COMPARATIVE RESEARCH FOR THE INFLUENCE OF DRYING TECHNOLOGY ON THE CHEMICAL COMPOSITION OF *CHANTERELLE* (*Cantharellus cibarius*) AND *PORCINI* MUSHROOMS (*Boletus edulis*)

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Abstract: The aim of this research was to determine the differences in the chemical composition between fresh and dried *chanterelle* and *porcini* mushrooms. The quality properties were determined by determining the mechanical and the chemical properties. The research was done in 2014. Drying was made in ventricular drier with heated air. The principle of drying is accurately performed to obtain characteristic odor and appearance of the mushroom. All of determined components had higher values in both of dried *chanterelle* and *porcini* mushrooms, compared with fresh ones. The content of total dry matters was higher in dried *porcini* mushrooms (93.48%) and *chanterelle* mushrooms (92.40%) compared with fresh mushrooms (24.70% in *porcini* mushrooms, and 22.90% in *chanterelle* mushrooms). The content of total acids in dry *porcini* mushrooms was 0.40%, but in *chanterelle* mushrooms was 0.48%. Its value in fresh *porcini* mushrooms was 0.13% and in *chanterelle* mushrooms was 0.16 %. The content of vitamin C in dried *porcini* mushrooms was 12.70 mg/100g, and 13.90 mg/100 g in *chanterelle* mushrooms. In the fresh *porcini* mushrooms the value of vitamin C was 9.20 mg/100 g i.e. 9.15 mg/100 g in the fresh *chanterelle* mushrooms. The value of mineral matters in dried *porcini* mushrooms was 3.80% and in dried *chanterelle* mushrooms was 3.50%. The value of mineral matters was 0.75% in fresh *porcini* mushrooms and 0.90% in fresh *chanterelle* mushrooms. Drying in ventricular drier is fast method which reduces the necessary water quantity, inactivates the enzymes and reduces microorganism's metabolism. This is a basic principle in product conserving and storage for a longer period.

Key words: chemical composition, mushrooms, ventricular drying.

Introduction

Mushrooms are terrestrial organisms, without chlorophyll, eukaryotic and saprophytic ogranisms (Royse et al., 1985; Turner, 1988). Their fruitful bodies are excellent food for human nutrition. They have exotic taste and pronounced aromatic smell. They can be used both in fresh and in processed form (Ahmed, 1986; Eswaran et al., 2000; Shah et al., 2004).

Chanterelle (*Cantharellus cibarius*) is the best known edible mushroom from *chanterelle* family (*Cantharellaceae*). It looks like a duck leg with color as the egg yolk

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is or a little red and yellow in the middle (Choi et al., 2006). It grows in deciduous and coniferous forests, as a rule in the colonies, rarely individually. Time of growing is from late spring until winter, but looking rains and if not, this mushroom do not appear, or only in small quantities (Dundar et al., 2009; Chang et al. 1987).

Chanterelle mushroom is very tasty with top quality and diverse use. Mushrooms have excellent nutritional values. The meat is white, compact with a pleasant smell. Nutrients from this mushroom in the human body have three main functions: building function, power source and mechanism for protection. *Chanterelle* mushrooms belong to the highest quality mushrooms. They can be consumed fresh as well as processed. In addition to being a real delicacy and they have medicinal properties, too. They are known as a good source of minerals, vitamins A, B complex, enzymes, polysaccharides, proteins. It contains eight essential amino acids (Bano et al., 1986; Mattila et al., 2001). The minerals that are most common are calcium, potassium, phosphorus, iron, magnesium and zinc.

Porcini mushrooms (*Boletus edulis*) or summer mushroom is growing from early June to late July and from September until the end of October. It grows on bush, birch and mixed forests at altitude of 1200 m, but on the other hand it can be seen through the meadows. It has a special taste and great nutritional value. It has a semicircular cap with light to dark brown. This mushroom grows after the summer rains in a semicircle hidden under leaves (Bonatti et al., 2004). *Porcini* is a high quality mushroom easily dried and transported (Burnett et al., 1988; Das et al., 2007). This mushroom is widespread in many meridians. There are several types but some of them are not for consumption.

Because of the chemical composition and nutritional value, mushrooms are healthy, tasty and non-contaminated food (Sun and Jian-Jun, 1989; Khydagi et al., 1998).

The content of nutrients in mushrooms depends on the origin of the mycelium from the substrate, conditions and methods of cultivation (Chang et al., 2004; Oseni et al., 2012).

