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Influence of Freezing and Drying on the Nutritional Composition of an Edible Mushroom *Pleurotus sajor-caju* in Nigeria

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Abstract
The influence of different preservation methods on the nutritional composition of P. sajor-caju was investigated in this study. Fresh sample of the mushroom was collected, sorted and preserved using three different methods viz: freezing, oven drying and sun drying. Fresh and preserved samples were subjected to proximate, minerals and vitamins A and C analyses using standard methods. Results revealed that the drying methods (oven drying and sun drying) preserved and enhanced the proximate and mineral composition of the edible mushroom while freezing led to loss of all the proximate content except moisture. Minerals such as sodium, manganese, magnesium, phosphorus and copper were also lost in the frozen sample while other minerals were enhanced and preserved. Drying resulted in the loss of the vitamins A and C contents of the mushroom while freezing enhanced the vitamin A content but also led to loss of vitamin C content of the mushroom. Drying had a significant edge over freezing vis-à-vis retention and preservation of proximate and mineral contents and is therefore recommended for the preservation of the nutritional quality of the mushroom.

***Key words**: Preservation method, Mushroom, Proximate analysis, Mineral analysis, Vitamin analysis.*

Introduction

Mushrooms are fungi fruit – bodies which are typically produced above the ground on soil or on its food source. Mushrooms are saprophytes. They are most often applied to fungi (Basidiomycota, Agaricomycetes, order Boletales and family Boletaceae) that have stem (stipe), a cap (pileus) and gills (lamellae) on the other side of the cap (Bahl, 1998). Mushrooms are found in areas with range of temperature 20 – 40^{0}C and grow well in agricultural wastes. They require a moderate rainfall and pH range of 3-10 for growth (Chang and Fernandex, 1980). They are found growing on dead organic matter of plant origin, therefore, utilizing almost all plant materials as substrates (Chang, 1980). Edible mushrooms are used for centuries by people as food or traditional medicine to cure certain diseases. Edible mushrooms have been proven to possess good quality of protein, unsaturated fatty acids, fibers, minerals and vital vitamins that we need in our daily diet (Hung and Nhi, 2012). Recently, mushrooms have assumed greater importance in the diets of both rural and urban dwellers unlike previously when consumption was confined to rural areas. Mushrooms are now marketed along major highways and urban centers. They are also relatively much cheaper than beef, pork and chicken that contain similar nutrients.

Studies showed that some of the edible mushrooms contain potential anti-carcinogenic, anti-cholesterolaemic and anti-viral properties (Emilia, 2006). Studies have also revealed that some species exhibit potential anti-oxidative effect in preserving food or as anti-aging agents (Lee *et al.,* 2003). Many health promoting substances e.g. antimicrobial, anticancer, antioxidant, cholesterol lowering property and immunostimulatory effects have been documented for some species of mushrooms (Akinyele *et al*., 2011). In Nigeria, conditions often dictate that mushrooms are preserved for future use. After harvesting, moisture loss, shrinkage and rapid spoilage in terms of colour and texture occur. The shelf life of mushrooms is only about 2 to 5 days depending on the variety (Kulshreshta *et al*., 2009). There are many methods for preservation and enhancement of shelf life of mushrooms. The most common methods include canning, freezing and drying. Although canning is widely used on a commercial scale, it is quite expensive. Previous studies (Aishah and Rosli, 2013; Danso-Boateng, 2013) have reported the effect drying and other preservative methods on the nutritional quality of different food crops.

Therefore, this study was carried out to investigate the effect of freezing and drying on the nutritional properties of *P. sajor-caju*, an edible mushroom in Nigeria.

Materials and Methods

Sample collection and identification

Fresh and matured samples of the edible mushroom were collected from Afe Babalola University, Ado Ekiti, Ekiti State, Nigeria where they are cultivated. The mushroom was identified in the herbarium of the Department of Plant Science and Biotechnology, Ekiti State University, Ado Ekiti, Nigeria.

