Effect of different drying temperatures on the nutritional composition of *P. sajor-caju,* an edible mushroom in Ekiti State, Nigeria

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Abstract: This study was aimed at investigating the effect of different drying temperatures on the proximate, mineral and vitamins A and C composition of an edible mushroom, *P. sajor-caju*. The fresh and matured mushroom was collected from Afe Babalola University, Ado Ekiti where it is being cultivated. Fresh samples were converted to paste using mortar and pestle and immediately subjected to proximate, mineral and vitamins A and C analysis using standard methods. The oven dried samples (treated with 50, 60 and 70^0C) were converted to powder using a blender and then subjected to the same analysis to determine the nutrients retained in the samples. Results revealed that the drying temperatures preserved and enhanced the nutritional characteristics of the edible mushroom. The treatment using 70^0C was the most suitable to dry the edible mushroom as it retained most of the nutrients (except vitamin C).
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Introduction

Mushrooms are important constituents of minor forest produce that grow on most abundant biomolecule of the biosphere. Presently, mushrooms are regarded as macro-fungi with distinctive fruiting bodies which can be either epigeous or hypogeous and large enough to be seen with the naked eyes and to be picked by hand (Chang and Miles, 1992). Man has been hunting for wild mushrooms since antiquity (Cooke, 1977). Thousands of years ago, fructifications of higher fungi have been used as a source of food due to their chemical composition which is attractive from the nutrition point of view. Mushrooms have been used as a valuable food source and as traditional medicine around the world, especially in Japan and China (Akinyele*et al.,* 2011). 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). Mushrooms fall between the best vegetables and animal protein source (Adejumo and Awosanya, 2005). They are considered as sources of protein, vitamins, fats, carbohydrates, amino acids and minerals (Jiskani, 2001). All the essential amino acids are present as well as water soluble vitamins and all the essential minerals (Buigut, 2002). Mushrooms are good sources of vitamins like riboflavin, biotin and thiamines (Chang and Buswell, 1996). The protein value of mushrooms is twice as that of asparagus and potatoes, four times as that of tomatoes and carrots and six times as that of oranges (Jiskani, 2001). Mushrooms are also characterized by a high level of well assimilated mineral constituents (Kalac, 2009). However, edible mushrooms are characterized by a short shelf life due to post-harvest changesresulting from the activity of enzymes such as polyphenol oxidase that is responsible for browning reactions during storage (Keyhani and Keyhani, 2011).

Dehydration is among the most popular methods for shelf-life extension of highly perishable foods. Connective drying is widely used; however several disadvantages of this method have been reported such as the degradation of important nutritional substances due to relatively long drying times and high temperature (Vega-Galvez *et al.,* 2012).

This study was carried out to investigate the effect of different drying temperatures on the nutritional and phytochemical composition of *P. sajor-caju.*

Materials and Methods

Sampling and identification of mushroom

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.

Sample preparation

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 and oven dried (at 50^0C, 60^0C and 70^0C for 24 hrs). The fresh sample was however converted into paste using mortar and pestle and used immediately for the analysis while the portions for drying were placed on stainless trays and oven dried accordingly. The dried portions were then separately converted into fine powder using a clean blender. It was then stored at room temperature and used for the analysis.

Proximate analysis

All the treated mushroom samples were analyzed for proximate composition (moisture, protein, crude fat, ash, crude fiber and carbohydrates) using standard procedures according to the Association of Official Analytical Chemists (AOAC, 2000). All the analyses were done in triplicates.

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 and Discussion

The result of the proximate composition (%) of fresh and oven dried samples of the mushroom is shown in Table 1. The level of moisture content of the fresh sample (26.32) was significantly higher than that of the treated samples which were 6.17, 6.05 and 5.25 for samples treated with 50, 60 and 70^0C respectively. The protein content of the fresh sample (9.24) was significantly lower than that of that of the treated samples which were 16.10, 16.27 and 16.63 respectively. There was no significant difference in the protein content among the treated samples. The fat content of the sample treated with 70^0C (2.24) was significantly higher than that of the fresh (0.76) and the other treated samples (2.03 and 1.94) for 50 and 60^0C respectively. The least ash content (3.57) was also found in the fresh sample while samples treated with 50, 60 and 70^0C had values of 5.33, 5.27 and 5.36% respectively. There was no significant difference in the ash content of samples treated with 50 and 70^0C. The crude fiber content also increased significantly from 0.41 in the fresh sample to 0.53, 0.54 and 0.63 in samples treated with 50, 60 and 70^0C respectively. The contents of carbohydrate in the treated samples were significantly higher than that of the fresh sample. Samples treated with 50, 60 and 70^0C had carbohydrate contents of 69.89, 69.85 and 69.87 respectively while the fresh sample had a value of 59.66%. There was no significant difference in the carbohydrate contents of the treated samples. The results clearly showed that all the proximate contents except moisture were enhanced and preserved by oven drying at different temperatures. However, samples treated with 70^0C retained the highest amount of the proximate contents. This observation tends to agree with the report of Abioye *et al.* (2014) who reported increase in the proximate contents of baobab leaves subjected to different drying methods. The result of this study is also in agreement with that of Yuen *et al.* (2014) who reported increase in the proximate contents of an edible mushroom which was subjected to different drying temperatures. The authors also reported that the mushroom sample treated with the highest temperature (60^0C) retained the highest amount of the nutrients. Results of this study also confirm this. Aremu and Akintola (2014) also reported increase in the proximate contents of moringa seeds subjected to different drying methods. The result of this study is also in consonance with this. The results of the present investigation also agrees favourably with the report of Aishah and Rosli (2014) who reported variations in the proximate contents of oyster mushroom under different drying techniques. Ayodele *et al.* (2011) reported loss of proximate contents in edible mushrooms under different drying methods. The result of the present investigation disagrees with this. Also, the result obtained in this study is not in line with the variations in the proximate contents of basil leaves reported by Danso-Boateng (2013).