The chemical composition of the mushrooms has an essential importance for human nutrition as well as for choosing of technological method for processing. It has an influence on the final products (Baughman, 1989; Harris et al., 1986; Sonali and Randive, 2012).

In the Republic of Macedonia, these mushrooms are widely distributed in nature. But the rise in production with the application of modern technology in the manufacturing industry is growing. From the processed form, the most used is dried mushroom.

The aim of this research was to determine the differences in the chemical composition between fresh and dried *chanterelle* and *porcini* mushrooms.

Material and methods

In this research, as a work material were used fresh and ventricular dried *chanterelle* and *porcini* mushrooms. In the Republic of Macedonia analyzed mushrooms are widespread. Both of mushrooms for this research were picked from Baba Mountain. *Chanterelle* mushrooms were picked in April 2014 and *porcini* mushrooms were picked

in the end of June 2014. Both of them were picked when the cap was approximately 70 percent open that is when the mushroom caps were still slightly curled under. The quality properties of the analyzed mushrooms were determined with determining the mechanical and the chemical properties. Research was made in 2014.

The mechanical properties were determined only in fresh *chanterelle* and *porcini* mushrooms. From the mechanical properties were determined the diameter of the mushroom cap and the length of the mushroom stalk.

The chemical composition of fresh and dried mushrooms was determined. The drying was made in the ventricular drier with heated air. The principle of drying was accurately performed to obtain characteristic odor and appearance of the mushroom.

The following chemical properties of fresh and dried *chanterelle* and *porcini* mushrooms were determined:

- Content of total dry matter - determined by drying the material in dryer at a temperature of 105°C (Sarić et al., 1989);
- Moisture content – determined by calculation that 100 % will be deducted % of total dry matter;
- Content of vitamin C - determined by the Thilmans method based on the redox reaction between L-ascorbic acid and organic color 2.6 dichlorophenolindophenol;
- Total acid content - determined by the method of neutralization with 0.1 M NaOH solution in the presence of the indicator 1 % solution of phenolphthalein indicator;
- Content of total carbohydrates - determined by HPLC method;
- Content of mineral matter (ash) - determined with material burning at a temperature of 500 °C;
- Content of nitrogen (N) - determined using Kjeldhl method (Sarić et al., 1989);
- Content of phosphorus (P_2O_5) - determined by using atomic emission spectrometry with inductively coupled plasma (ICP - AEC) (Sarić et al., 1989);
- Content of potassium (K_2O) - determined by incineration of the material with concentrated H_2SO_4 and plamenfotometar (Sarić et al., 1989);
- Content of calcium (SAT) - determined by using atomic emission spectrometry with inductively coupled plasma (ICP - AEC) (Sarić et al., 1989);
- Content of magnesium (Mg) - determined by applying atomic; emission spectrometry with inductively coupled plasma (ICP - AEC) (Sarić et al., 1989);
- Proteins – determined with calculation when the % N is multiplying with coefficient 6.25.

In the dried *chanterelle* and *porcini* mushrooms were made two pretreatments, and three variants were getting: variant M1 – control variant; variant M2 – where the pretreatment was made with 2% solution of ascorbic acid for 5 minutes; variant M3 – where the pretreatment was made with 3% solution of potassiummetabisulphite for 5 minutes. The content of mineral matters nitrogen, phosphorus, potassium, calcium and magnesium was analyzed only in the variants of dried *chanterelle* and *porcini* mushrooms.

Results and discussion

The mechanical and the chemical content are specific for each kind of mushrooms. The mechanical properties are basic requirement for cost-effective production of mushrooms. Size is an important characteristic for each mushroom kind. By analyzing the mechanical properties, is determined the weight ratio of separate parts of the mushrooms (cap diameter and stalk length) in percentage (San and James, 1981; Wilcke et al., 1989). Chemical composition of the mushrooms means the content of all ingredients in the mushroom including the water (Brauer et al., 2002).

The mechanical properties were determined with measuring of 50 *chanterelles* and 50 *porcini* mushrooms. According to the results of measuring was determined that the average cup diameter of *chanterelles* mushrooms was 8.20 cm and the average stalk length of *chanterelles* mushrooms was 7.10 cm.

The average cup diameter of *porcini* mushrooms was 15.40 cm and the average stalk length of *porcini* mushrooms was 8.50 cm. Ajonina and Tatah (2012) observed that the stalk length of *porcini* mushrooms is 2.43 to 3.24 cm.

The results of the chemical composition of both *chanterelles* and *porcini* mushrooms are shown in the tables.