Preparation of the mushroom for drying

The mushroom was washed thoroughly 3 to 4 times with plenty of water to remove all adhering dust and dirt particles. The sample was then weighed and shared into four equal parts representing fresh, sun dried, oven dried (at 50^0C for 24 hrs) and frozen samples. These were treated as follows:

Freezing: The mushroom was kept in the freezer for 7 days and used for the analysis.
Sun drying: The mushroom was spread on cotton sheets and was constantly exposed to direct sunlight until they became brittle.
Oven drying: The mushroom was placed in trays and oven dried at 50^0C for 24 hrs.

The portions for drying were dried properly before converting into fine powdered form using a blender.It was then stored at room temperature and used for the analysis. The fresh and frozen samples were however converted into paste using mortar and pestle and used immediately for the analysis.

Proximate analysis

The proximate analyses (moisture, fiber, ash, crude fats, proteins and carbohydrates) of the samples were determined according to (AOAC, 2000). The moisture and ash were determined using weight difference method. Fiber content was estimated from the loss in weight of the crucible and its content on ignition. Carbohydrate was determined by subtracting the sum of all the proximate composition from 100. The nitrogen value which is the precursor for protein of a substance was determined by micro Kjeldahl method described by Pearson (1976). The nitrogen value was converted to protein by multiplying by a factor of 6.25. Crude lipid content of the samples was determined using soxhlet type of direct solvent extraction method.

Mineral and Vitamins determination

Elemental analyses were carried out using an atomic absorption spectrophotometer (Buck Scientific Model-210 VGP) for sodium, potassium, manganese, magnesium, iron, calcium, zinc and copper while phosphorus was determined calorimetrically. Vitamins were determined using standard procedures. Ascorbic acid was determined by iodine titration (Helmenstine, 2001) while vitamin A was determined as β – carotene using AOAC Official Method of Spectrophotometric method.

Results

Table 1 shows the proximate composition of the fresh and preserved mushrooms. The moisture content ranged from 5.06% in the sun dried sample to 35. 61% in the frozen sample. The fresh and oven dried samples had moisture contents of 26.33 and 6.17% respectively. The crude protein composition ranged from 7.83% in the frozen sample to 17.57% in the sun dried sample. The fresh and oven dried samples had protein contents of 9.25 and 16.11% respectively. Fat was also enhanced and retained in the dried samples of the mushroom. The fresh mushroom had fat content of 0.77% while the oven dried and sun dried samples had fat contents of 2.04 and 2.53% respectively. However, the fat content of the frozen sample was reduced to 0.56%. The ash content ranged from 3.11% in the frozen sample to 5.84% in the sun dried sample. The fresh and oven dried samples had ash contents of 3.57 and 5.34% respectively. Similarly, results showed that the crude fiber in the fresh sample was also retained in the dried sample (0.60% and 0.53% in the sun dried and oven dried samples respectively) while it significantly reduced in the frozen sample (0.35%). The carbohydrate content of the four samples of the mushroom analyzed in this study ranged between 52.56% in the frozen sample to 69.82% in the oven dried sample. The fresh and sun dried samples contained 59.68 and 68.40% of carbohydrates respectively. Sun drying was able to enhance and retain most of the proximate contents of the mushroom more than the other two methods.

