Asian Journal of Fisheries and Aquatic Research

4(1): 1-8, 2019; Article no.AJFAR.50617

Mycoflora, Proximate Composition and Mineral Analysis during the Storage of Smoked Dried Crayfish (*Penaeus natialis* - Shrimps)

Emmanuel Dayo Fagbohun[1*], Ayobami Opeoluwa Durojaiye[1] and Oluwabukola Atinuke Popoola[2]

[1]Department of Microbiology, Ekiti State University, Ado Ekiti, Ekiti State, Nigeria.
[2]National Biotechnology Development Agency South West Zonal Center, University of Ibadan, Ibadan, Nigeria.

Authors' contributions

This work was carried out in collaboration among all authors. Author EDF designed the study, wrote the protocol and the first draft of the manuscript. Authors AOD and OAP carried out the laboratory and statistical analyses of the study. Author OAP managed the literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJFAR/2019/v4i130046
Editor(s):
(1) Dr. Luis Enrique Ibarra Morales, Research Professor, Faculty of International Trade, State University of Sonora, Sonora, Mexico.
Reviewers:
(1) Mohamed El. Sayed Megahed, National Institute of Oceanography and Fisheries, Egypt.
(2) Wafaa Abd El-Ghany, Cairo University, Egypt.
(3) Jamila Patterson, India.
Complete Peer review History: http://www.sdiarticle3.com/review-history/50617

Original Research Article

Received 02 June 2019
Accepted 09 August 2019
Published 23 August 2019

ABSTRACT

This study was carried out to assess the changes in proximate composition, mineral content and mycoflora associated with smoked dried crayfish *Penaeus natialis* (shrimps) stored for twenty weeks. Smoked dried crayfish *Penaeus natialis* (shrimps) were purchased at Igbokoda, Ilaje Local Government Market, Ondo State, Nigeria. They were studied under storage for twenty weeks (6 months) and the proximate, mineral and mycofloral analyses were carried out at four weeks interval. The mycoflora were isolated using direct plating and dilution methods on Potato Dextrose Agar (PDA), Saboraud Dextrose Agar (SDA) and Malt Extract Agar (MEA) and identified using their cultural and morphological features with reference to standard procedures accordingly. The fungi isolated using direct plating methods and dilution methods were *Aspergillus niger, Aspergillus*

**Corresponding author: Email: drfagbohun08@gmail.com;*

flavus, Aspergillus fumigates, Rhizopus sp*., Phytophthora siskiyouensis, Penicillum* sp. and *Mucor* sp. The proximate analysis result showed a decrease in Ash, fat, and crude fibre content while moisture, crude protein and carbohydrate content increased respectively during the twenty four weeks storage. The mineral analysis result of the smoked dried crayfish *Penaeus natialis* (shrimps) showed a decrease in Sodium, Potassium, Calcium, Magnesium, Zinc, Iron, Copper, Manganese, Cadmium and Phosphorous respectively. This study showed that the smoked dried crayfish *Penaeus natialis* (shrimps) were contaminated by fungi; which is an indication that the market places where these products were displayed for sale were not hygienic coupled with leaving the products in open air without coverage which could allow products contamination with fungal spores leading to fungal spores germination, deterioration and spoilage of products during storage. Good hygiene, constant product checking and sensitization of the products processors, handlers and sellers will minimize exposure to fungal spores' contamination while mitigating deterioration and spoilage of the products during storage.

Keywords: Storage; mycoflora; proximate; minerals and shrimps.

1. INTRODUCTION

Crayfish *Penaeus natialis* (shrimps) is an important flavour ingredient in many Nigerian local preparations. Crayfish are eaten worldwide like other edible crustaceans, only a small portion of the body of a crayfish is eaten in most prepared dishes, such as soups, bisques, only the tail portion is served [1]. Crayfish processing has become a large part of the crawfish industry. Crawfish processing is a modern industry that produces a high quality product available for consumption world-wide [2,3].

