (82.11 %) but those means did not vary statistically.

Generally, fruiting bodies of the genus *Auricularia* showed the biggest variation among the evaluated species and cultivation substrates (Table 1). The biggest differences between the means were observed in protein content in fruiting bodies.

In presented study, examined mushroom species and strains contained different amounts of protein, fat, carbohydrates and ash in the fruiting bodies (Fig. 1).

Fruiting bodies of both strains of *P. eryngii* ('B124' and 'B127') contained the highest amount of protein (17.04 and 17.16 %, respectively). Those means were lower than reported by Breene [12] and Cheung [13] – 19.8 %, however higher than in the experiment of Dundar et al [14] – 11.95 %. Use of different cultivation substrates within mentioned experiments could be explanation of this fact. Dundar et al [14] grew *P. eryngii* on wheat stalk, which is much easier to decompose than sawdust used in our experiment. In our experiment the lowest amount of protein contained fruiting bodies of *A. polytricha*, only 6.66 %, which is generally much higher than reported by Mau et al [15] – 5.7 %. General investigation on amount of crude protein in *Auricularia* species showed range only from 4.2 % up to 5.52 % of dry matter in *A. auricula-judae* [4, 9]. Both strains of *L. edodes* contained similar amount of protein in fruiting bodies (14.73 % in 'SH27' and 14.48 % in 'SH37'), however 'SH27' tend to contain higher amount of protein (Fig. 1). Those amounts are comparable with results obtained by

Table 1

Chemical compositions of dried fruiting bodies of some mushrooms species and strains

Constituent	Kind of sawdust	*Lentinula edodes*		*Pleurotus eryngii*		*Auricularia auricula-judae*	*Auricularia polytricha*
		SH 37	SH 27	B124	B127		
		[%]					
Water	AS	8.10 ± 0.62 a	7.91 ± 0.28 a	10.82 ± 0.43 *a*	10.12 ± 0.11 *a*	11.21 ± 0.31 A	10.80 ± 0.72 A
	BS	8.16 ± 0.17 a	8.20 ± 0.36 a	10.24 ± 0.62 *a*	10.64 ± 0.81 *a*	10.98 ± 0.14 A	11.06 ± 0.58 A
Protein (Nx4.38)	AS	15.06 ± 0.68 a	14.84 ± 0.77 a	17.87 ± 0.09 *a*	18.35 ± 0.41 *a*	10.24 ± 0.54 A	6.30 ± 0.04 C
	BS	13.91 ± 0.53 b	14.00 ± 0.06 b	16.21 ± 0.12 *b*	15.98 ± 0.54 *b*	8.99 ± 0.41 B	7.03 ± 0.25 C
Fat	AS	2.60 ± 0.19 a	2.41 ± 0.21 a	2.21 ± 0.06 *a*	2.11 ± 0.11 *a*	1.00 ± 0.13 A	0.93 ± 0.08 A
	BS	2.63 ± 0.07 a	2.54 ± 0.17 a	2.34 ± 0.31 *a*	1.98 ± 0.43 *a*	1.02 ± 0.03 A	0.90 ± 0.11 A
Carbohydrates	AS	65.00 ± 0.58 b	66.12 ± 0.18 b	58.93 ± 0.17 *b*	59.13 ± 0.25 *b*	79.71 ± 0.38 B	81.22 ± 0.07 B
	BS	68.52 ± 0.72 a	68.41 ± 0.21 a	60.87 ± 0.10 *a*	62.03 ± 0.34 *a*	82.11 ± 0.54 A	83.30 ± 0.73 A
Ash	AS	6.81 ± 0.37 a	7.00 ± 0.11a	5.10 ± 0.39 *a*	5.12 ± 0.25 *a*	3.46 ± 0.90 A	3.02 ± 0.17 B
	BS	6.56 ± 0.61 a	6.98 ± 0.09 a	4.96 ± 0.21*a*	5.09 ± 0.08 *a*	3.91 ± 0.01 A	2.87 ± 0.37 B

AS – beech sawdust; BS – birch sawdust; Significant differences in contents of analyzed substances in dried mushrooms are marked with different letters.