Table 2 shows the mineral composition of the fresh and preserved mushroom. The sodium content varied from 87.70 mg/100g in the frozen sample to 134.75 mg/100g in the sun dried sample. The fresh and oven dried samples had values of 96.40 mg/100g and 125.23 mg/100g respectively; potassium content ranged from 673.30 mg/100g in the fresh sample to 747.10 mg/100g in the frozen sample. The oven dried and sun dried samples had values of 718.30 mg/100g and 731.2 mg/100g respectively; manganese content ranged from 1.18 mg/100g in the frozen sample to 2.33 mg/100g in the sundried sample. The fresh and oven dried samples had values of 1.43 mg/100g and 2.23 mg/100g respectively; magnesium content ranged from 30.55 mg/100g in the frozen sample to 39.05 mg/100g in the sun dried sample. The fresh and oven dried samples had values of 33.51 mg/100g and 38.88 mg/100g respectively; phosphorus content ranged from 685.35 mg/100g in the fresh sample to 823.75 mg/100g in the sun dried sample. The frozen and oven dried samples had values of 671.33mg/100g and 744.10mg/100g respectively; iron content ranged from 13.15 mg/100g in the fresh sample to 22.35 mg/100g in the sun dried sample. The frozen and oven dried samples had values of 15.25 mg/100g and 18.15 mg/100g respectively; calcium content ranged from 123.25 mg/100g in the fresh sample to 157.25 mg/100g in the sun dried sample. The frozen

and oven dried samples had values of 124.05 mg/100g and 144.70 mg/100g respectively; zinc content ranged from 5.31 mg/100g in the fresh sample to 6.78 mg/100g in the sun dried sample. The frozen and oven dried samples had values of 5.85 mg/100g and 6.42 mg/100g respectively; copper content ranged from 0.70 mg/100g in the frozen sample to 2.90 mg/100g in the sun dried sample. The fresh and oven dried samples had values of 0.81 mg/100g and 2.08 mg/100g respectively.

Table 3 shows the vitamins A and C contents of the fresh and preserved mushrooms. The highest content of vitamin A was found in the frozen sample (0.08 µg/g) while the least was found in the dried samples (0.05 µg/g). The fresh sample contained the highest content of vitamin C (135.85 µg/g) while sun dried sample contained the least (80.00 µg/g).

Table 1: Proximate composition of fresh and preserved mushrooms

Parameter (%)	Fresh	Frozen	Oven dried	Sun dried
Moisture	26.33^{b}	35.61^{a}	6.17^{c}	5.06^{d}
Protein	9.25^{c}	7.83^{d}	16.11^{b}	17.57^{a}
Fat	0.77^{c}	0.56^{d}	2.04^{b}	2.53^{a}
Ash	3.57^{d}	3.11^{c}	5.34^{b}	5.84^{a}
Crude fiber	0.41^{c}	0.35^{d}	0.53^{b}	0.60^{a}
Carbohydrate	59.68^{c}	52.56^{d}	69.82^{a}	68.40^{b}

Means with the same letters within rows are not significantly different at $p < 0.05$

Table 2: Mineral contents of fresh and preserved mushrooms

Nutrient (mg/100g)	Fresh	Frozen	Oven dried	Sun dried
Sodium	96.40^{c}	87.70^{d}	125.23^{b}	134.75^{a}
Potassium	673.30^{d}	747.10^{b}	718.30^{c}	731.25^{a}
Manganese	1.43^{c}	1.18^{d}	2.23^{b}	2.33^{a}
Magnesium	33.51^{c}	30.55^{d}	38.88^{b}	39.05^{a}
Phosphorus	685.35^{c}	671.33^{d}	744.10^{b}	823.75^{a}
Iron	13.15^{d}	15.25^{c}	18.15^{b}	22.35^{a}
Calcium	123.25^{d}	124.05^{c}	144.70^{b}	157.25^{a}
Zinc	5.31^{d}	5.85^{c}	6.42^{b}	6.78^{a}
Copper	0.81^{d}	0.70^{d}	2.08^{b}	2.90^{a}

Means with the same letters within rows are not significantly different at $p < 0.05$

Table 3: Vitamins A and C composition of fresh and preserved mushrooms

Vitamin (µg/g)	Fresh	Frozen	Oven dried	Sun dried
Vitamin A	0.06^{b}	0.08^{a}	0.05^{c}	0.05^{c}
Vitamin C	135.85^{a}	107.35^{b}	102.45^{c}	80.00^{d}

Means with the same letters within rows are not significantly different at $p < 0.05$