Tabela 1. Hemiski sastav sveze gljive lisicarka i vrganj
Table 1. Chemical composition of fresh chanterelle and porcini mushrooms

Komponente *Components*	Sveza lisicarka Fresh *chanterelle* mushrooms	Svez vrganj Fresh *porcini* mushrooms
Ukupna voda (%) *Total water (%)*	77.10	75.30
Ukupne suve materija (%) *Total dry matters (%)*	22.90	24.70
Ukupne kiseline (%) *Total acids (%)*	0.12	0.11
Vitamin C mg/100g *Vitamin C mg/100g*	9.15	9.20
Mineralna materija (%) *Mineral matters (ash) (%)*	0.90	0.75
Ukupne jaglehidrate (%) *Total carbohydrates (%)*	4.50	4.90

Tabela 2. Hemiski sastav susene gljive lisicarka po varijantama
Table 2. Chemical composition of dried chanterelle mushrooms per variants

Komponente *Components*	**M1**	**M2**	**M3**
Ukupna voda (%) *Total water (%)*	7.70	7.60	8.40
Ukupne suve materije (%) *Total dry matters (%)*	92.30	92.40	91.60
Ukupne kiseline (%) *Total acids (%)*	0.36	0,25	0,27
Vitamin C mg/100g *Vitamin C mg/100g*	12.55	13.90	12.40
Mineralna materija (%) *Mineral matters (ash) (%)*	3.50	3.20	3.00
Ukupne jaglehidrate (%) *Total carbohydrates (%)*	8.80	7.90	7.30
N (%)	2.35	1.95	1.70
P (%)	1.35	1.20	0.95
K (%)	1.23	1,17	1.25
Ca (%)	3.90	3.20	3.60
Mg (%)	1.95	1.60	1.80
Proteini (%) *Proteins (%)*	14.68	12.19	10.62

Tabela 3. Hemiski sastav susene gljive vrganj po varijantama
Table 3. Chemical composition of dried porcini mushrooms per variants

Komponente *Components*	**M1**	**M2**	**M3**
Ukupna voda (%) *Total water (%)*	6.60	6.52	6.85
Ukupne suve materije (%) *Total dry matters (%)*	93.40	93.48	93.15
Ukupne kiseline (%) *Total acids (%)*	0.35	0.33	0.32
Vitamin C mg/100g *Vitamin C mg/100g*	12.00	12.70	12.40
Mineralna materija (%) *Mineral matters (ash) (%)*	3.80	3.30	3.00
Ukupne jaglehidrate (%) *Total carbohydrates (%)*	7.50	6.30	7,00
N (%)	2.50	2,00	1.75
P (%)	1.20	1,00	1.10
K (%)	1.05	1.25	1.30
Ca (%)	3.30	3.00	2.40
Mg (%)	2.20	2.10	2.15
Proteini (%) *Proteins (%)*	15.62	12.50	10.94

From the data shown in Table 1 and Table 2, can be concluded that the content of total water was higher in the fresh *chanterelle* mushrooms where its value was 77.10%, and in the dried mushrooms the highest content of total water had variant M3 (8.40%). Jamalali et al (2009) found that the content of total water in fresh *chanterelle* mushrooms is 76.50 - 78.50%. The content of total dry matters is in correlation with the content of total water and its value was 22.90% in the fresh, but 92.40% in the variant M2 from dried *chanterelle* mushrooms. Fresh *chanterelle* mushrooms had lower content of total acids (0.12%) compared to dried mushrooms from the variant M1 (0.36%). The vitamin C in fresh mushrooms was presented with 9.15 mg/100g and in dried *chanterelle* mushrooms the content of vitamin C was the highest in variant M2 (13.90 mg/100g) where the pretreatment was made with 2% solution of ascorbic acid. According to Sadler (2003) the content of vitamin C in fresh *chanterelle* mushrooms is 7.30 mg/100g. Fresh *chanterelle* mushrooms contained 0.90% mineral matters, compared to dried mushrooms from the variant M1, where its content was 3.50%. The content of total carbohydrates in the fresh mushrooms was lower (4.50%), compared to dried *chanterelle* mushrooms from the variant M1 (8.80%). The content of mineral matters: nitrogen (2.35%), phosphorus (1.35%), calcium (3.90%) and magnesium (1.95%) were the highest in dried *chanterelle* mushrooms from the variant M1. The content of potassium (1.25%) was the highest in dried mushrooms from the variant M3, where the pretreatment was made with 3% solution of potassiummetabisulphite. The content of proteins is in correlation with the nitrogen content, and its value was the highest in dried *chanterelle* mushrooms from the variant M1 (14.68%).

