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Nutritional and functional properties of protein concentrate from two edible mushrooms

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Abstract

Mushrooms (*Pleurotus florida* and *Pleurotus sajor-caju*) protein concentrates were prepared using the iso-electric precipitate method. Nutritional and functional properties of the concentrates were evaluated. *P-florida* had moisture content of 12.17%, which is higher than 10.51% obtained for *P-sajor-caju*. Significant differences existed in the protein content of mushrooms concentrates estimated by kjedahl method. *P-florida* and *P-sajor-caju* had estimated protein concentration of 38.33% and 54.55% respectively based on nitrogen content. The ash and crude fibre content were higher in *P-florida.* The fat content of the concentrates were less than 1%. Carbohydrate contents of P-*florida* and *P-sajor-caju* were 40.96 % and 30.14% respectively. Water absorption capacity in P-florida and P-sajor-caju were 3.09g/g and 3.39g/g respectively, while oil absorption capacity was within the range of 2.16g/g-1.49g/g of *P-florida* and *P-sajor-caju*. The loose bulk density varies as 0.30g/ml in p-florida and 0.44g/ml in p-sajor-caju. The bulk density ranged between 0.37g/ml in *P-florida* and 0.61g/ml in *P-sajor-caju*. It could be recommended that edible mushroom may be used as thickener and flavor enhancer in some food production.

Keywords: -Mushroom; Thickener; Enhancer; Iso-electric; Concentrates

1. Introduction

Mushrooms are among minor forest produce which presently are regarded as a macro - fungi that belongs to the class Ascomycetes [1]. For industrial use and human consumption, mushrooms have been reported to be the third most cultivated largest macro-fungus. Its identity as natural and healthy foods is an indicator for global acceptability. It has been consumed by humans since ancient times among other naturally grown fungi.

For decades, the use of Mushrooms for medicinal and food purposes had been explored. However, with respect to its use for nutritional purposes and enhancement of palatability, mushroom is still among the untapped resources. Though mushrooms are of high nutritional and functional value, they can also be taken as nutraceutical foods. Their consumption has been linked to their economic importance, medicinal properties and organoleptic merit [2;3].

Research reported that mushrooms protein value doubles that obtainable from vegetables and quadruples for oranges while significantly more than in wheat [4]. The nutritional content of Mushrooms makes it a suitable source of protein for diet enrichment, capable of use in countries where animal proteins are expensive or not available. Food and Agriculture Organization Publication in 1978 reported 3.7% as the protein content of fresh mushroom. According to Rai [5], comparatively the protein content of mushrooms on dry weight basis was reported to be 19-35% while rice, wheat, soybean, and corn were about 7.3%, 12.7%, 38.1% and 9.4% respectively.

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Mushrooms have been reported as a source of physiological beneficial and non-toxic medicines, having high proteins with the presence of essential amino acids. It is regarded as a nutritionally functional food due to its high fibre and minerals, and presence of vitamins [6]. When consumed, mushrooms impact health benefit which could be in the area of disease prevention or treatment; it can be considered as a nutraceutical and it has proven to be the richest sources of functional foods with it bioactive properties [7;8;9]. Due to its composition, mushrooms found its usefulness as a food supplements and inadvertently useful in promoting human health.

Of importance in the nutritional value of food are proteins. According to Pandey [10], high protein content of mushroom made it to be referred to as "Poor Man's Protein". And because mushrooms can provide all the essential amino acids for adult requirement which are found in animal protein, it has found popularity among vegetarians. Proteins elaborated by these fungi have shown several biological activities like anti-proliferative and other antibacterial effects [11].

In the last decade, mushrooms have attracted many researchers in food and pharmaceutical firms. Mushrooms have been seen as a mini-food that is also used in the industry to produce active components with potentials for outstanding biological properties [12]. Nowadays, commercialization of mushrooms as a food supplement due to their properties is majorly to enhance immune functions and antitumor activity [13;14;15].

This study aimed at concentrating protein from the two different edibles mushroom species and to determine the proximate and functional properties of the protein concentrate.

2. Materials and methods

2.1. Materials

Two different edible mushroom species namely; *Pleurotus florida* and *Pleurotus sajor-caju* was purchased from and identified by Forestry Research Institutes of Nigeria (FRIN), Ibadan, Oyo State. The purchased mushroom species were kept at 4 ^{o}C before further analysis.