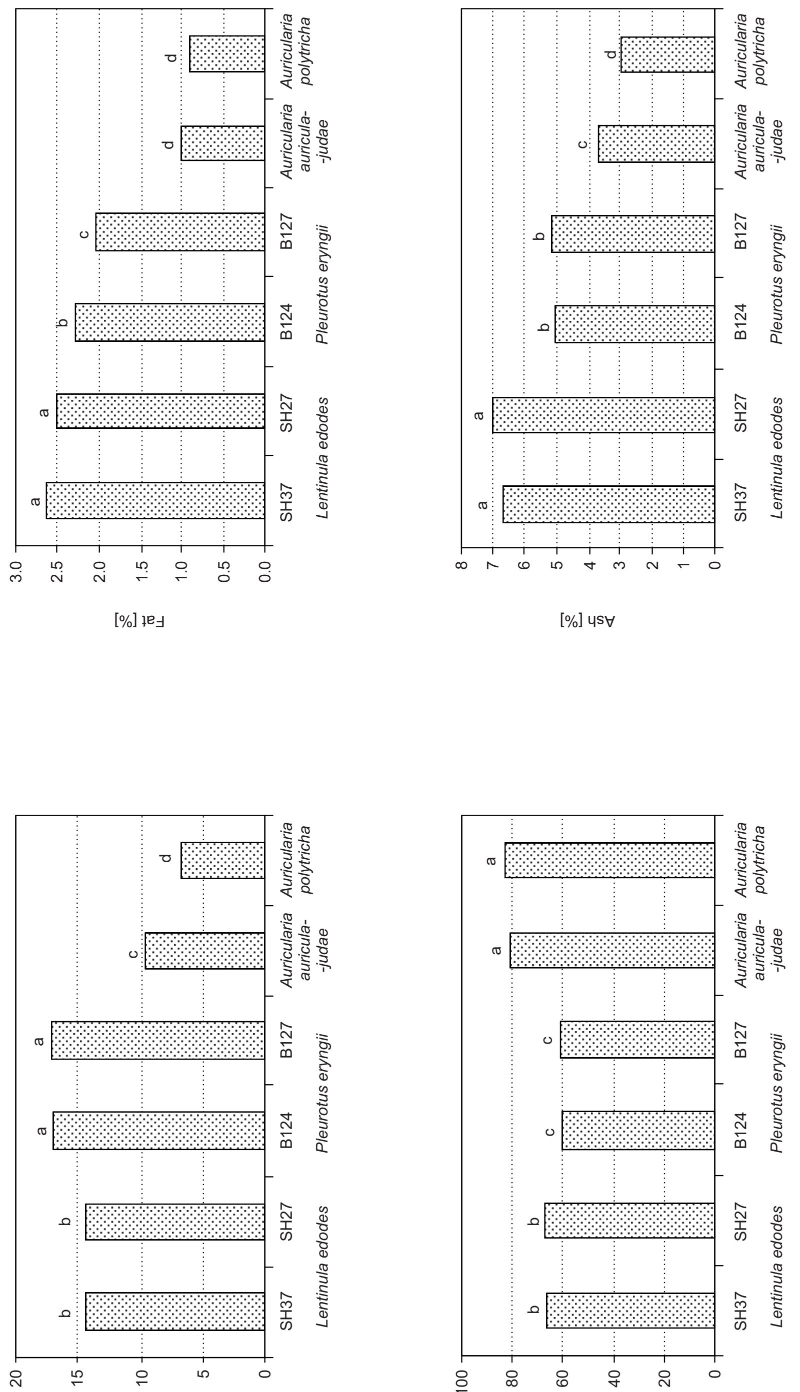

Fig. 1. Protein, fat, carbohydrates and ash content of dried fruiting bodies of some mushrooms species; Significant differences in contents of analyzed substances in dried mushrooms are marked with different letters

Chang and Miles [9] – 13.4–17.5 %, however much lower than those of later experiment by Regula and Siwulski [16] (17.2 %).

Mushrooms are shown to be low-fat products, and general content of crude fat in dry matter of *L. edodes* fruiting bodies according to many authors range from 1.3 % to 8.7 % [17, 18]. Two strains of *L. edodes* contained the highest value of crude fat (2.62 % in 'SH37' and 2.5 % in 'SH27') (Fig. 1) which is in accordance with investigation held by Regula and Siwulski [16] (2.89 %). *A. polytricha* contained the lowest amount of crude fat (0.92 %) and *A. auricula-judae* contained 1.01 % of crude fat, which is even lower than the results obtained by Shin et al [4] – 3.5 %. Lower fat contents are only noted by Mau et al (0.48 %) [15]. In the experiment conducted in 2008 by Dundar et al [14] the amount of fat content in *P. eryngii* was quite high (7.5 %), in our study the content of fat was much lower (2.28 % and 2.04 % in 'B124' and 'B127', respectively). Furthermore, those amounts are comparable with the results obtained by Cheung [13] (1.93 %).

