Asian Journal of Advances in Agricultural Research

1(1): 1-7, 2017; Article no.AJAAR.33551

Nutritional Evaluation of *Lentinus sajor-caju* (Fr.) Mushroom at Different Growth Stages and Effect of Boiling on Antinutrient Components

G. O. Oyeleke[1*], E. O. Olagunju[1], T. Busari[1], A. D. Ishola[1] and R. T. Lawal[1]

[1]Department of Science Laboratory Technology, Osun State Polytechnic, P.M.B. 301, Iree, Nigeria.

Authors' contributions

This work was carried out in collaboration between all authors. Author GOO designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors EOO, TB, ADI and RTL managed the analyses of the study and the literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJAAR/2017/33551
Editor(s):
(1) Tancredo Souza, Centre for Functional Ecology, Department of Life Sciences, University of Coimbra, Portugal.
Reviewers:
(1) Paulin Mutwale Kapepula, University of Kinshasa, Congo.
(2) Fatih Kalyoncu, Manisa Celal Bayar University, Manisa, Turkey.
(3) Eduardo Bernardi, Universidade Federal de Pelotas, Brazil.
Complete Peer review History: http://prh.sdiarticle3.com/review-history/19481

Original Research Article

Received 20th April 2017
Accepted 11th May 2017
Published 12th June 2017

ABSTRACT

The proximate composition, some mineral elements and antinutrients components of *Lentinus sajor-caju* (Fr.) mushroom at different growth stages (button, egg and mature) were determined using standard methods of analysis. The mature stage has the highest values of percentage crude protein (41.70± 0.01) and carbohydrate (43.62± 0.20) contents. The mineral elements analyses in mg/kg revealed that mature 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 level of antinutrients (oxalates, phytates and tannins) in raw was reduced by boiling. Phytates in mg/100 g was found to be 40.27± 0.05 in raw mature sample which was reduced by boiling to 12.16± 0.01 (69.80% reduction). The same trend was obtained for oxalates and tannins components with 56.59% and 70.41% reduction respectively after boiling. The results of this work revealed that mature stage is more nutritious than those from button and egg stages especially in crude protein and mineral elements. Boiling was found to be a means of reducing antinutrient components of the samples.

**Corresponding author: Email: mr.oyeleke@yahoo.com;*

Keywords: Proximate; mineral; nutritious; reduction; egg; button; mature.

1. 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 edible portion of mushroom 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]. The fruiting body formation starts with tiny clusters of white hypha aggregates called primordial and it is followed by several morphological stages in the fruiting body development process. The successive stages are called button, egg, elongation and mature stages respectively. Differentiation can be seen first at the button stage. At maturity, the buttons enlarge and umbrella –like fruit bodies emerged. *Lentinus* 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, elongation and mature [4], it therefore necessary to determine the stage at which it can be harvested for optimum utilization of the nutrients. Several substrates such as millet seeds, enriched saw dust, corn cobs of maize e.t.c. have been used as substrates to ensure a high production of mushrooms [5-7]. The main focus of this research work is to determine the nutrient and antinutrient components of the different stages of growth as well as the effect of boiling on the antinutrient levels in order to determine the stage at which the mushroom would be more useful to the body nutritionally as much work has not been directed towards this aspect in the years past while available ones are contradicting.

2. MATERIALS AND METHODS

2.1 Sample Collection

The production of cultivated *L. sajor-caju* (Fr.) mushroom was done according to the methods of Oyetayo and Akindahunsi [6] where corn cobs of maize were shredded into pieces of between 13 cm long and soaked in water to achieve moisture content of 60-65%. Polypropylene bags were filled with moist corn cobs substrate sterilized at 121°C for 15 min. After cooling, the substrate was incubated with the mushroom spawn for 30 days with regular watering. Since the period between elongation and mature stages is very short, samples (cap and stalk) were therefore collected at the button, egg and mature stages, cleaned to remove dirt, cut into small bit, oven dried (at 60°C) and grinded in a laboratory blender (Philip Harris model). The powered products were passed through a 2 mm sieve, kept in a polythene bag inside a refrigerator at 4°C ready for further analysis.