2.2. Methods

2.2.1. Preparation of mushroom flour

The cleaned samples were sorted, weighed, washed, trimmed and dried to a constant weight using over dryer and then milled into flour using a grinder. The mushroom flour was packed for further isolation and concentration.

2.2.2. Method of concentration

The iso-electric precipitation method of [16] was used to concentrate protein from Mushrooms. Briefly as shown in figure 1, 10g of mushroom flour was homogenized with (100ml) NaOH solution (0.15M) and mixed for 2 hr at 35 ºC. pH meter (Hanna Model HI 8521) was used to monitor and maintain mixture pH at 9.91 before the mixture was further homogenized at 4 ºC using a Jouan model GR 4.11. The supernatant was recovered and the remainder pellet was centrifuged and re-dissolved in the 0.15M of NaOH solution as done with the mushroom sample. The pH of the mixture was adjusted to 9.91 as previously done and stirred at 4ºC for 30 minute and then centrifuged. Supernatants obtained from the two alkaline extractions were mixed with the addition of one-part volume of 95% (v/v) ethanol. While stirring, the pH of the mixture was adjusted to 4.5 and filtration was done with Whatsman No. 1 filter paper under vacuum to recover the precipitated proteins. Subsequently, freeze drying of the protein concentrate was done before it was ground and sieved through 150 µm mesh sieve.

2.3. Determination of proximate composition of flour

Ash, Crude fat, crude fibre, moisture and protein contents were determined using the AOAC [17] methods published by the association of analytical Chemist. Carbohydrate was calculated by difference (that is summation of ash, fat, protein, crude fibre and moisture contents were subtracted from 100). The Energy value (in kcals) was obtained by using factors of 2.44, 8.37 and 3.47 to multiply the percentages of crude protein, crude lipid and carbohydrate respectively as described for vegetables analysis [18].

2.4. Determination of functional properties of flour

The method described by [19] was used to determine bulk density while water absorption capacity was determined by the method of [20]. [21] method for determination of Oil absorption properties was used for samples. [22] method was used to determine the swelling index of flour samples.

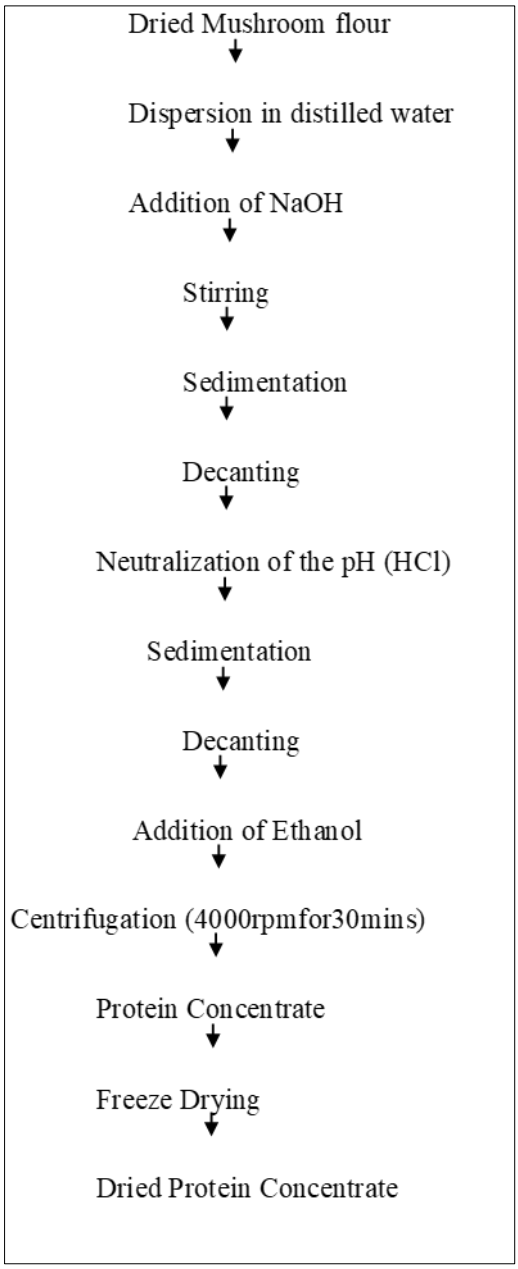

Figure 1 Concentration of Protein from edible Mushrooms

3. Results and discussion

3.1. Proximate composition of protein concentrated from mushroom

From Table 1, the moisture content of *P. Florida* (12.17%) was found greater than *P. Sajor caju* (10.51 %). Moisture content (9.2 %) obtained by Adejumo and Awosanya [23] on the work on *Lentinus trigrinus* (Bull). Fr. was lower than that determined in the present work. Higher value of mushroom moisture content increases its rate of perishability due to the tendency for high moisture content to promote enzymatic activity and microbial growth, thus accelerating spoilage.