From the data shown in Table 1 and Table 3, can be concluded that the content of total water was higher in the fresh *porcini* mushrooms where its value was 75.30%, and in the dried mushrooms the highest content of total water had variant M3 (8.40%). The content of total dry matters is in correlation with the content of total water and its value was 24.70% in the fresh, but 93.48% in the variant M2 from dried *porcini* mushrooms. Fresh *porcini* mushrooms had lower content of total acids (0.11%) compared to dried mushrooms from the variant M1 (0.35%). According to Demirbaş (2001) the content of total dry matters in dried *porcini* mushrooms with no pretreatments is 91.00-94.00%. The vitamin C in fresh mushrooms was presented with 9.20 mg/100g and in dried *porcini* mushrooms the content of vitamin C was the highest in variant M2 (13.90 mg/100g) where the pretreatment was made with 2% solution of ascorbic acid. Fresh *porcini* mushrooms contained 0.75% mineral matters, compared to dried mushrooms from the variant M1, where its content was 3.80%. The content of total carbohydrates in the fresh mushrooms was lower (4.90%), compared to dried *porcini* mushrooms from the variant M1 (7.50%). Dan et al. (2010) found that the content of total carbohydrates in fresh *porcini* mushrooms is 5.50-6.50%. The content of mineral matters: nitrogen (2.50%), phosphorus (1.20%), calcium (3.30%) and magnesium (2.20%) were the highest in dried *porcini* mushrooms from the variant M1. The content of potassium (1.30%) was the highest in dried mushrooms from the variant M3, where the pretreatment was made with 3% solution of potassiummetabisulphite. The content of proteins is in correlation with the nitrogen content, and its value was the highest in dried *porcini* mushrooms from the variant M1 (15.62%).

From the presented data can be concluded that *chanterelle* and *porcini* mushrooms are suitable for ventricular drying because their chemical composition after drying does not change in a negative direction. From the varieties of dried mushrooms, the variant M1 which had no pretreatment had the best chemical composition. Therefore, this variant is recommended for consumption as food with rich chemical composition and excellent nutritional properties.

Conclusion

Based on this research and the results for determining the influence of ventricular drying technology on the chemical composition of *chanterelle* and *porcini* mushrooms, can be concluded that in both of *chanterelle* and *porcini* mushrooms M1 variant, which had no pretreatment, was characterized with the best chemical composition. *Chanterelle* mushroom had higher content of total water, total acids, mineral matters, calcium and magnesium in M1 variant. The content of the other parameters: total dry matters, vitamin C, total carbohydrates, nitrogen, phosphorus, potassium, calcium and proteins were higher in M1 variant of *porcini* mushrooms.

From the presented data can be concluded that both of the analyzed mushrooms are suitable for ventricular drying, because their chemical composition after drying does not change in negative direction. *Porcini* mushrooms were characterized with better chemical composition, but on the other hand they are widespread in the Republic of Macedonia, compared to *chanterelle* mushroom. Because of that, *porcini* mushrooms are recommended for consummation, as food with rich chemical composition and excellent nutritive values.

Ventricular drying is in the initial stage in our country. With the introduction of ventricular dryers in general practice will increase the income of farmers, production, employment and foreign exchange inflow into the country.

References

Ahmed, I. (1986). Some studies on oyster mushroom (Pleurotus spp) on waste material for corn industry. M. Sc. Thesis, University of Agriculture, Faisalabad, Pakistan, 55-59.

Bano, Z. (1976). The nutritive values of mushrooms. In Proceeding of the first symposium on survey and cultivation of edible mushrooms in India Vol. II: 172. R.R.L. Shrinagar, 121-125.

Brauer, D., Kimmons, T., Phillips, M. (2002). Effects of management on the yield and highmolecular-weight polysaccharide content of shiitake (*Lentinula edodes*) mushrooms. Journal of Agricultural and Food Chemistry Vol. 50 (19), 333-337.

Bonatti, M., Karnopp, P., Soares, H.M., Furlan, SA. (2004). Evaluation of Pleurotus ostreatus and P. sajor-caju nutritional characteristics when cultivated on different lignocellulosic wastes. Food Chemistry, 88, 425-428.

Burnett, C. (1988). Porcini mushroom production: good food combines good forestry and good economics. In Illinois Forest Management. Cooperative Extension Service. Univercity of Illinois. Urbana, Illinois. Vol. 2 (15), 1-4.