2.2 Proximate Analysis

The methods of Association of Official Analytical Chemists [8] were used to determine the moisture, ash, crude oil and protein contents of the mushroom samples. The moisture content was determined by drying the sample in an oven at 105± 1°C to a constant weight. Crude oils were determined by continuous extraction in a Soxhlet apparatus for 4 h using hexane as solvent. After evaporation of the solvent, the oil content was obtained by gravimetric method. Ash was calculated from the weight remaining after incinerating the sample at 550°C for 2 h in a muffle furnace. Crude protein was calculated by nitrogen x 4.38 (for mushroom). Crude fibre was determined gravimetrically while total carbohydrate was obtained by difference method [9]. Energy content was estimated by multiplying the crude protein, fat and carbohydrate by their AT WATER factor of 4, 9, 4 respectively as reported by Aremu et al. [10].

2.3 Mineral Composition

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

2.4 Antinutrient Compositions

The tannin content was determined using the method described by Doss et al. [11] while phytate and oxalate contents were determined by the methods described by A.O.A.C. [12] respectively.

3. RESULTS AND DISCUSSION

3.1 Results

The results of the proximate, minerals and antinutrient components of the mushroom at different growth stages as well as the effect of boiling on the antinutrient levels are presented on Tables 1, 2, 3 and 4 respectively.

Table 1 showed the proximate composition of *L. sajor-caju* at the button, egg and mature stages. The moisture content varied from 90.25±0.01% in mature to 91.64±0.04% in button stage. Oyetayo and Akindahunsi [6] reported a range of 10.09 - 12.60% and 10.20-12.60% moisture for dried samples of cultivated and wild *Pleurotus sajor-caju* mushroom respectively. The high moisture content accounts for the spoilage of fresh mushrooms within 1-3 days of harvest.

The protein content varied from 31.91±0.01% in button to 41.70±0.01% in mature, this values compared well with 30-40%, 28.68 - 40.49% and 27.20% protein reported by Vodouhe and Capo-chichi [13], Achu et al. [14] for egusi seeds and Maina and Aliyu [15] for Guna seed. The higher amount of protein found in mature mushroom compared to the other two stages 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 of the mature sample was in line with the work of Oyetayo and Akindahunsi [6]. Ola and Oboh [16] also reported higher protein in the cap of *Termitomyces robustus* and *Lentinus subnudus*. The protein content of the three samples suggests that they can contribute to the daily protein need of 23.6 g/100 g for adults as reported by Ajayi et al. [17].

The crude oil contents of the three stages varied from 2.78±0.02% in mature to 2.96±0.02% in button stage, this observation compared favourably with the previous findings of Ogbonda [18] and Oyetayo and Akindahunsi [6] that reported low crude oil for mushrooms. The results were in agreement with the range of 1-20% and 2-8% fat contents in mushrooms as reported by Rambelli [19] and Farr [20] respectively.

The crude fibre content varied from 6.60±0.01% in mature to 18.84±0.10% in button. The crude fibre values were higher than 4.63% obtained by Khattab et al. [21] for some legume seeds but lower than 19-25%, 21-38%, 28% and 29% required by children, adult, pregnant and lactating mothers respectively [22]. The egg and button stages contained high fibre which could be linked to the report of Ola and Oboh [16] that stalk of mushroom contain higher crude fibre than the cap. Since both the egg and button stages are more of stalk than cap, hence the high values reported in this research work.

The ash contents varied from 5.30% in mature to 9.75% in egg stage. The ash contents of the three samples were higher than 2.12% reported for *Citrullus ecirrhosus* by Umar et al. [23]. The low ash content in the mature sample was in close agreement to that obtained by Ardabili et al. [9] and Al-fawaz [24]. Ash content determination has been reported to be an index of the quality of feeding materials used by animal feed producers for poultry and cattle feeding [25].

