



THE INFLUENCE OF FROZEN STORAGE ON SOME COMMERCIAL MUSHROOMS

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Abstract: *The aim of our study was to determine some specific parameters of two mushroom species that were frozen and stored under freezing conditions for six months. The sensorial variation of thawed mushrooms was also analyzed. With reference to macronutrients, reducing sugars and total protein were determined. We found that Agaricus mushrooms had a larger amount of reducing sugars than Pleurotus and after six months of frozen storage, Agaricus showed a decrease in reducing sugars amount by 2.38% and Pleurotus by 7.69%. The total protein content was higher for Agaricus than for Pleurotus, and after six months of frozen storage Agaricus showed a diminution of 5.17% and Pleurotus a diminution of 8.74%. A biochemical analysis was made in order to study peroxidase enzyme. The initial value of peroxidase was 0.78 abs/g for Agaricus and 0.48 abs/g for Pleurotus. The variation of two micronutrients: niacin and ascorbic acid were also determined. Niacin was found in high amount in both mushroom species and after frozen storage it decreased slightly. Ascorbic acid decreased dramatically at frozen storage. After the first month of storage the ascorbic acid amount in Agaricus decreased by 64.43% and in Pleurotus by 34.56%. After six months of storage, it decreased by 76.73% and by 76.91% respectively. The sensorial analysis showed that the firmness, appearance and taste of Agaricus and Pleurotus were lower after six months of storage.*

Keywords: *Agaricus bisporus, Pleurotus ostreatus, niacin, peroxidase.*

1. Introduction

In Romania *Pleurotus ostreatus* and *Agaricus bisporus* are the most commercialized species of mushrooms in markets. Mushrooms are largely consumed due to their great nutritional value and content in proteins and vitamins. *Agaricus bisporus*, *Lentinula*, *Pleurotus* and *Flammulina* are the most cultivated mushrooms worldwide [1, 15] because those mushrooms require shorter growth time compared to other edible mushrooms, also they demand few environmental controls and can be cultivated in a simple and cheap way [5]. Raw mushrooms are a very perishable food and its shelf life

varies between 3 and 5 days when stored at 0 to 2°C [11, 13]. But when stored at ambient conditions, raw, fresh mushrooms have a shelf-life of 24 hours [8]. After harvesting, mushrooms loose quality because of: enzymatic browning, microbial decay, moisture loss, tissue softening, development of some off-flavors, etc. Therefore, mushrooms need to be preserved properly to extend use time. dehydrated and drying can be used as preservation methods [10]. These two methods of water elimination from mushrooms are the most commonly used for preservation.

Giri [8] remarks that dehydrated mushrooms are valuable ingredients in a variety of sauces and soups.

Arora [2] and Tuley [19] mention that dehydrated mushrooms are used as an important ingredient in several food formulations including instant soups, pasta, salads, meat, snack seasonings, stuffing, casseroles and rice dishes.

They can also be preserved by tinning (canning) [9, 10, and 17]. Guillamon [9] sustains that freeze-dried mushrooms have a long shelf-life, present better structural integrity and flavor retention. Bernas [4] and Czapski [6] state that freezing is one of the best postharvest preservation methods. Sloan [17] affirms that the dominant trend in modern food processing technology is towards convenience foods of the “ready-to-cook” type, which can be consumed after thermal treatment, as well as “ready-to-heat” and “ready-to-eat” type foods which can be preserved by frozen or canning.

Usually, before applying the mentioned preservation methods, mushrooms are blanched. Blanching is an important operation during mushroom processing because it inactivates the polyphenol oxidase enzyme, which is responsible for browning of mushroom.

The objective of this work is to determine some physicochemical parameters and sensorial characteristics of frozen stored mushrooms cultivated in Romania.

2. Materials and methods

Materials

The studied mushrooms are: *Agaricus bisporus* and *Pleurotus ostreatus*, first quality, purchased in refrigerated and packaged state from a local market. After a minimum processing: washing in cold water, blanching in hot water at 95 to 99°C for 10 minutes, water cooling at 15 to

20°C, cutting in slices of two millimeter thick, cooling in an ice-water mixture at final temperature of 2 to 4°C, water draining with a strainer, the mushrooms were frozen at -20°C using Platilab 500 freezer (Angelantoni Industrie, Italy) and stored in frozen state for six months.