The ash content of protein concentrate ranged from 4.09% for *P. sajor caju* to 6.88% in *P. Florida*. Ash content in *P. florida* (6.88%) was greater compared to *P.sajor caju* (4.09%).

The protein content of *P.sajor caju* (54.55%) was found to be greater than *P. Florida* which was 38.35%. The high protein content (38.33% in *P. florida* and 54.55% in *P. sajor caju*) showed the significance of protein isolate from the two edible

mushrooms. These results are similar to that reported by [24], that have the protein content range from 36.4% - 53.59% and [25] for beach pea (67.9% - 77.3%). Often times protein recovery is not total due to the presence of acid soluble protein which is lost during isolation. As observed by [26], when at the iso-electric pH and in alkaline conditions, 18% of extracted protein from chick pea flour (80.9%) remains soluble. Also formation of complex with seed components such as fibre could reduce the amount of protein isolated. In the work of [27] on protein isolate from *Chilcan* hazel nut seeds, it was observed that enzymatic hydrolysis of fibre increased extractability of protein. The crude fibre content in *P. florida* was greater than *P. sajor caju;* 1.62% and 0.64% respectively. The Crude fibre content (0.64 – 1.62%) is in the range of values previously reported for most legumes [28]. Research has proven that dietary fibre is of utmost importance in diet, as this is directly related to digestibility of food in the small intestine. The fat content in *P.sajor caju* was found to be 0.06% greater than *P. florida* (0.02%). The carbohydrate content of *P. florida (*40.96%) was greater than *P.sajor caju* (30.14%). The carbohydrate content obtained in the present work is comparable to that reported by Anthony and Joyce [29] for the mushroom specie *Volvariella valvacea*

The estimated metabolizable energy values (2043.77KJ in *P. sajor caju* and 2167.90 KJ in *P. florida)* indicated that the samples could be referred to as a good energy source since values obtained are comparable to that of cereals with respect to their energy content [30].

Table 1 Proximate analysis of protein concentrated from mushroom flours *P.florida* and *P. sajor caju*

Sample	***P. florida***	***P. sajor caju***
Moisture	12.17±0.45[a]	10.51±0.03[b]
Ash	6.88±0.77[a]	4.09±0.16[b]
Protein	38.33±0.07[b]	54.55±0.35[a]
Crude Fibre	1.62±0.14[a]	0.64±0.15[b]
Fat	0.02±0.01[b]	0.06±0.01[a]
Carbohydrates	40.96±1.31[a]	0.06±0.01[a]
Energy (kcal)	2167.90±49.50[a]	2043.77±6.26[b]

Values are means of the samples ± standard deviation of the duplicate determinations. Means having different superscript letter on same column are different significantly at P<0.05.

3.2. Functional Properties of Protein Concentrated from Mushroom

The Result of oil and water absorption capacities of protein concentrates are given in Table 4.2. *P. florida* and *P. sajor caju* water absorption capacity were 3.09 g/g and 3.39 g/g respectively. African yam bean colour varieties of flours had a lower value of 1.18 – 1.79g/g, and 1.30g/g in the case of groundnut [31]; 2.40% in various lima bean flours [32]; 1.30 – 1.40g/g in wheat flour [33] and 1.40g/g for oil seeds flours [34], 0.70 – 1.20g/g [35]. The high water absorptivity obtained in the present work is an indication that these varieties of protein-concentrated mushroom flours could be suitable for the production of foods such as sausage, baked products, processed cheese and soups [36].