The NFE contents varied from 36.84±0.04% in button to 43.62±0.20% in mature which showed that it contained more carbohydrate than the other two stages. The NFE contents of the three samples were slightly lower than the value reported for cowpea [21] but higher than the range of 28.67-34.54% obtained for three species of bean seeds [26]. NFE provides the necessary calories in the diets and promotes the utilization of dietary fats.

The calculated energy value in Kcal/100 g varied from 446.49 in button stage to 500.90 in mature stage and this showed that the mature stage would supply more energy when consumed than the button and egg stages. The values obtained here were relatively higher than 295.37 Kcal/100 g obtained for *Senna siamea* [27] but lower than 601.7 Kcal/100 g for *C. ecirrhosus* seed [23].

Table 2 showed the values of some nutritive mineral elements. K in mg/kg was found to have highest concentration in the three stages with the mature 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 Aremu et al. [10] and Manzi et al. [28] on Nigeria agricultural products. The values were considered low compared to the range of 447.3 – 544.0 mg/100 g obtained by Ghanya et al. [29] for *Nigella sativa* seeds.

The next abundant element is Ca which varied from 24.42±0.02 in egg stage to 42.64±0.01 in mature stage and these are considered low to the values reported for *Nigella sativa* seeds by the same authors. The concentration of Ca in the mature sample is higher than 35.5 mg/100 g for *Caesalpinia pulcherrima* seed [30]. Ca is essential for muscle contraction while deficiency can lead to rickets and osteomalacia situations.

The Na content varied from 15.61±0.10 in button stage to 22.63±0.10 in mature stage. These values were found to be much higher than 0.75 mg/100 g and 13.0 mg/100 g reported by Al-Jassir [31] and Ojieh et al. [32] for black cumin and egusi seeds respectively. Na is useful in body fluid balance and glucose absorption. The low amounts of Na in the samples might be an advantage because excessive intake of Na in human can result in arterial hypertension while it deficiency can cause body dehydration, poor growth and reduced utilization of digested protein [33]. The Na/K with a ratio of 0.37, 0.43 and 0.46 in egg, button and mature stages respectively is an indication that all the samples from the three growth stages with Na/K ratio of < 1 can be used in treating cases of hypertension as reported by Oyetayo and Akindahunsi [6].

The Mg content also varied from 28.41±0/01 in button to 34.84±0.01 in mature samples. The Mg and Fe contents of our own results were lower compared to 68.50 and 15.0 (mg/100 g) obtained by Yusuf et al. [34] for Pride of Barbados seed nuts. Mg is an important component of blood and also useful in cellular respiration [27]. It can easily be obtained from green leafy vegetables because it is a component of chlorophyll [35]. The Fe contents varied from 4.61 mg/100 g in button stage to 8.70 mg/100 g in mature stage. The Fe contents of the three samples were very low to 49.40 mg/100 g reported for *C. ecirrhosus* seed [23]. Fe is an essential trace element for haemoglobin formation and in oxidation of carbohydrates, proteins and fats [36].

P and zinc Zn contents varied from 6.46±0.01 and 3.46±0.10 in mature to 8.72±0.01 and 6.24±0.01 in button stage respectively. The Ca/P ratios of 2.9, 3.1 and 6.6 were obtained for button, egg and mature stages respectively. The three samples could be termed as good foods based on the observations of Nieman [37] that good foods should have Ca/P > 1 and poor foods Ca/P < 0.05. The same author also reported that Ca/P > 2 helps to increase the absorption of calcium in the small intestine. Our results showed that button and egg stages are more of phosphorus and zinc than the mature stage. Dietary phosphorus and zinc are required for body growth, normal functioning of immune system and obligatory excretions [38]. The Zn contents of the three samples were quantitatively lower than the value reported for *Citrullus lanatus* seeds [32] and 15 mg recommended as dietary allowance for human adults [39]. Zn has been reported to be involved in enzyme activities as well as in wound healing [40] and in the management of diabetes [33].