Discussion

The lower proximate and mineral content in the fresh mushroom sample in this study could be attributed to high moisture content. Mushrooms are known to contain high moisture content. The moisture content observed in the fresh mushroom in this study suggest that it cannot be stored for long without spoilage, since a high water activity could enhance microbial action that can lead to spoilage. Hence, there is the need for preservation of the mushroom. The lifetime of the bulk of the fruiting body is only about 10 – 14 days (Kalac, 2009). Thus, preserving mushrooms can reduce the post-harvest loss and extend their shelf life (Muyanja *et al.,* 2012). Ruberto and Baratta (2000) reported that high moisture content reduces the shelf life of food substances. Removal of moisture results in increased concentration of nutrients (Morris *et al*., 2004). Thus, the higher the moisture a food contains, the lower the nutrient content of the food. This is in consonance with the results of previous studies (Odo, 2007; Udofia, 2005; Oguntona, 1998) in some seasonal vegetables. Previous researchers have reported the effect of different methods of preservation on the nutritional quality of mushrooms and other food commodities. Aishah and Rosli (2014) reported the effect of different drying techniques on the nutritional values of oyster mushroom *(Pleurotus sajor-caju*) in Malaysia and reported that the drying methods retained the nutritional quality of the mushroom. Adeyemi *et al.* (2014) also worked on the influence of different drying methods on the proximate and phytochemical composition of *Moringa oleifera* and observed that sun drying favored the retention of the proximate contents. Results obtained in the present study are in consonance with these results. It is worthy of note that drying increased the protein content of the mushroom which is contrary to the report of Morris *et al.* (2004) that heat denatures protein. Since heat denatures protein, the reason for increased protein in the dried mushroom could be attributed to the type of protein present in it. This calls for a further study on the protein constituent of the mushroom. The loss of nutrients (proximate and some minerals) could be as a result of oxidation. Rickman *et al*. (2007) observed that frozen products loose more nutrients during storage due to oxidation.

The comparable proximate and mineral content of the sun and oven dried samples showed that either of the methods was as good as the other to preserve and increase the nutrients. Dried samples had a significant edge over the frozen sample vis-à-vis retention and preservation of proximate and mineral contents. This indicates the superiority of drying to conserve the nutrients (Aletor and Adeogun, 1995; Rickman *et al*., 2007; Reid *et al.,* 2016).

The loss in vitamins A and C content of the mushroom by drying method is in line with the findings of Ogbu (2007) that drying might have adverse effect on the volatile nutrients such as vitamin content of fresh foods.

Conclusion

In this study, variations in the nutritional composition of the edible mushroom *P. sajor-caju* as influenced by different methods of preservation employed have been established. Thus, the nutritional quality of the mushroom depends on the method of preservation. Dying (oven drying and sun drying) produced better results for enhancing and preserving the nutrients relative to freezing which brought about loss of nutrients in the mushroom except vitamin A. However, the highest values of the nutrients except moisture content and vitamins were observed in the dried samples. Therefore, drying is recommended for the preservation of the mushroom.

References

Adeyemi, S.B., Ogundele, K.O. and Animasaun, M.A. (2014). Influence of drying methods on the proximate and phytochemical composition of *Moringa oleifera* Lam. *Global Journal of Medicinal Plant Research*, 2(1): 1-5.

Aishah, M.S. and Rosli, W.I. (2013). Effect of different drying techniques on the nutritional values of oyster mushroom (*Pleurotus sajor-caju*). *Sains Malaysiana*, 42(7):937-941.

Akinyele, B. J., Obameso, J. O. and Oladunmoye, M. K. (2011). Phytochemical screening and antimicrobial potentials of three indigenous wild Ganoderma mushrooms from Ondo state, Nigeria. *Nigerian Journal of Microbiology.* 25: 2280-2290.

Aletor, M.V.A. and Adeogun, O.A. (1995) Nutrient and antinutrient components of some tropical leafy vegetables. *Food Chemistry, 53,*375-379.

