

Original Research Article

Nutritional Evaluation of *Pleurotus sajor-caju* Mushroom at Different Growth Stages and Effect of Boiling on Antinutrients Composition

ABSTRACT

The proximate composition, some mineral elements and antinutrients contents of *Pleurotus sajor-caju* mushroom at different growth stages (button, egg and full grown) were determined using standard methods of analysis. The full grown stage has the highest values of percentage protein (41.70 ± 0.01) and carbohydrate (43.62 ± 0.20) contents. The mineral elements analyses in mg/kg revealed that full grown stage has highest values in Ca (42.64 ± 0.01), K (48.16 ± 0.20), Na (22.63 ± 0.10), Fe (8.70 ± 0.20) and Mg (34.84 ± 0.01) with least values in Zn (3.46 ± 0.10) and P (6.46 ± 0.01). The oxalate, phytates and tannin were determined in the raw and boiled samples where it was discovered that the level of the antinutrients were reduced by boiling. Phytates mg/100g was found to be 40.27 ± 0.05 in raw full grown sample which was reduced by boiling to 12.16 ± 0.01 (69.80% reduction). The same trend was obtained for oxalate and tannin contents of the samples with 56.59% and 70.41% reduction respectively after boiling. The results of this work revealed that full grown stage of *Pleurotus sajor-caju* mushroom is more nutritious than those from button and egg stages especially in protein and mineral element contents.

Keywords: *Pleurotus sajor-caju*, mushroom, proximate, boiling, antinutrient, egg, button, full grown

INTRODUCTION

Mushrooms are the fleshy, spore-bearing fruiting body of a fungus, typically produced above ground on soil or on its food source. Edible mushrooms are sources of food and delicacies all over the world. They are considered as either condiments or a source of nutrients depending on the country or geographical region [1]. The mushroom we see and eat is a part of the reproductive structure of a plant we know as fungus. The sole purpose of this organ is to manufacture and spread spores to reproduce its species. Edible mushrooms such as shiitake have important salutary effects on health and treatment of diseases. Mushrooms characteristically contain many different bioactive compounds with diverse biological activities. They are good source of non starchy carbohydrate dietary fibre, essential amino acids and B vitamins including riboflavin, niacin and pantothenic which helps to provide energy by breaking down proteins, fats and carbohydrates. Vitamin B also plays a good role in the nervous system. Mushrooms are excellent source of important minerals such as selenium and copper. They are also reported to contain essential antioxidants which help to strengthen the immune system [2]. Long chain carbohydrate (β glucan) found in numerous mushroom species have been reported to show marked immunity-stimulating effect which may contribute to resistance against physiological processes related to the metabolism of fats and sugars in the body [3]. *Pleurotus spp* commonly called oyster mushroom are primarily wood rot fungi and are highly appreciated for the meaty taste. They are common in Nigeria especially south western part of the country. Mushrooms could be harvested at different growth stages: button, egg and full grown, it therefore necessary to determine the stage at which it can be harvested for optimum utilization of the nutrients. The main focus of this research work is to determine the nutrient and antinutrients compositions of the different stages of growth as well as the effect of boiling on the

42 antinutrient levels in order to determine the stage at which the mushroom would be more useful to the
43 body nutritionally as much work has not been directed towards this aspect in the years past while
44 available ones are contradicting.

45 **MATERIALS AND METHODS**

46 **Sample collection**

47 The production of cultivated *Pleurotus sajor-caju* mushroom was done according to the methods of
48 [4] where corn cobs of maize were shredded into pieces of between 13 cm long and soaked in water to
49 achieve moisture content of 60-65%. Polypropylene bags were filled with moist corn cobs substrate
50 sterilized at 121° C for 15 min. After cooling, the substrate was incubated with the mushroom spawn
51 for 30 days with regular watering. Samples were collected at the button, egg and full grown stages,
52 cleaned to remove dirt, cut into small bit, oven dried (at 60°C) and grinded in a laboratory blender
53 (Philip Harris model). The powered products were passed through a 2 mm sieve, kept in a polythene
54 bag inside a refrigerator at 4°C ready for further analysis.