Tables 3 and 4 showed the levels of some antinutrients of raw and boiled *L. sajor-caju* at the three growth stages. The oxalate content in mg/100 g of the raw mushroom varied from 4.46±0.01 in button stage to 5.16±0.01 in mature stage. The oxalate values obtained for the samples were considered low compared with 45.51 mg/100 g in *Senna siamea* seeds [27]. McDonald et al. [41] observed that oxalate will inhibit Ca absorption at low pH.

Boiling was found to reduce the oxalate contents with CPR of 54.04%, 56.43% and 56.59% in button, egg and mature stages respectively.

The phytates level was the highest among the toxicants determined with a range in mg/100 g found to be 38.14±0.02 in button stage to 40.27±0.05 in mature stage. The values for phytates obtained for the three samples were found to be lower to those obtained by Abeke et al. [42] for *Lablab purpurens* beans. The effect of boiling showed a reduction in the phytate

Table 1. Proximate composition of *L. sajor-caju* at different growth stages (%)

Parameter	Button	Egg	Mature
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/100 g)	446.49	457.84	560.90

n= 3, Except the moisture content which is on fresh weight basis, all are on dry basis, NFE = Nitrogen Free Extract

Table 2. Minerals in *L. sajor-caju* mushroom at different growth stages (mg/100)

Element	Button	Egg	Mature
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 *L. sajor-caju* mushroom at different growth stages (mg/100 g)

Antinutrient	Button	Egg	Mature
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 (mg/100 g)

Antinutrient	Button	CPR	Egg	CPR	Mature	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	**70.77**	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 = 3, CPR = Calculated Percentage Reduction

contents from 11.15±0.05 in button to 12.16±0.01 in mature stage with CPR values of 70.77, 69.94 and 69.80 in button, egg and mature stages respectively.

Tannin content in mg/100 g was found to be 8.46±0.01, 9.20±0.02 and 10.38±0.01 in egg, button and mature stages which are higher to the value reported by Bawa et al. [43] for *Parkia filicoidea* seeds. These values were reduced to 3.25±0.01, 3.40±0.05 and 3.16±0.01 with CPR values of 61.58, 63.04 and 70.71 in button, egg and mature stages respectively after boiling.

Generally, the difference in the concentration of nutrients and antinutrients components in materials has been ascribed to so many reasons including edaphic factors [44] such as moisture contents, substrate used and mineral constituents among others.