The result of the mineral composition (mg/100g) of fresh and oven dried samples of the mushroom is shown in Table 2. Phosphorus represented the most abundant mineral in the mushroom with values ranging from 685.32 in the fresh sample to 743.56, 896.62 and 903.84 in samples treated with 50, 60 and 70^oC respectively. Copper was the least abundant mineral in the mushroom with values ranging from 0.81 in the fresh sample to 2.07, 3.01 and 2.87 in samples treated with 50, 60 and 70^oC respectively. The sodium content ranged from 95.78 in the fresh sample to 125.08, 127.35 and 136.22 in samples treated with 50, 60 and 70^oC respectively; potassium content ranged from 673.57 in the fresh sample to 718.30, 766.93 and 781.43 in samples treated with 50, 60 and 70^oC respectively; manganese content ranged from 1.43 in the fresh sample to 2.22, 2.62 and 2.83 in samples treated with 50, 60 and 70^oC respectively; magnesium content ranged from 33.01 in the fresh sample to 38.85, 39.48 and 40.21 in samples treated with 50, 60 and 70^oC respectively; iron content ranged from 13.13 in the fresh sample to 18.13, 25.37 and

26.64 in samples treated with 50, 60 and 70°C respectively; calcium content ranged from 123.30 in the fresh sample to 144.33, 154.00 and 157.50 in samples treated with 50, 60 and 70°C respectively while zinc content ranged from 5.31 in the fresh sample to 6.42, 6.84 and 7.03 in samples treated with 50, 60 and 70°C respectively. Also, the sample treated with 70°C preserved and retained the highest amount of the minerals. This result tends to agree with the variations in the elemental composition of moringa leaf samples under different drying techniques reported by Umar *et al.* (2014). However, the result of the present study does not agree with the report of Ayodele *et al.* (2011) and Abioye *et al.* (2014) who reported loss of elements in dried mushrooms and baobab leaves respectively.

The result of the vitamins A and C contents (µg/g) of fresh and oven dried samples of the mushroom is presented in Table 3. Vitamin A content decreased from 0.07 in the fresh sample to 0.06 in the treated samples. Vitamin C content decreased significantly from 135.63 in the fresh sample to 102.38, 96.97 and 95.93 in samples treated with 50, 60 and 70^{0}C respectively. This result is in agreement with the results of previous researchers (Abioye *et al.*, 2014; Fhatuwani and Ngezimana, 2014; Mohanom *et al.,* 1999).

In general, the high moisture for fresh the sample as well as the decreased moisture in the treated samples is expected as it is known that foods exposed to drying loose moisture (Ezeife, 2003). This has some nutritional implications. Odo (2007) reported that the lower the moisture contents of food, the higher the nutrient as well as shelf life of the food. Therefore, the higher proximate and mineral contents for all the treated samples in this study may be attributed to their lower moisture content. Also, the loss of vitamins A and C in the treated samples may be due to the heat applied. Vitamin C is water soluble and as such is easily leached into water and then degraded by heat.

Table 1: Proximate composition of fresh and oven dried mushroom

Parameter (%)	Fresh	Temperature (^{0}C)		
		50	60	70
Moisture	26.317^a	6.17^b	6.05^b	5.25^c
Protein	9.24^b	16.10^a	16.27^a	16.63^a
Fat	0.76^d	2.03^b	1.94^c	2.24^a
Ash	3.57^d	5.33^a	5.27^b	5.36^a
Crude fiber	0.41^c	0.53^b	0.54^b	0.63^a
Carbohydrate	59.66^b	69.89^a	69.85^a	69.87^a

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

Table 2: Mineral contents of fresh and oven dried mushroom

Nutrient (mg/100g)	Fresh	Temperature (^{0}C)		
		50	60	70
Sodium	95.783^c	125.08^b	127.35^b	136.22^a
Potassium	673.57^d	718.30^c	766.93^b	781.43^a
Manganese	1.433^d	2.22^c	2.62^b	2.83^a
Magnesium	33.01^b	38.85^a	39.48^a	40.21^a
Phosphorus	685.32^d	743.56^c	896.62^b	903.84^a
Iron	13.13^d	18.13^c	25.37^b	26.64^a
Calcium	123.30^d	144.33^c	154.00^b	157.50^a
Zinc	5.31^d	6.42^c	6.84^b	7.03^a
Copper	0.81^d	2.07^c	3.01^a	2.87^b

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 oven dried mushrooms

Vitamin (µg/g)	Fresh	Temperature (°C)		
		50	60	70
Vitamin A	0.07^a	0.06^b	0.06^b	0.06^b
Vitamin C	135.63^a	102.38^b	96.97^c	95.93^c

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

Conclusion

The results of the present study revealed that the different drying temperature enhanced and retained the proximate and mineral composition of the mushroom but resulted in the loss of vitamins. The sample treated with 70^{o}C retained the highest amount of the nutrients and is therefore recommended for the preservation of the mushroom.

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