The highest oil absorption capacity determined was 2.16g/g in *P. florida* and lowest value was from *P. sajor caju* (1.49g/g). The values obtained for different varieties of legume seeds flours, 1.27 – 1.72g/g [32], Jack bean flour, 1.70g/g [37], and *Blighia sapida K*. Konig pulp and seed flours, 1.25 – 1.31g/g [38] are lower than the values obtained in the present study. Oil absorption capacity is critical due to the ability of oil to enhance mouth feel of foods, and also act as flavor retainer. Researches have opined that oil capacity of flours varies due to non-polar side chains that bind the hydrocarbon side chains of oil [37]. The oil absorption capacity obtained for the edible mushroom protein concentrate flours is an indication of their potential suitability for structural interaction in food. Specifically, this flavours enhancement of food palatability, retention of food flavor, alongside with making the food material shelf stable, especially in baked foods or meat products where fat absorption is desirable.

The result of least gelation concentration in the present study is 2.00% in both varieties. Having the same value for the least gelation concentration is an indication of relative ratio of protein, carbohydrates and lipid content. The least gelation concentration described as the least protein value at which gel stays in the inverted tube was considered as the gelation capacity index. According to [38], gelation ability of protein ingredient is inversely related to the least gelation concentration. Gel formation is related to the ability of protein to provide a structural matrix for holding water, flavours, sugars and food ingredients is an essential part of new product development. This added a new perspective to functional

property of protein [39;40]. The low gelation concentration reported in the present study is an indication of the usefulness of these flours for curd formation or their suitability as additive when used with other gel-forming food materials.

The loose bulk density values ranged between 0.30g/ml (*P. florida)* to 0.44g/ml (*P. sajor caju)*. The tapped density values ranged between 0.37g/ml in *P. florida* and 0.61g/ml in *P. sajor caju.* Higher values were obtained for samples of extrusion texturized soya products with varied soluble sugar contents and protein (2.38 – 4.46g/ml) and processed defatted fluted pumpkin seed flours (1.80 – 3.80g/ml) [41]. The values reported by [28] for the rare cowpea flour, 5.31g/ml and bambara groundnut flour, 5.86g/ml were also higher than that obtained in the present work.

Table 2 Functional properties of protein isolated from mushroom flours *P. florida* and *P. sajor caju*

Property apparent	***P. florida***	***P. sajor caju***
Water Absorption Capacity	3.09±0.35^{b}	3.39±0.16^{a}
Oil Absorption Capacity	2.16±0.22^{a}	1.49±0.08^{b}
Least Gelation Concentration	2.00±0.00^{a}	2.00±0.00^{a}
Loose Bulk Density	0.30±0.12^{b}	0.44±0.02^{a}
Tapped Density	0.37±0.01^{b}	0.61±0.03^{a}

Values are means of the samples ± standard deviation of the duplicate determinations. Means having different superscript letter along the same column are significantly different ($P<0.05$).

4. Conclusion and recommendation

In this study, it could be concluded that the production of good quality edible mushroom (*P. sajor caju* and *P. florida*) concentrate had helped us to know the nutritional composition in the mushroom concentrates. Since it contains high protein and moderate ash content, this could serve as a good source of nutrient to human body. This could be utilized in the formulation and fortification of high starchy staple or low proteinous foods. The functional properties showed that it can be used as a thickener and flavor enhancer in the food system. It is therefore recommended that the anti-nutritional composition of the products must be carry out to ascertain any available anti-nutrient that could be harmful for human consumption and knowing their tremendous medicinal, drugs and mineral values since they are valuable assets for human welfare.

Compliance with ethical standards

Acknowledgments

All authors contributed equally to the conception and design of the study.

Disclosure of conflict of interest

No conflict of interest to disclosed.

Statement of ethical approval

The present research work does not contain any studies performed on animals'/humans subjects by any of the authors

References

[1] Fukushima M, Ohashi T, Fujiwara Y, Sonoyama K, Nakano M. Cholesterol- lowering effects of maitake (Grifola frondosa0 fiber, shiitake (Lentinus edodes) fiber, and enokitake (Flammulina velutipes) fiber in rats. ExpBiol Med [Maywood], 2001 Sep, 226(8): 758 - 765.

[2] Chang ST, Miles PG. Mushrooms: cultivation, nutritional value, medicinal affect, and environmental impact, CRC press, 2nd ed. Boca Raton; Fla, USA: 2008.

[3] Ergonul PG, Akata I, Kalyoncu F, Ergonal B. Fatty acid compositions of six wild edible mushroom species. Scientific world journal, 2013 Jun, doi:10.1155/2013/163964.

[4] Aletor VA. A Monograph prepared for the presidential task force on Alternative formulation livestock feed products Development, Quality, Evaluation and Health Implications. Cabinet Office, Lagos, Nigeria. 1990.