4. CONCLUSION

This research work has indicated that the three stages of growth of *L. sajor-caju* mushroom are good sources of nutrients. From the results of this work, it can be deduced that mature stage of *L. sajor-caju* mushroom is 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 be a valuable source of protein especially to vegetarians. Antinutrient components were also reduced by boiling and therefore proper cooking should be done before consumption in order to reduce these anti nutrients.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Leichter J, Bandoni RJ. Nutrient content of mushrooms grown in British Columbia. Can. Inst. Food Sci. & Techn. 1980; 13:122-128.
2. Duyff R. American Dietetic Association's Complete Food and Nutrition Guide. 3rd Addition. Wilson & Sons NJ; 2006.
3. Rop O, Micek J, Jurikova T. β -glucans in higher fungi and their health effects. Nutr. Rev. 2009;67:642-631.
4. Tao Y, Van peer AF, Chen B, Chen Z, Zhu J, Deng Y, Jiang Y, Li S, Wu T, Xie B. Gene Expression profiling reveals large regulatory switches between succeeding stipe stages in *Volvariella volvacea*. PLOS ONE. 2014;9(5):e97789.
DOI: 10.1371/journal.pone.0097789.
5. Mata G, Gaitan-Hernandez R, Perez-Merrlo R, Ortega C. Improvement of shiitake spawn for culturing on pasteurized wheat straw. In: Sanchez JE, Huerta, G., Montiel, E, Editors. Mushroom Biology and Mushroom Product. UAEM. Mexico. 2002; 303-309.
6. Oyetayo FL, Akindahunsi AA. Nutrient distribution in wild and cultivated edible mushroom, *Pleurotus sajor-caju*. Food, Agric. & Environ. 2004;2:166-168.
7. Przybylowics P, Donoghue J. The art and science of mushroom cultivation. Kendall/Hunt Publishing Company. Dubuque, Shiitake Growers Handbook; 1990.
8. A.O.A.C. Association of Official Analytical Chemists. Official Method of Analysis (19th edition), Washington D.C., U.S.A; 2005.
9. Ardabili AG, Farhoosh R, Khodaparast MHH. Chemical composition and physicochemical properties of pumpkin seeds (*Cucurbita pepo subsp. Pepo var styriaka*) Grown in Iran. J. Agric. Sci. Tech. 2011;13:1053-1063.
10. Aremu MO, Olonisakin A, Bako DA, Madu PC. Compositional studies and physicochemical characteristics of cashewnut (*Anarcadium occidentalis*) flour. Pak. J. Nutr. 2006;5(4):328-333.
11. Doss A, Pugalenthi M, Vadivel VG, Subhashini G, Subesh RA. 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. 2011;88(3):965-970.
12. A.O.A.C. Association of Official Analytical Chemists. Methods of Determining Antinutrients Using Spectrophotometer. Laboratory Science. 1989;21:8-10.
13. Vodouche SR, Capo-Chichi. Egusi high protein crop with multiple uses but neglected and under-utiltzed. Bullettin CIEPCA/West Africa Cover Crops. Cotonou, Republic of Benin. 1996;6.
14. Achu MB, Fokou E, Tchiegang C, Fotso M, Tchouanguep FM. Nutritive value of cucurbitaceae oilseeds from different regions in Cameroon. Afri. J. Biotechnol. 2005;4(11):1329-1334.
15. Maina CY, Aliyu HM. Extraction and characterisation of Guna Oil. Int. J. Food Agric. Res. 2009;6:93-100.
16. Ola FL, Oboh G. Nutrient distribution and zinc bioavailability estimation in some tropical edible mushroom. Nahrung. 2001;45:67-68.
17. Ajayi IA, Oderinde RA, Kajogbola DO, Uponi JI. Oil content and fatty acid composition of some underutilized legumes from Nigeria. Food Chem. 2006; 99:115-120.
18. Ogbonda KH. Chemical composition of selected mushrooms and truffles grown in Rivers State. Nig. Food J. 1997;15:1-8.
19. Rambelli A. Manual of mushroom cultivation. FAO Plant Production and Protection Paper 43. Rome; 1983.
20. Farr DF. Mushroom industry: Diversification with addition species in the United States. Mycologia. 1983;75(2):351-360.
21. Khattab RY, Arntfield SD, Nyachoti CM. Nutritional quality of legume seeds as affected by some physical treatments. Part 1. Protein Quality Evaluation. LWT. Food Sci. & Tech. 2009;42:1107-1112.
22. Ishida H, Suzuno H, Sugiyama N, Innami S, Todokoro T, Maekawa A. Nutritional evacuation of chemical components of leaves, stalks and stem of sweet potatoes (*Ipomea batatas poir*). Food Chem. 2000; 68:359-367.
23. Umar KJ, Hassan H, Wasagu RSU. Nutritional composition of the seeds of wild melon (*Citrullus ecirrhosus*). Pak. J. Biol. Sci. 2013;16:536-540.
24. Al-Fawazi MA. Chemical composition and oil characteristics of pumpkin (*Cucurbita*