55 **Proximate analysis**

56 The methods of Association of Official Analytical Chemists [5] were used to determine the
57 chemical composition of the mushroom samples. The moisture content was determined by
58 drying the sample in an oven at 105± 1°C to a constant weight. Crude oils were determined
59 by continuous extraction in a Soxhlet apparatus for 4 h using hexane as solvent. After
60 evaporation of the solvent, the oil content was obtained by gravimetric method. Ash was
61 calculated from the weight remaining after incinerating the sample at 550°C for 2 h in a
62 muffle furnace. Crude protein was calculated by nitrogen x 4.38 (for mushroom). Crude fibre
63 was determined gravimetrically while total carbohydrate was obtained by difference method
64 [6]. Energy content was estimated by multiplying the crude protein, fat and carbohydrate by
65 their AT WATER factor of 4, 9, 4 respectively [7].

66 **Mineral composition**

67 Mineral elements were determined by dissolving the ash in a drop of trioxonitrate (iv) acid
68 made up to 50 ml with deionised water. The solution was then analyzed for Ca, Mg, Zn and
69 Fe using Atomic Absorption Spectrophotometer (AAS) while Na and K contents were
70 determined on Flame Emission Spectrophotometer (FES).

71

72 **Antinutrient compositions**

73 The tannin content was determined using [8] methods while phytate, and oxalate contents
74 were determined by the methods described by A.O.A.C. [9] respectively.

75 **Results and Discussion**

76 **Results**

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Table 1: Proximate Composition of *Pleurotus sajor-caju* at Different Growth Stages (%)

Parameter	Button	Egg	Full-grown
Moisture	91.64 ± 0.04	91.00 ± 0.01	90.25 ± 0.01
Crude protein	31.91 ± 0.01	32.52 ± 0.20	41.70 ± 0.01
Ether extract	2.96 ± 0.02	2.88 ± 0.01	2.78 ± 0.02
Crude fibre	18.84 ± 0.01	15.44 ± 0.02	6.60 ± 0.10
Ash	9.45 ± 0.05	9.75 ± 0.05	5.30 ± 0.01
NFE	36.84 ± 0.04	38.41 ± 0.01	47.62 ± 0.20
Energy (kcal/100g)	446.49	457.84	560.90

n=3

Except the moisture content which is on fresh weight basis, all are on dry basis

Table 2: Minerals in *Pleurotus sajor-caju* Mushroom at Different Growth Stages (mg/100)

Element	Button	Egg	Full- grown
Ca	25.14 ± 0.01	24.42 ± 0.02	42.64 ± 0.01
K	41.56 ± 0.10	41.98 ± 0.02	48.16 ± 0.20
Na	15.61 ± 0.01	18.46 ± 0.01	22.63 ± 0.10
Fe	4.61 ± 0.01	5.20 ± 0.01	8.70 ± 0.20
Mg	28.41 ± 0.01	29.13 ± 0.20	34.84 ± 0.01
Zn	6.24 ± 0.01	5.81 ± 0.01	3.46 ± 0.02
P	8.72 ± 0.01	7.84 ± 0.02	6.46 ± 0.01

n= 3

Table 3: Antinutrients in *Pleurotus sajor-caju* Mushroom at Different Growth Stages (mg/100g)

Antinutrients	Button	Egg	Full-grown
Oxalate	4.46±0.01	4.82±0.02	5.16±0.01
Phytate	38.14±0.02	38.65±0.05	40.27±0.05
Tannin	8.46±0.01	9.20±0.20	10.68±0.01

n= 3

Table 4: Reduction in the Antinutrients Levels after Boiling

Antinutrient	Button	CPR	Egg	CPR	Full-grown	CPR
Oxalate	2.05±0.02	54.04	2.10±0.05	56.43	2.24±0.04	56.59
Phytate	11.15±0.05	70.76	11.62±0.02	69.94	12.16±0.01	69.80
Tannin	3.25±0.01	61.58	3.40±0.05	63.04	3.16±0.01	70.41