Physicochemical evaluation

Fresh and thawed samples of *Pleurotus ostreatus* and *Agaricus bisporus* were subjected to several analyses: dry matter by AOAC 984.13 method [3], reducing sugar by Schrool method [16], total protein by Kjeldahl method [16] using UDK 130 D distilling unit (Velp Scientifica, Italy), ascorbic acid [16], niacin by iodometric method [14], and peroxidase by colorimetric method [16], expressed as absorbance/g mushroom (abs./g). The dry matter and the chemical analyses of mushrooms were made on 3 samples, in triplicates.

Sensorial evaluation

We applied the Romanian standard referring to the general guidance on establishing a sensorial profile (SR EN ISO 13299/2010). Five trained panelists gave scores for each sample with respect to their perception attributes as follows: 1 (worst) to 5 (best), by using the attributes mentioned in table 1. In order to familiarize the panel with different intensities for the different sensory properties of mushrooms, and to assimilate the scoring scale, two sessions of 1 hour each were carried out. The sensory profile used was obtained from two previous open sessions. Evaluations were conducted in a sensory testing room.

Statistical data treatment

The statistic analysis was made using Microsoft Office Excel to determine the mean and standard deviations of the chemical evaluation.

Table 1.

Sensorial attributes and quality of mushrooms

Attributes	Mushroom characteristics				
	1	2	3	4	5
Flavor	Moldy, advanced altered product	Specific to the beginning of alteration	Pleasant	Well	Typical
Taste	Specific to advanced alteration	Specific to the beginning of alteration		Well	Typical
Appearance	Mould stains over 50% of product surface	Little moldy spots	Pleasant	Well	Typical
Firmness	Specific to altered product	Very low	Low	Well	Typical

3. Results and discussion

The values of chemical parameters, after mushroom blanching and before frozen state, are shown in table 2. mushrooms have a high amount of protein and a good

amount of reducing sugars. Among the two species of mushrooms, *Agaricus bisporus* has higher amounts of protein, reducing sugars and ascorbic acid than *Pleurotus ostreatus*. After blanching, the enzyme peroxidase remained in higher quantity in *Agaricus*.

Table 2.

The initial parameters of mushrooms (only mean values)

Mushroom	Reducing sugars (g/100g dry weight)	Total protein (g/100g dry weight)	Peroxidase (abs./g)	Ascorbic acid (mg/100g dry weight)	Niacin (mg/100g dry weight)
<i>Agaricus</i>	22.62	44.03	0.78	28.37	49.18
<i>Pleurotus</i>	10.24	27.66	0.48	17.33	45.65

The data of table 2 show that these The following figures have zero value on the frozen storage axis, meaning that the values are determined after blanching and before freezing operation of mushrooms. The values of 1 to 6 months are the frozen storage times for mushrooms and the determinations were made after thawing the products. All values were calculated by reporting to dry weight values (d.w.).

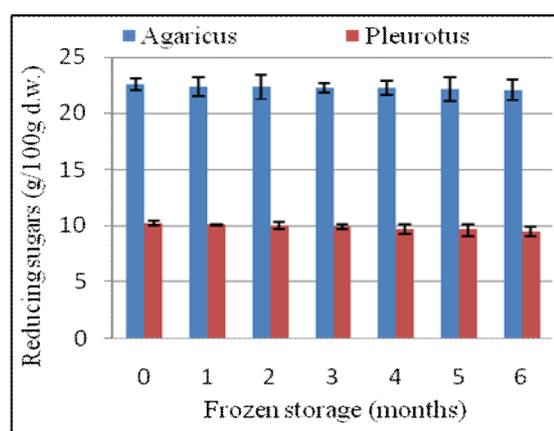


Fig. 1.Reducing sugars amount of frozen mushrooms.

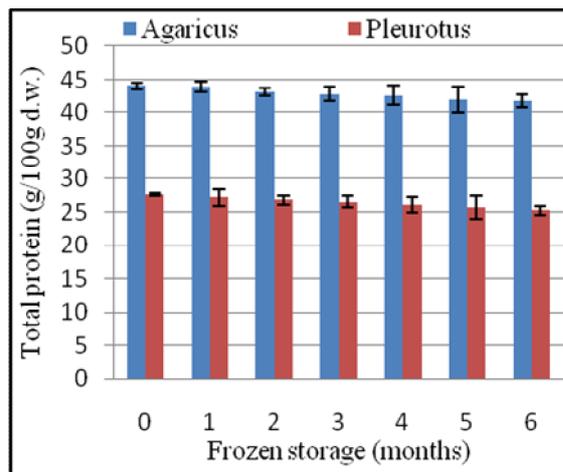


Fig. 2. Total protein amount of frozen mushrooms.

