Contribution to the Study of the Preservation by Drying of Mushrooms *Pleurotus Ostreatus* P969 Strain

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Abstract— *Mushrooms make parts of foodstuffs very perishable. With the aim of extending their shelf life, the drying is recommended. In this work, we used two modes of drying: the freeze-drying and the solar drying. After drying, samples were packaged in some newspaper paper and stored during 4 months at room temperature. Some small modifications were observed in the parameters studied before drying and after storage. The pH passes from 6,5 to 6,2, the nitrogen of 0,067 mg at 0,057 mg, the phosphorus concentration decrease of 224 mg at 182,2 mg, the potassium did not change 0,6 mmol, the proteins rate decrease 0,419 % at 0,338 % and the concentration of vitamin C decrease of 9,25 mol at 8,75 mol.*

Keywords— Pleurotus, drying, micronutrients, storage, room temperature.

I. INTRODUCTION

The mushroom is a part of the reign of eumycetes, it is an essential organism in the ground preservation of the ecosystems (Adisco et *al*., 2007; Després et *al*., 2012). It transforms the glassy chemical elements which make up the organic matter into other component assimilable by other organisms. Almost all the vegetables need to live in symbiosis with the mushrooms, which help their roots to absorb the water and the minerals (Raven et *al*., 2014). It is one vegetable containing glycogen, a complex sugar that helps regulate blood sugar. It would contain even more than meat and fish. The content in fiber, is high enough, what can have an action on the intestinal transit (Capon et *al*., 2005). It is now scientifically proven that their nutritional value is not negligible and can be a solid contribution to our daily diet (René, 2004). The mushroom is a perishable foodstuff, what requires particular precautions in its processing, to protect its quality (Boa 2006). The losses also occur during their preservation and during their preparations. They exist various techniques of drying to lengthen the life expectancy of food such as the freeze-drying, the fluidization, the atomization and the solar drying (Gret-Geres 1986; Jean-Noël Mputu et *al*., 2014).

The objective pursued in this work is to preserve by drying mushrooms pleurotes, and to determine the physicochemical properties of fresh mushrooms and dried.

II. MATERIALS AND METHODS

The study was made in the Laboratory of food chemistry at an Evangelical University in Africa (UEA) and in the IITA laboratory to Kalambo in Bukavu. The study was realized in the Food Chemistry laboratory of the Evangelical University in Africa and in the laboratory of the IITA Kalambo at Bukavu. The mushroom used in this study is P969 strain (*Pleurotus ostreatus*) from Rwanda.

2.1 pH measurement

pH determination is very important in microbial fermentation control. Its variation, informs about the metabolic activity of microflora present. In our work conditions, pH determination is made by a direct reading on a calibrated pH-meter METTLER TOLED model.

2.2 Solar drying

Mushrooms must be cut in two or into thin slices from 2 to 3 mm to accelerate the drying and spread over a sieve, turn them from time to time to facilitate the elimination of the water. Samples are weighed after 6 hours of sun exposure until the obtaining of a constant mass. We divided the sample in two parts, one for freeze-drying and another intended for the solar

drying. The sample of the solar drying is also divided in two parts, one with the addition of the salt and another one without salt.

2.3 Freeze drying

Then samples were placed in the freezer for 24Hrs. and the frozen samples were freeze-dried for 72Hrs. in a freeze-drier (LOUW KOELTECHNIEK BVBA) with a standard program. The time for primary drying was about 6 h, the condenser temperature -45°C and the final sample temperature was 25°C by increasing the temperature gradually from -45°C to 25°C at 0.9 mbar pressure (Jean-Noël Mputu *et al*., 2012).

2.4 Protein concentration

The protein dosage is made by the method Kjeldahl (AFNOR 2002). The obtained value of proteins is multiplied by 6,25.

2.5 Phosphorus

Available phosphorus was determined by using Bray's Method modified (Abdu 2006). In these methods, specific coloured compounds are formed with the addition of appropriate reagents in the solution, the intensity of which is proportionate to the concentration of the element being estimated.

2.6 Potassium

Available potassium present in the sample is extracted with neutral ammonium acetate of 1 morality. This is considered as plant-available K in the soils. It is estimated with the help of a flame photometer (Motsara and Roy 2008).

2.7 Vitamin C

It is realized in the presence of an iodine solution (I_2) of concentration known with the starch indicator to detect the point of the end of titration (AFNOR 2002).

2.8 Dry matter

The dry material of the products is determined by the evaporation of their humidity without causing the volatilization of the constituent substances of the product, in an oven at 105° C for 24 hours (Elie 2006).

2.9 Statistical analysis

Data from three replications were analysed by using analysis of variance to determine if significant differences ($P \leq 0.05$) existed between mean values and using Duncan multiple range test.

III. RESULTS

The results of physico-chemical and biochemical analyses of our samples are shown in the table below.

TABLE 1
THE RESULTS OF PHYSICO-CHEMICAL ANALYSES AND BIOCHEMICAL MUSHROOMS FRESH AND AFTER DRYING.