Chang, S.T. (1987). World production of cultivated edible mushrooms in 1986. Mushroom Journal Tropics Vol. VII (4), 117-120.

Chang, S.T., Miles, P.G. (2004). Mushrooms: Cultivation, nutritional value, medicinal effect, and environmental impact. Second Edition. CRC Press, Boca Raton, Fla, 451-455.

Choi, Y., Lee, S., Chun, J., Lee, H., Lee, J. (2006). Influence of heat treatment on the antioxidant activities and polyphenolic compounds of chanterelle mushroom. Food Chem, Vol. 99 (2), 381.

Dan Zhang, Aneta Frankowska, Gra yna Jarzyska, Anna K. Kojta, Małgorzata Drewnowska, Daria Wydmaska, Leszek Bielawski, Jipeng Wang, Jerzy Falandysz (2010). Metals of King Bolete (Boletus edulis) Bull.: Fr. collected at the same site over two years. African Journal of Agricultural Research Vol. 5(22), pp. 3050-3055.

Das, N., Mukherjee, M. (2007). Indoor Cultivation of P. ostreatus. Philo Agric 61: 253-262.

Demirbaş A. (2001). Concentrations of 21 metals in 18 species of mushrooms growing in the East Black Sea region. Food Chem 75: 453-457.

Dundar, A., Acay, H., Yildiz, A. (2009). Effect of using different lignocellulosic wastes for cultivation of Pleurotus ostreatus (Jacq.) P. Kumm. On mushroom yield, chemical composition and nutritional value. Afr. J. Biotechnol. 8(4): 662-666.

Eswaran, A., Ramabadran, R. (2000). Studies on some physiological, cultural and post harvest aspects of oyster mushroom, Pleurotus ostreatus. Tropi Agric Res 12: 360 – 374.

Harris, B. (1986). Growing shiitake commercially. Science Tech Publishers, Madison, Wisconsin, 69-72.

Jamalali Olfati, Gholamali Peyvast, Yaqvob Mami (2009). Identification and chemical properties of popular wild edible mushrooms from northern Iran. Journal of Horticulture and Forestry Vol. 1(3) pp. 048-051.

Khydagi, K.S., Sharada, G.S., Meera, R. (1998). Proximate Composition of Oyster mushrooms. Karnataka Journal Agricultural Sciences. 11(2): 548.

Mattila, P., Kanko, K., Earola, M., Pihlava, J.M., Astola, J., Vahterist, L. (2001). Contents of vitamins, mineral elements, some phenolic compounds in cultivated mushrooms. Journal of Agriculture and Food Chemistry, 49: 2343–2348.

Oseni, T.O., Dlamini, S.O., Earnshaw, D.M., Masarirambi, M.T. (2012). Effect of substrate pre-treatment methods on Oyster mushroom (Pleurotus ostreatus) production. Int. J. Agric. Biol., 14: 251-255.

Royse, D.J., Schisler, L.C., Diehle, D.A. (1985). Shiitake Mushrooms: consumption, production and cultivation. Interdisciplinary Science Reviews, Vol. 10 (4), 329-335.

Sadler, M. (2003). Nutritional properties of edible fungi. British Nutrition Foundation Nutrition Bulletin, 28: 305-308.

San, A., James, P. (1981). Cultivation of the shiitake mushroom. Hort Science, Vol. 16 (2), 151-156.

Sarić, M., Stanković, Z., Krstić, B. (1989). Plant physiology, Science book, Novi Sad, Serbia.

Sonali, D. Randive. (2012). Cultivation and study of growth of oyster mushroom on different agricultural waste substrate and its nutrient analysis. Pelagia Research Library 3 (4): 1938-1949.

Sun, P., Jian-Jun, Y. (1989). The cultivation of Pleurotus mushrooms on sterilized substrate in the field. Mushroom Science 12(2): 219-228.

Shah, Z., Ashraf, M., Ishtiaq, M. (2004). Comparative study on cultivation and yield performance of oyster mushroom (Pleurotus ostreatus) on different substrates (wheat straw, leaves, sawdust). Pakistan Journal of Nutrition. 2004:3(3): 158-60.

Turner, S. (1988). The new fungus among us. Extension Review, Vol. 59 (2), 18-20.

Wilcke, W.F., Haugh, S.G., Diehl, K., Coale, W. (1989). Design of a shiitake mushroom packing line. Applied Engineering in Agriculture, Vol. 5 (3), 405-411.