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THE INFLUENCE OF DRYING TECHNOLOGY ON THE CHEMICAL CONTENT OF *SHIITAKE* MUSHROOMS

SUMMARY

In the Republic of Macedonia *shiitake* mushroom is grown in little spaces. It is used for consummation fresh, as well as processed. From the processed forms widely used is dried mushroom. The mushrooms chemical content has an essential importance for human diet and for the technological process, too. Chemical content of fresh mushrooms is important for choosing the technological processes and for products quality properties. The aim of this research was to determine the differences of the chemical content of both fresh and dried *shiitake* mushrooms. The quality properties were determined by determining the mechanical and the chemical properties. Research was made in 2013. 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 have higher values in dried mushrooms, compared with fresh ones. The content of total dry matters is higher in dried mushrooms (92.20%) compared with fresh mushrooms (25.20%). The content of total acids in dried mushrooms is 0.48% and its value in fresh mushrooms is 0.16 %. The content of vitamin C in dried mushrooms is 13.53 mg %, but in the fresh ones is 8.24 mg %. The value of mineral matters is 4.80% in dried and 1.00 % in fresh mushrooms. Drying in ventricular drier is fast method which reduces the necessary water quantity, inactivates the enzymes and reduces microorganism's metabolism. This is basic principle in product conserving and storage for a longer period.

Keywords: mushrooms, ventricular drying, chemical content

INTRODUCTION

Shiitake mushrooms (*Lentinus edodes*) have an origin from south Asia, China and Japanese, and the first written records were found 2000 years ago. This kind of mushrooms was grown approximately 300 years ago (Chang, 1987). In Asia, *shiitake* mushrooms were known for its characteristic smell, taste and medicinal properties. The beginnings of cultivation of *shiitake* mushrooms are recorded in Sung Dynasty of China (year of 960). In the nature, this kind of

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mushrooms grow on dry and broadleaf trees, on the shii tree (*Castanopsis cuspidate*), as well as in many kinds of oaks and beeches (Burnett, 1988).

In Europe, the first producers of *shitake* mushrooms appeared in 20th century. The knowledge for the big value of this mushroom as food, and especially as raw for pharmaceutics industry, is the main reason for intensive the new technologies adapted on the European areas (Harris, 1986).

Systematically, *shiitake* mushroom belongs to the class *Basidiomycetes*, underclass *Holobasidiomycetes*, genus *Agaricales*, row *Lentinus* and kind *Lentinus edodes*.

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. Very important factor in production of *shiitake* mushrooms is having adequate nutrition, because it has big influence on the yield, the size of biomass, and the time between yields, too (Choi et al., 2006). Commonly used substrates are straw, compost, sawdust or other organic matter. *Shiitake* mushrooms have excellent nutritive values. The nutritive matters from the mushrooms have three basic functions in the human body, such as: building function, energy source and protecting mechanism (Turło et al., 2010). *Shiitake* mushrooms are source of mineral matters, vitamins and essential amino acids, too. The nutritive values of the mushrooms depend on the origin of the mycelium from the substrate, conditions and the methods of growth. On the other hand, in *shiitake* mushrooms there are antibiotic substances, too. (Chang and Miles, 2004).

The chemical content 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). In the Republic of Macedonia, *shiitake* mushrooms are grown in very small areas. But the rise in production by applying modern technology in the processing industry is growing. From the processed forms, the most used is dried mushroom.

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

MATERIAL AND METHODS

In this research, as a work material were used fresh and ventricular dried *shiitake* mushrooms. This kind of mushrooms, in the Republic of Macedonia, grows in very small quantities. The mushrooms for this research were picked from Baba Mountain. *Shiitake* mushroom were picked when the cap was approximately 70 percent open, i.e. 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 2013.

The mechanical properties were determined only in fresh *shiitake* mushrooms. From the mechanical properties were determined the diameter of the

mushroom cap and the length of the mushroom stalk. The chemical content 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 *shiitake* mushrooms were determined:

Content of total dry matter - determined by drying the material in dryer at a temperature of 105°C;

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 *shiitake* 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 *shiitake* mushrooms.