	MF	ML	MS	MWS
pH	6,2	6,5	6,3	6,2
Nitrogen (mgN/kg)	0,067	0,055	0,046	0,050
Phosphorus (mg/kg)	224,4	217,4	191,8	170,8
Potassium (mmol/l)	0,6	0,6	0,7	0,4
Protein (%)	0,419	0,343	0,289	0,315
Vitamin C (mol/ml)	9,25	9,15	7,7	9,05
Dry matter (%)		50,2	13,2	12,7

Legend. MF: fresh mushroom, ML : freeze-dried mushroom, MS : mushroom without salt, MWS : mushroom with salt.

This table presents the physico-chemical properties of the samples of fresh mushrooms and dried, among which the pH, the nitrogen, the phosphor, the potassium, the proteins, the vitamin C and the material dries.

The table 2 gives results of physico-chemicals and biochemicals analyzes of our mushroom freeze-dried samples after 4 months storage at room temperature in the newspaper.

TABLE 2
PHYSICO-CHEMICAL AND BIOCHEMICAL PARAMETERS OF MUSHROOMS DRIED AFTER 4 MONTHS STORAGE AT ROOM TEMPERATURE.

	CL	CS	CAS
pH	5.8	5.7	6
Nitrogen (mgN/l)	0.049	0.057	0.054
Phosphorus (mg/kg)	198.2	180.4	182.2
Potassium (mmol/l)	0,6	0,6	0,4
Protein (%)	0.306	0.356	0.338
Vitamin C (mol/ml)	7,35	8,75	8,05
Dry matter	46	9,3	10,2

Legend: ML : freeze-dried mushroom, MS : mushroom without salt, MWS : mushroom with salt.

IV. DISCUSSION

These tables show that the pH of our samples did not change considerably and it in spite of the type of use drying. This one varies from 6,2 to 6,5 before and during the drying.

Concerning the concentration of nitrogen, we observe a sharp drop after the drying. We obsrseve a decrease of 0,067 mg / kg to 0,046 mg/kg for the mushroom dried without salt; and, a decrease 0,067 mg / kg to 0,055 mg/kg for the mushroom freeze-dried and a decrease 0,067 mg / kg to 0,050 mg / kg for the mushroom dried with salt.

For the phosphorus, the reduction is more pronounced for samples dried in the sun compared with the freeze-dried sample, we observe a decrease of 224,4 mg/kg of fresh sample to 217,4 mg/kg for freeze-dried mushroom and 191,8 mg/kg for sample dried without salt and 170,8 mg/kg for sample dried with salt. Concerning the potassium, we have almost the same values for the fresh mushroom as the mushroom dried with the exception of that dried with the addition of the salt.

Concerning the content in protein and the concentration of vitamin C, we notice that only the sample dried without salt presents a reduction pronounced compared with the other samples. In term of dry matter, the sample freeze-dried contains more water than samples dried in the sun and what the sample without salt contains less humidity than that with the salt.

The table 2 gives the results of mushrooms dried, after 4 months of storage at room temperature. The dried mushrooms were packaged in newspaper paper and stored at room temperature in the laboratory.

We observe a slight reduction in the pH for all the samples, our dried mushrooms become slightly acid after 4 months storage with regard to their pH at the end of the drying as show table 1. As regards nitrogen concentration, we observe a decrease for the freeze-dried mushroom of 0,055 mg before the storage to 0,049 mg after 4 months of storage at room temperature; whereas for mushrooms dried in the sun we have an increase of nitrogen concentration, is an increase of 0,011 mg nitrogen for the mushroom dried without salt and an increase 0,004 mg for the mushroom dried with salt. But there are however no modifications concerning the concentration of potassium before and after drying.

As for the content in protein, we have a light decrease for the freeze-dried mushrooms whereas for mushrooms dried in the sun, we have an increase, but this increase is more pronounced for the mushroom dried without salt from 0,289 % to 0,356 % against 0,315% to 0,338% for the mushroom with salt. The results obtained by Bernard et *al*., (2008) show that the mushroom is one of the vegetables the richest in phosphor it is one of the vegetable the richest which in protein 2,5 to 3,5 mg/g and its proteins contains amino acids (lysine, leucine...). The rate of protein varies, for the edible species. The proportion of proteins, amino acids and the quantity of minerals seem to be more important in the hat of the mushroom than at the foot.

Concerning vitamin C concentration, we have a decrease for mushrooms freeze-dried and dried in the sun with salt, whereas the mushroom dried without salt presents a light increase of its concentration in vitamin C. And concerning the dry matter rate, we observe a decrease of the humidity after preservation at room temperature figure 2.

V. CONCLUSION

This study focuses on the different drying methods of the mushrooms P969 strain, cultivated at the Evangelic University in Africa in Bukavu, who led to the encouraging results whose the conclusion is the following one: the drying of pleutorus mushrooms allows to keep quite the natural properties of these mushrooms; whatever is the type of used drying. And after 4 months. And after 4 months of storage of mushrooms conditioned in the newsprint at room temperature, we can say with certainty which this study allows to reduce the losses postharvest mushrooms. As for the sun-curing, he confers a long lasting of life on mushrooms. By drying, mushrooms retain their best appearance, their properties, their color and aroma.

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