The results of our studies showed that the carbohydrates contents ranged from 59.4 to 82.26 % in the following order: *P. eryngii*, *L. edodes*, *A. auricula-judae*, *A. polytricha* (Fig. 1). Other authors [4, 15, 19] report the carbohydrates content in *Auricularia* species range from 70 to 88 %. In our investigation the highest amount was observed in *A. polytricha* (82.26 %), which fits within the reported average. The lowest amount (59.4 %) of carbohydrates contained strain *P. eryngii* 'B124', however this was higher than noted in experiment carried out by Dundar et al [14] (39.85 %). In the earlier studies, Lasota and Sylwestrzak [17] reported the total carbohydrates content in fruiting bodies of *L. edodes* range from 30–38 %. Later, Regula and Siwulski [16] obtained in their experiment much higher content of carbohydrates, up to 66 %. This amount is similar to amount of carbohydrates obtained in our experiment.

The ash contents in the carpophores of investigated mushrooms was the highest in *L. edodes* and differed between strains, where the average amount of ash in 'SH27' was higher than in 'SH37' (6.99 % and 6.68 %, respectively) (Fig. 1). Those amounts are similar to those obtained by other authors [9, 16, 18]. The lowest amount of ash contained *A. polytricha* (2.94 %), regardless to the cultivation substrates, which is comparable with results obtained by Mau et al [7] – 2.5 %. It can be explained that the mushrooms with pileus and stipe tend to had higher level of ash compared with those without stipe [20, 21]. The content of ash in fruiting bodies of both strains of *P. eryngii* in our investigation ranged from 5.03 % to 5.1 % for 'B124' and 'B127', respectively and is comparable with earlier experiments conducted by Cheung [13] (5.18 %) and Dundar et al [14] (4.89 %).

The differences between the chemical compositions of mushrooms investigated in this study can of course be caused by use of different growing substrate, morphogenetic differences between the species and special individual character of the selected species and strains. The biological efficiency of the substrate is one of the key factors here.

For the reason that data on the nutritive value of described mushrooms grown on common and cheap substrates such as: wheat straw, beech or birch sawdust are limited in Poland, there is a strong need of conducting further experiments.

Conclusions

1. Cultivation substrates influenced chemical composition of fruiting bodies of investigated mushrooms, especially the content of protein and carbohydrates. Higher amount of protein was noted in fruiting bodies of mushrooms cultivated on beech sawdust, while carbohydrates content was higher on birch sawdust substrate.

2. The fruiting bodies of tested mushroom species differed in content of protein, carbohydrates, fat and ash. Fruiting bodies of *P. eryngii* contained the highest amount of protein; while fruiting bodies of *L. edodes* had the highest content of fat and ash. The highest amount of carbohydrates was observed in fruiting bodies of *Auricularia* genus.

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PORÓWNANIE SKŁADU CHEMICZNEGO OWOCNIKÓW WYBRANYCH GRZYBÓW UPRAWIANYCH NA PODŁOŻU Z TROCIN

Katedra Warzywnictwa
Uniwersytet Przyrodniczy w Poznaniu

Abstrakt: Określono skład chemiczny owocników wybranych grzybów uprawnych: dwóch odmian *Lentinula edodes*; dwóch odmian *Pleurotus eryngii*, *Auricularia auricula-judae* oraz *A. polytricha.* Uprawę prowadzono na dwóch rodzajach trocin: brzozowych i bukowych. Określono zawartość białka, tłuszczu, węglowodanów oraz popiołu w owocnikach badanych grzybów.

Uzyskane wyniki wykazały wpływ rodzaju trocin na skład chemiczny owocników badanych gatunków i odmian grzybów jadalnych. Najwyższą zawartością białka charakteryzowały się owocniki *P. eryngii*, natomiast owocniki *L. edodes* zawierały największą ilość tłuszczu i popiołu. Owocniki grzybów z rodzaju *Auricularia* charakteryzowały się największą zawartością węglowodanów.

Słowa kluczowe: *Lentinula edodes*, *Pleurotus eryngii, Auricularia auricula-judae, Auricularia polytricha,* owocniki, skład chemiczny, trociny