[5] Rai RD. Nutritional and medicinal values of mushrooms. Advances in horticulture 12th eds Chandra and Sharma SR, New Delhi, Malhotra publishing house. 1995.

[6] Mattila P, Salo- Vaananen P, Konko K, Aro H, Jalava T. Basic composition and amino acid contents of mushrooms cultivated in Finlands. J. Agric food chem.2002 Oct, 50 (9): 6419-6422.

[7] Ribeiro B, Valentao P, Baptista P, Senbra RM, Andra de, PB. Phenolic compounds, organic acids profiles and antioxidative properties of beefsteak fungus (Fistulina hepatica). Food chem. toxicol., 2007 Oct, 45: 1805-1813.

[8] Kruger CL, Man SW. Safety evaluation of functional ingredients. Food and chemical Toxic.,2003 Jun, 41 :793-805.

[9] Caglaririmak N. The nutrients of exotic mushrooms (Lentinula edodes and Pleurotus species) and an estimated approach to the volatile compounds. Food chem,2007, 105 :1188-1194.

[10] Pandey N. Chemical analysis of mushroom of Kathmandu valley, submitted to university Grant Commission. 2004.

[11] Jonathan SG, Fasidi JO. Antimicrobial activities of the Nigerian edible macro-fungi Lycoperdon pusilum [Bat Ex] and Lycoperdon giganteum (pers). African J. Biomed, 2003, 6: 85- 90.

[12] Patal S, Goyal A. Recent developments in mushrooms as anticaular theraoentics a review, 3. Biotech, 2012 Mar, 2 (1): 1-15.

[13] Guillamon E, Garcia A, Lafuente M, Lozano...-Fitoterapia. Edible mushroom s: role in the prevention of cardiovuscular diseases Physiotherapy. Elsevier, 2010 Oct, 81(7): 715-723.

[14] Barros L, Ferreira MJ, Queiros B, Ferreira ICFR, Baptists P. Total phenols,ascorbic acid,beta- carotene and lycopene in Portuguese wild edible mushrooms and their antioxidant activities. Food chem, 2007 Dec, 100 :413-419.

[15] Finimundy TC, Gambato G, Fontana R, Camassola M, Salvador M, Moura S, Hess J, Henriques JAP, Dillon AJP,Roesch – Ely M. Agucous extracts of lentinulaedodes and Pleurotus sajur-caju exhibit high antioxidant capability and promising in vitro antitumor activities. Nutrition the search, 2013 Jan, 33(1): 76 – 84.

[16] [Mune MA, Minka SR, Mbome LI. Response surface methodology for optimization of proteinconcentrates preparation from cowpea (Vigna unguculate L walp). Food chem, 2008 Oct, 110: 735 – 740.

[17] AOAC. Association of official analytical chemists, official method of analysis (18th edition AOAC Intl., USA. 2005.

[18] Ijarotimi SO, Oluwole AA, Ariyo O. Comparative study on nutrient composition, photochemical, and functional characteristics of raw, germinated, and fermented moringa Oleifera seed flour. Fd. Sci and Nut, 2013 Nov, 1(6): 452-463.

[19] Mbofung CMF, Njintang Abou bakar. YN, Abdou Bouba A, Balaam F. Physicochemical and functional properties of six varieties of taro (Colocasia esculanta L.schoott) flour. Journal of food technology,2006 Jan, 4 (2):135-142.

[20] Sosulski FW, Garatt MO, Slink and Van AE. Functional properties of ten legume flours. Inter J. Food sci technol., 1976, 9: 66-69.

[21] Sathel SK, Pont LG, Rangnekar PD, Salunkhe DK. Effect of addition of great northern bean flour and protein concentrates on the rheological properties of dough and baking quality of bread. Cereal chem, 1981, 58:97-100.

[22] Tharise N, Juliana F, Nurminah M. Evaluation of physic-chemical and functional properties of composite flour from cassava, rice, potato, soybean santhan gum as alternative of wheat flour. Int. food research, 2014 Jan, 21: 141-164

[23] Adejumo TO, Awosanya BO. Proximate and mineral composition of edible mushroom species from South Western Nigeria. Afri J. biotech, 2005, 4(10): 1084-1087.