AOAC (2000). "Official method of analysis". 16th edition. Washington DC: Association of Official Analytical Chemists.

Bahl, N. (1998). *Handbook on mushroom.* Oxford: An IBH Publication Co. Ltd.: 21-23.

Chang, S. T. and Fernandex (1980). Studies on the Padi Mushroom (*Volvariella volvacea*) use of oil palm pericarp waste on alternative substrate. *Mal. Agric. Res*., 2:15- 22.

Danso-Boateng, E. (2013). Effect of drying methods on nutrient quality of Basil (*Ocimum viride*) leaves cultivated in Ghana. *International Food Research Journal,* 20(4):1569-1573.

Emilia, B., Grazyna, J. and Zofia, L. (2006). Edible mushrooms as a source of valuable nutritive constituents. *Acta Sci Pol-Technol Aliment.,*5(1): 5-20

Helmenstine, A.M. (2001). Vitamin C determination by iodine titration, About.com

Hung, P.V. and Nhi, N.N.Y. (2012). Nutritional composition and antioxidant capacity of several edible mushrooms grown in the southern Vietnam. *Int. Food Research J.,* 19(2):611-613.

Kalac, P. (2009). Chemical composition and nutritional value of European species of wild growing mushrooms: A review. *Food Chemistry*: 113:9-16.

Kulshreshta, M., Singh, A. and Deepti, V. (2009). Effect of different drying conditions on mushroom quality. *Journal of Engineering Science and Technology.* 4(1): 90-98.

Lee, H., Song, M. and Hwang, S. (2003). Optimizing bioconversion deproteined cheese to mycelia of *Ganoderma lucidum. Process Biochem*., 38:1685-1693.

Muyanja, C., Kyambadde, D. and Namugunya, B. (2012). Effect of pretreatments and drying methods on chemical composition and sensory evaluation of oyster mushroom *Pleurotus oeasstrus*) powder and soup. *Journal of Food Processing and Preservation* .DOI:1111/j, 1745-4549.2102.00794.x

Morris, A., Barnett A. and Burrows O. (2004). Effect of processing on nutrient content of foods. *Cajarticle*; 37: 160-164.

Odo, C.C. (2007). Effect of Dry Season on Green Leafy Vegetable production on Household Food Security and Women Empowerment in Adani and Opi. (Unpublished B.Sc. Thesis, University of Nigeria, Nsukka).

Ogbu, I.F. (2007). Evaluation of beta-carotene, iron and other micronutrient status of rats fed sun and shade dried fluted pumpkin. (*Telifaria occidentalis*) leaves and its product, the leaf curd. Masters thesis, Dept of Nutrition and Dietetics, U.N.N.

Oguntona, T. (1998). Green leafy vegetables In: Nutritional Quality of plant foods. Osagie, A.U &Eka, O.U. Benin, Nigeria, PP 114-120.

Pearson, D. (1976). Chemical analysis of foods. 7th ed. London, Churchchill, Livingstone, pp. 218-336.

Reid, T., Munyanyi, M. and Mduluza, T. (2016). Effect of cooking and preservation on nutritional and phytochemical composition of the mushroom *Amanita zambiana. Food Science and Nutrition.* DOI.1002/fsn3.428.

Rickman C.J., Barrett, D.M. and Bruhn, C.M. (2007). Nutritional comparison of fresh, frozen and canned fruits and vegetables. Part 1. Vitamins C and B and phenolic compounds. *J. Sci. Food Agric,* 87:930-944.

Ruberto, G. and Baratta, M. T. (2000). Antioxidant activity of selected essential oil components in two lipid model systems. *Food Chemistry*; 69: 167-174.
Udofia, U.S. (2006). The nutrient potentials of blends of "atama" (*Heinsia arinata)* soup meal and cassava (*Manihot esculentus)* fufu dishes as consumed in Ugo, Akwa Ibom State, Nigeria. (Unpublished Ph.D Thesis. University of Nigeria, Nsukka).