n= 2

CPR – calculated percentage reduction

Discussion

Table 1 showed the proximate composition of *Pleurotus sajor-caju* at the button, egg and full grown stages. The moisture content varied from $90.25 \pm 0.01\%$ in full grown to $91.64 \pm 0.04\%$ in button stage. The decrease in the moisture content might be as a result of increase in other nutritive parameters. The high moisture content accounts for the spoilage of mushrooms within 1-3 days of harvest. The protein content varied from $31.91 \pm 0.01\%$ in button to $41.70 \pm 0.01\%$ in full grown. The full grown mushroom has the highest amount of protein content than the other two stages. This might be as a result of the fact that the cap is fully grown and protein is expected to be more concentrated in the cap as a sign of maturity than the stalk which dominated the button and the egg stages. The high protein content was in line with the work of [4] that cultivated mushroom contain higher concentration of protein than the wild type. [10] also reported higher protein in the cap of *Termitomyces robustus* and *Lentinus subnudus*. The crude oil contents of the three stages were low and varied from $2.78 \pm 0.02\%$ in full grown to $2.96 \pm 0.02\%$ in button stage, this observation compared favourably with the findings of [11,4] that reported low crude oil for mushrooms. The crude fibre content varied from $6.60 \pm 0.01\%$ in full grown to $18.84 \pm 0.10\%$ in button. The egg and button stages contained high fibre content which could be as a result of the fact that stalk of mushrooms have been found to contain higher crude fibre concentration than the cap [10]. Since both the egg and button stages are more of stalk than cap, hence the high values reported from this research work. The carbohydrate content varied from $36.84 \pm 0.04\%$ in button stage to $43.62 \pm 0.20\%$ in full grown which showed that the full grown stage of *Pleurotus sajor-caju* contained more carbohydrate than the other two stages. The calculated energy value in Kcal/100g varied from 446.49 in button stage to 500.90 in full grown stage and this showed that full grown *Pleurotus sajor-caju* would supply more energy when consumed than the button and egg stages.

Table 2 showed the values of some nutritive mineral elements. Potassium in mg/Kg was found to have highest concentration of in the three stages with the full grown stage having the highest value of 48.16 ± 0.20 and button stage having the least value of 41.51 ± 0.10 . This is in line with the findings of other researchers on Nigeria agricultural products [12]. The next abundant element is calcium (Ca) which varied from 24.42 ± 0.02 in egg stage to 42.64 ± 0.01 in full grown stage while the sodium (Na) content varied from 15.61 ± 0.10 in button stage to 22.63 ± 0.10 in full grown stage. The low Na and high K (Na/K) showed a ratio of 0.37, 0.43 and 0.46 in egg, button and full grown stages respectively. This indicates that all the three growth stages in *Pleurotus sajor-caju* with Na/K ratio of < 1 can be used in treating cases of hypertension [4]. The magnesium (Mg) content also varied from 28.41 ± 0.01 in button to 34.84 ± 0.01 in full grown. Mg is also an important component of blood. Phosphorus (P) and zinc (Zn) contents varied from 6.46 ± 0.01 and 3.46 ± 0.10 in full grown to 8.72 ± 0.01 and 6.24 ± 0.01 in button stage respectively. This observation showed that button stage is more phosphorus and zinc than the full grown stage. The dietary phosphorus and zinc is related to the need for growth, repair, normal functioning of immune system and obligatory excretions [13].

Tables 3 and 4 showed the levels of some antinutrients of raw and boiled *Pleurotus sajor-caju* at the three growth stages. The oxalate content in mg/100g of the raw mushroom varied from 4.46 ± 0.01 in button stage to 5.16 ± 0.01 in full grown stage. The oxalate content was low but boiling still reduced it further as detected on Table 4 with calculated percentage reduction (CPR) of 54.04%, 56.43% and 56.59% in button, egg and full grown stages respectively. The phytates level was the highest among the toxicants determined with a range in mg/100g found to be 38.14 ± 0.02 in button stage to 40.27 ± 0.05 in full grown stage. The effect of boiling as seen on Table 4 showed the reduction in the phytates content to varied from 11.15 ± 0.05 in button to 12.16 ± 0.01 in full grown stage which showed a CPR of 70.76, 69.94 and 69.80 in

button, egg and full grown stages respectively. Tannin content in mg/100g was found to be 8.46±0.01, 9.20±0.02 and 10.38±0.01 in egg, button and full grown stages, these values were reduced to 3.25±0.01, 3.40±0.05 and 3.16±0.01 with CPR of 61.58, 63.04 and 70.71 in button, egg and full grown stages respectively. The difference in the concentration of antinutrients in materials has been ascribed to so many reasons including edaphic factors [14] such as moisture contents and mineral constituents among others.