Figure 1 shows the variation of reducing sugars for both species of mushrooms. The *Agaricus* mushroom has a larger amount of reducing sugars than *Pleurotus*.

The values of 1 to 6 months are the frozen storage times for mushrooms and the determinations were made after thawing the products. All values were calculated by reporting to dry weight values (d.w.).

Figure 1 shows the variation of reducing sugars for both species of mushrooms. The *Agaricus* mushroom has a larger amount of reducing sugars than *Pleurotus*. The mean values of reducing sugars have slightly decreased after thawing, due to drip losses, for both mushrooms species. After frozen storage for six months *Agaricus* presented a decrease in reducing sugars amount by 2.38% reported to the initial mean value (month 0). Also, *Pleurotus* presented a decrease by 7.69%.

Figure 2 shows that the total protein amount is higher in *Agaricus* than in *Pleurotus*, and all along the frozen storage time the mean values decrease is probably due to drip loss after the thawing of the mushrooms.

The total protein losses for *Agaricus* after frozen storage for six months reported to the initial mean value is of 5.17%.

Pleurotus presented a loss in total protein of 8.74%.

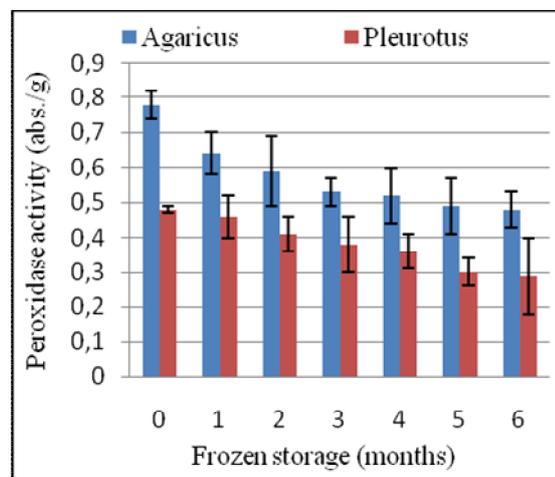


Fig. 3. Peroxidase activity of frozen mushrooms.

According to figure 3, the peroxidase activity has decreased for both mushroom species. The enzymatic activity of mushrooms was reduced by blanching operation that had happened before freezing. Frozen state of mushrooms also inhibited peroxidase activity that could affect the color of mushrooms. The decreasing value of the enzymatic activity can be due to the drip loss at thawing.

Agaricus and *Pleurotus* mushrooms presented a decrease in ascorbic acid values especially after frozen storage. After the first month of storage the ascorbic acid amount in *Agaricus* decreased by 64.43%, in *Pleurotus* by 34.56% and after six months of storage, it decreased by 76.73% and by 76.91% respectively. This is due both to drip losses after thawing and to freezing of mushrooms.

According to Fennema [7], ascorbic acid losses are temperature dependent. According to the scientific literature [12] ascorbic acid in *Pleurotus* can vary from none to 144 mg/100g d.w.

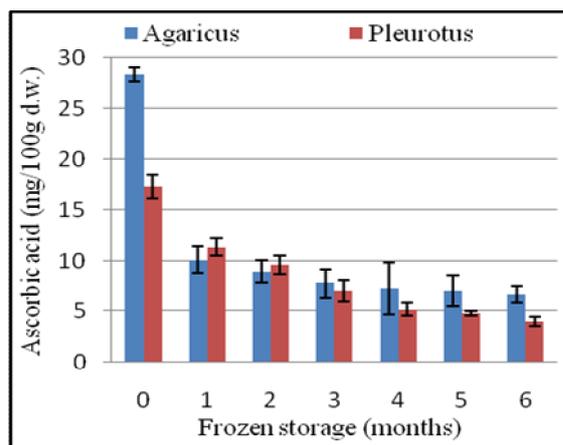


Fig. 4. Ascorbic acid amount of frozen mushrooms.