maxima) Seed Kernels. Res Buil., No (129). Food Sci. Agric. Res. Centre King Saud Univ. 2004;5-18.
25. Esuoso K, Lutz H, Kutubuddin M, Bayer E. Chemical composition and potential of some underutilized tropical biomass 1: Fluted pumpkin (*Telfairia occidentalis*). Food Chem. 1998;61:487-492.
26. Kisambara A, Muyonga JH, Byaruhanga YB, Tukamuhabwa P, Tumwegamire S, Grunberg WJ. Composition and functional properties of yam bean *(Pachyrhizus* spp*)* seed flour. Food & Nutr. Sci. 2015;6:736-746.
27. Ingweye JN, Kalio GA, Ubua JA, Effiong GS. The potentials of a lesser known Nigeria Legume, *Senna siamea* Seeds as a Plant Protein Source. Austr. J. Basic & Appl. Sci. 2010;4(8):2222-2231.
28. Manzi P, Gambelli L, Marconi S, Vivanti V, Pizzoferato L. Nutrients in edible mushrooms: An interspecies comparative study. Food Chem. 1999;48:255-258.
29. Ghanya NA, Ismail MM, Al-Zubairi AS, Esa NM. Nutrients composition and mineral content of three different samples of *Nigella sativa* L. Cultivated in Yemen. Asian J. Biol. Sci. 2009;2:43-48.
30. Omole JO. The Chemical Composition of *Caesalpinia pulcherrima*. Nig. J. Anim. Prod. 2003;30:15-19.
31. Al-Jassir MS. Chemical composition and microflora of black cumin (*Nigella sativa* L) Seeds Growing in Saudi Arabia. Food Chem. 1992;45:239-242.
32. Ojieh G, Oluba O, Ogunlowo Y, Adebisi K, Eidangbe G, Orole R. Compositional studies of *Citrullus lanatus* (Egusi melon) seed. The Internet J. Nutr. & Wellness. 2007;6(1).
33. Igwe OU, Okwu DE. Investigation of the chemical composition of *Brachystegia eurycoma* harms plant parts used in herbal medicine. Int. Res. J. Pharm. & Appl. Sci. 2013;3(6):51-56.
34. Yusuf AA, Mofio BM, Ahmed AB. Nutrient contents of pride of barbados (*Caesalpinia pulcherrima linn*.) seeds. Pak. J. Nutr. 2007;6(2):117-121.
35. Okaka JC, Akobundu ENT, Okaka ANC. Human nutrition. An Integrated Approach. Enugu, Obio Press Ltd.; 1992.
36. Adeyeye EI, Otokiti MKO. Proximate composition and some nutritionally valuable minerals of two varieties of capsicum annum (Bell and Cherry Peppers). Discovery and Innovation. 1991;11:75-81.
37. Nieman DC, Butterworth DE, Nieman CN. Nutrition. WM.C Brown Publishers, Dubuque; 1992.
38. Hassan IG, Umar KJ. Proximate and mineral composition of seeds pulp of African locust bean (*Parkia biglobosa* L.). Nig. J. Basic & Appl. Sci. 2004;13:15-27.
39. RDA. Recommended dietary allowance. 10^{th} Edn., National Academy Press. Washington, DC., USA; 1989.
40. Eastwood M. Principle of human nutrition. London. Chapman & Hall, U.K; 1992.
41. McDonald P, Edwards RA, Greehalgh JFD, Morgan CA. Animal nutrition. 5^{th} Edn. Essex Pearson Education Publishers. 1995;49-127.
42. Abeke FO, Ogundipe SO, Dafwang II, Sekoni AA, Abu A, Adeyinka IA. Effect of duration of cooking on the levels of some antinutritional factor on nine varieties of *Lablab purpurens* Beans. Nig. J. of Animal. Prod. 2008;35(2):217-222.
43. Bawa GS, Abu EA, Adegbulu A. Effect of duration of cooking whole or crushed African locust bean (*Parkia filicoidea* welw) seeds on the level of some antinutritional factors and growth performance of young rabbits. Nig. J. Anim. Prod. 2007;34(2): 2008-1019.
44. Offor CE, Nweke FN, Okaka ANC, Igwenyi IO, Onwe VN. Analysis of the antinutrients levels in staple food crops in three different local government areas of Ebonyi State, Nigeria. Cont. J. Food Sci. &Technol. 2011;5(1):26-30.

Peer-review history:
The peer review history for this paper can be accessed here:
http://prh.sdiarticle3.com/review-history/19481