Conclusion

From the results of the research work, it can be deduced that matured *Pleurotus sajor-caju* mushroom are richer in nutrients than the button and egg stages especially in protein and mineral elements. It is therefore advisable to harvest mushrooms when they are fully matured as it can provide a valuable source of protein especially to vegetarians. Antinutrients were also reduced by boiling and therefore proper cooking should be done before consumption in order to reduce these anti nutrients.

References

- Leichter, J. and Bandoni, R.J. (1980). Nutrient Content of Mushrooms Grown in British Columbia. *Canadian Institute of Food Science and Technology*. 13:122-128.
- Duyff, R. (2006). *American Dietetic Association's Complete Food and Nutrition Guide*. 3rd Addition. Wilson & Sons NJ.
- Rop, O., Micek, J. and Jurikova, T. (2009). β -glucans in Higher Fungi and Their Health Effects. *Nutrition Reviews*. 67:642-631.
- Oyetayo, F.L. and Akindahunsi, A.A. (2004). Nutrient Distribution in Wild and Cultivated Edible Mushroom, *Pleurotus sajor-caju*. *Food, Agric. & Environ*. Vol. 2: 166-168.
- A.O.A.C. (2005). Association of Official Analytical Chemists. Official Method of Analysis (19th edition), Washington D.C., U.S.A.
- Ardabili, A.G., Farhoosh, R. and Khodaparast, M.H.H. (2011). Chemical Composition and Physicochemical Properties of Pumpkin Seeds (*Cucurbita pepo subsp. Pepo var styriaca*) Grown in Iran. *J. Agric. Sci. Tech*. 13: 1053-1063.
- Aremu, M.O., Olonisakin, A., Bako, D.A. and Madu, P.C. (2006). Compositional Studies and Physicochemical Characteristics of Cashewnut (*Anarcadium occidentalis*) Flour. *Pak. J. Nutr*. 5(4): 328-333.
- Doss, A., Pugalenth, M., Vadivel, V.G., Subhashini, G. and Subesh, R.A. (2011). Effects of Processing Technique on the Nutritional Composition and Antinutrients Content of Under-utilized Food Legume *Canavalis ensiformis* L.C.D. *Int. Food Res. Jour*, Vol. 88 No. 3: 965-970.
- A.O.A.C. (1989). Association of Official Analytical Chemists. Methods of Determining Antinutrients Using Spectrophotometer. *Laboratory Science* 21:8-10.
- Ola, F.L. and Oboh, G. (2001). Nutrient Distribution and Zinc Bioavailability Estimation in Some Tropical Edible Mushroom. *Nahrung*. 45: 67-68.
- Ogbonda, K.H. (1997). Chemical Composition of Selected Mushrooms and Truffles Grown in Rivers State. *Nigerian Food Journal*. Vol. 15: 1-8.

- 225 Manzi, P., Gambelli, L., Marconi, S., Vivanti, V. and Pizzoferato, L. (1999). Nutrients in
226 Edible
227 Mushrooms: An Interspecies Comparative Study. *Food Chem.* 48:255-258.
- 228 Hassan, L.G., Sani, S.M. and Ladan, M.J. (2008). Nutritional Value of Bottle Gourd
229 (*Lagenaria*
230 *siceraria*) Seeds. *Global Journal of Pure and Applied Sciences*. Vol. 14. No. 3: 301-306.
- 231 Offor, C.E., Nweke, F.N., Okaka, A.N.C., Igwenyi, I.O. and Onwe, V.N. (2011). Analysis of
232 the
233 Antinutrient Levels in Staple Food Crops in Three Different Local Government Areas
234 of
235 Ebonyi State, Nigeria. *Cont. J. Food Sci. & Technol.* 5(1): 26-30.