RESULTS AND DISCUSSION

The mechanical and the chemical content is 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 *shiitake* mushrooms. According to the results of measuring was determined that the average diameter of the mushroom cup is 8.60 cm and the average length of the mushroom stalk is 4.10 cm.

The results of the chemical composition of *shiitake* mushrooms are shown in the next tables.

Table 1. Chemical content of fresh *shiitake* mushrooms

Components	**Fresh *shiitake* mushrooms**
Total water (%)	74.80
Total dry matters (%)	25.20
Total acids (%)	0.16
Vitamin C mg/100g	8.24
Mineral matters (ash) (%)	1.00
Total carbohydrates (%)	4.20

Table 2. Chemical content of dried *shiitake* mushrooms per variants

Components	**M1**	**M2**	**M3**
Total water (%)	7.80	7.90	7.95
Total dry matters (%)	92.20	92.10	92.05
Total acids (%)	0.48	0.43	0.40
Vitamin C mg/100g	13.53	14.70	13.00
Mineral matters (ash) (%)	4.80	4.70	4.65
Total carbohydrates (%)	7.10	6.40	6.60
N (%)	2.10	1.70	1.80
P (%)	1.29	0.90	1.00
K (%)	1.15	1.10	1.26
Ca (%)	4.15	4.00	4.02
Mg (%)	2.58	2.40	2.50
Proteins (%)	13.16	10.63	11.25

From the data shown in Table 1 and Table 2, can be concluded that the content of total water is higher in the fresh mushrooms where its value is 74.80%, and in the dried mushrooms the highest content of total water has variant M3 (7.95%). The content of total dry matters is in correlation with the content of total water and its value is 25.20% in the fresh i.e. 92.20% in the variant M1 from dried *shiitake* mushrooms. Fresh *shiitake* mushrooms have lower content of total acids (0.16%) compared with dried mushrooms from the variant M1 (0.48%). The vitamin C in fresh mushrooms is presented with 8.24 mg/100g and in dried *shiitake* mushrooms the content of vitamin C is the highest in variant M2 (14.70 mg/100g) where the pretreatment was made with 2% solution of ascorbic acid.

Fresh *shiitake* mushrooms contain 1% mineral matters, compared with dried mushrooms from the variant M1, where its content is 4.80%. The content of total carbohydrates in the fresh mushrooms is lower (4.20%), compared with dried *shiitake* mushrooms from the variant M1 (7.10%). The content of mineral matters: nitrogen (2.10%), phosphorus (1.29%), calcium (4.15%) and magnesium (2.58%) is the highest in dried *shiitake* mushrooms from the variant M1. The content of potassium (1.26%) is 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 is the highest in dried *shiitake* mushrooms from the variant M1 (13.16%).

From the presented data can be concluded that *shiitake* mushrooms are suitable for ventricular drying, because their chemical content after drying does not change in negative direction. From this three variant of dried mushrooms, the variant M1 which has no pretreatment, is characterized with the best chemical content. Because of that, this variant is recommended for consummation, as food with rich chemical content and excellent nutritive values.

CONCLUSIONS

Based on this research and the results for determining the influence of ventricular drying technology on the chemical composition of *shiitake* mushrooms, the following conclusions can be made:

- The chemical content of the mushrooms has an essential importance for human nutrition as well as for choosing of technological method for processing;
- In all of the variants of ventricular dried *shiitake* mushrooms is determined higher content of all parameters compared with fresh *shiitake* mushrooms;
- The content of dry matters is lower in fresh mushrooms, where its value is 25.20%, compared with dried mushrooms, where the highest content of dry matters has the variant M1 (92.20);
- The content of vitamin C is the highest in the variant M2 (14.70%), compared with fresh mushrooms (8.24%);
- Dried *shiitake* mushrooms from the control variant M1, have the highest content of nitrogen, phosphorus, calcium, magnesium and proteins;
- Dried *shiitake* mushrooms from the variant M1, which have no pretreatment, are characterized with the best chemical properties;
- 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.

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