[24] Mwasaru MA, Muhammad K, Bakar J, Che Man YB. Effects of isolation technique and conditions on the extractability physiochemical and functional properties of pigeon pea (Cajanus cajan) and cowpea (Vigna unguiculata) protein isolates physicochemical properties. Food chem,1999,67: 435 – 443.

[25] Chavan U D, Mckenzie DB, Fereidoon Shahidi F. Protein classification of beach pea. Food chemistry, 2001 Nov,75: 145-153.

[26] Sanchez- Vioque R, Clementa A, Vioque J, Bantiste J. Protein isolates from chickpea (Cicer arietinum L.) chemical composition functional properties and protein characterization. Food chemistry, 1999, 64 (2): 37-243.

[27] Moure A, Franco D, Sineiro J, Dominguez H, Nunez MJ, Lema JM. Evaluation of extracts from Gevuina avellanel hulls as antioxidants. J. Agric Food Chem, 2002 Sep, 48: 3890 – 3897.

[28] Aremu MO, Olaofe O, Akintayo ET. A comparative study on the chemical and amino acid composition of some Nigerian under-utilized legume flours. Pak J Nutri, 2006, 5 (1): 34-38.

[29] Anthony MM, Joyce C. Proximate and nutrient composition of three types of indigenous edible wild mushrooms growth in Tanzania and their utilization prospects.African journal of food ag riculture nutrition and development, 2007 Nov, 7 (6).

[30] Brain AF, Atlan GC. Food Science: A chemical approach, 3rd edition, Ellis Horwood Manchester,England, 1977, 3: 1-341.

[31] Lin CH, Sheu GT. A new immune-modilatory protein from Ganoderma-microsporum inhibit epidermal growth factor mediated migration and invasion in A549 lung Cancer cells process Biochemistry, 2010, 45(9): 1537 -1542.

[32] Aremu MO, Olaofe O, Akintayo ET. Functional properties of some Nigerian varieties of legume seed flours and flour concentration effect on foaming and gelation properties. J. Food technology, 2007 Jan, 5(2):109-115.

[33] Oshodi AA, Adelakun AO. Proximate composition, some valuable minerals functional properties of three varieties of Lima bean flour. Int. J. Food sci. and Nutr, 2009 Jul, 43: 175 – 181.

[34] Adeyeye EI, Aye PA. Chemical composition and the effect of salts on the food properties of Triticum durum wholemeal flour. Pak J. of Nutr., 2005 Mar, 4(3): 187-196.

[35] Olaofe O, Adeyemi FO, Adediran UO. Amino acid, chemical composition and functional properties of some oil seeds. Journal of Agric. Food chem., 2010 Aug, 42(4): 879 -881.

[36] Aremu MO, Olaofe O, Akintayo ET. Foaming waste absorption, emulsification and gelatin properties of cresting's groundnut (Kerstigella geocarpa) and Bambara groundnut (Vigna subterranean) flour as influenced by neutral salts and their concentrations. Pak. J Nutr., 2008 Jan, 7(1): 194- 201.

[37] Adebowale KO, Lawal OS. Comparative study of the functional properties of Bambara groundnut (Voandzeia sublenanca), Jack bean (Canavalia ensiformins) and mucum bean (Mucuna pruriens) flours. Food Res. Int., 2004 May, 37(4): 355-365.

[38] Akintayo E, Adebayo EA, Arogundade L. Chemical properties of a kee pulp and seed flours. Food chem. Journal, 2002 Jun, 77(3): 333-336.

[39] Oshodi AA, Olaofe O, Hall GM. Amino acid, fatty acid and mineral composition of pigeon pea (Cajanus cajan). Int. J. Food Sci. Nut., 2009 Jul, 43(4):187-191.

[40] Aremu MO, Basu SK, Gyar SD, Goyal A, Bhowmik PK, Datta Banik S. Proximate composition and functional properties of mushroom flours from Ganoderina spp. Omphalotus olearius (DC) sing and Hebeloma mesophaeum (pers.) quel. used in Nasarawa state, Nigeria. Mal. J. Nutri.,2009 Sep, 15(2): 233-241.

[41] Fagbemi TN, Oshodi AA, Ipinmoroti KO. Processing effect on some anti-nutritional factors and in vitro multi enzyme protein digestibility (NPD) of three tropical seeds. Breadnut (Articarpus altilis), cashew nut (Anacardium occidentalis) and fluted pumpkin (Telfairia occidentalis). Parkistan Journal of nutrition,2005, 4(4): 250-256.