We believe that the amount of vitamins present in mushrooms is due to the chemical composition of the substrate as nutritive feed and the postharvest attack of phenol oxidase.

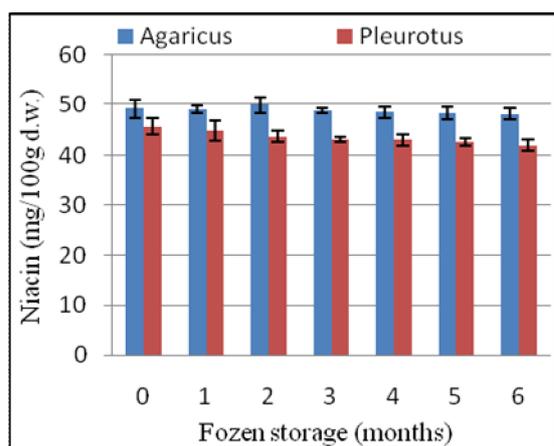


Fig. 5. Niacin amount of frozen mushrooms.

Both mushroom species are rich in niacin. Niacin amount in the case of frozen storage varied slightly. For *Agaricus* it varied (as mean values) around 48 to 49 mg/100g d.w. and for *Pleurotus* it decreased after six months of frozen storage by 8.12%. The scientific literature [12] shows the niacin content for *Agaricus* of 36 to 57 mg/100g d.w. and for *Pleurotus* of 33 to 108 mg/100g d.w.

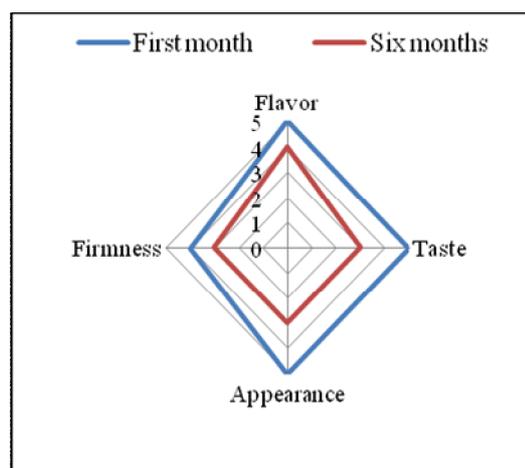


Fig. 6. *Agaricus bisporus* sensorial analysis.

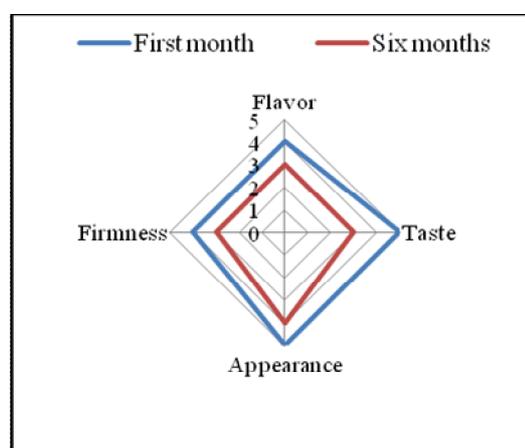


Fig. 7. *Pleurotus ostreatus* sensorial analysis.

The sensory analysis of mushrooms showed a very good quality for *Agaricus* after the first month of frozen storage; only firmness was slightly lower as compared with the fresh product. For *Pleurotus*, firmness and flavors were not at their best values after the first month of storage. The reduction of firmness is due to freezing-thawing cycle that affected the mushrooms due to the transformation of ice crystals into water at thawing. After six month of storage, the panelists determined that firmness, appearance and taste were lower for *Agaricus* and *Pleurotus*. Only appearance was pleasant for both mushroom species, possibly due to some oxidations made by air and enzymes that were not inactivated by blanching.

4. Conclusion

Our study proves that in the case of frozen mushrooms stored for six months (*Agaricus bisporus* and *Pleurotus ostreatus*) no major losses take place with reference to the macronutrient amounts. As for the micronutrients studied, the ascorbic acid makes an exception, its values being dramatically diminished on frozen storage. After six months of storage, the frozen mushrooms were not rejected by the trained assessors, only that their sensorial quality was slightly diminished. Frozen state and frozen storage are methods that can be successfully used for mushrooms preservation.

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