Preservation of crayfish *Penaeus natialis* (shrimps) is very important because it is easily susceptible to deterioration immediately after harvest and to prevent economic losses. The development of machinery that could be employed for effective handling, harvesting, processing and storage of sea foods such as fish and crayfish cannot be over-emphasized especially when aquaculture is growing fast in Nigeria [4]. The use of smoke in local fish preservation was reported by Eyo [5] and the implication of poor postharvest handling of crayfish has also been reported Kumolu-Johnson et al. [6]. Smoke drying is done to partially cook, remove water, obtain brown colour, improve organoleptic flavor and control microbial and enzymatic actions that may cause spoilage. Preservation effects of smoke derived from the antioxidant and antimicrobial properties of its phenolic compound have been reported by Shehu et al. [7] and Abou-zaid and Mohammed [8]. In local markets, crayfish is retailed open as small heaps on tables to attract consumers and information on duration of effectiveness of smoke drying on crayfish quality is scarce. The essence of processing is to preserve and stop microbial deterioration action on food and to retain the quality of the food [9]. However, there is little or no adequate information on the effectiveness of smoke drying on crayfish quality; hence this study is aimed at studying the changes in proximate composition, mineral content and mycoflora associated with smoked dried crayfish *Penaeus natialis* (shrimps) during twenty four weeks storage.

2. MATERIALS AND METHODS

2.1 Collection of Samples

Samples of Crayfish namely *Penaeus natialis* (shrimps) were randomly purchased at Igbokoda, Ilaje Local Government Market, Ondo State, Nigeria. The dried crayfish *Penaeus natialis* (shrimps) samples were clearly-labeled, stored at room temperature in a sterile airtight container, and kept in a well-ventilated laboratory for a period of twenty four weeks (6 months) under investigation.

2.2 Mycoflora Isolation from the Stored Smoked Dried Crayfish *Penaeus natialis* (Shrimps)

The mycoflora associated with smoked dried crayfish *Penaeus natialis* (shrimps) during storage were isolated using the methods described below.

2.2.1 Direct plating method

Visible mouldy sundried crayfish *Penaeus natialis* (shrimps) were examined and randomly selected from the stored samples for mycofloral

isolation using the method described by Amusa [10]. The sample surfaces were sterilized with ethanol and washed in sterile distilled water. The sterilized samples were aseptically placed on Potato Dextrose Agar plates with sterilized spatula and incubated at 28°C for 5days. The hyphae tips of each fungal growth were successively sub-cultured on freshly prepared Potato Dextrose Agar plates until pure colonies were obtained [11]. The cultures were examined microscopically to assess the fungi present.

2.2.2 Dilution plate method

The dilution plate method was done by placing 1 g of smoked dried crayfish *Penaeus natialis* (shrimps) in sterile distilled water and shaken thoroughly. One ml each of the standardized sample was pipette into 9 ml of sterile distilled water in test tube; and serially diluted in series of test tubes containing sterile distilled water. One ml each of aliquots of 10^{-2} and 10^{-3} was introduced into molten Potato Dextrose Agar (PDA) plates in duplicates for each isolate and incubated at 28°C for 5 days. The fungal growths were observed every 24hours for the fruiting bodies and hyphae tips of each fungus were sub-cultured successively until pure cultures were obtained [11]. The cultures were examined microscopically to assess the fungi present.

2.3 Identification of Mycoflora

The mycoflora isolated from the stored smoked dried crayfish *Penaeus natialis* (shrimps) were identified by their gross cultural and morphological features. The mycoflora were examined under bright day light for colour of the culture and further examination were carried out using Needle mount preparation method as described by Tuite [12], Crowley et al. [13] and Egbebi et al. [11] and Slide culture technique method as described by Fagbohun et al. [14].

2.4 Nutrient Analysis

2.4.1 Proximate analysis

Samples of the stored smoked dried crayfish *Penaeus natialis* (shrimps) were analysed for the for ash, crude fiber, moisture and fat contents according to the methods described by Pearson [15] and A.O.A.C. [16]. The nitrogen was determined by Micro-Kjeldahl method as described by Pearson [15] and the percentage nitrogen was converted to crude protein by multiplying 6.25. The carbohydrate content was estimated by the difference in value obtained when all the chemical composition values were subtracted from 100%. All determinations were in triplicates and values of each constituent were expressed in percentage.

2.4.2 Mineral analysis

The stored smoked dried crayfish *Penaeus natialis* (shrimps) were analysed for the minerals using the solution obtained by dry ashing the sample at 550°C and dissolving it in 10% HCL (25 ml) and 5% lanthanum chloride (2ml), boiling, filtering and making up to standard volume with deionized water. Mn, Cu, Co, Zn, Fe, Mg, Na, and Ca were determined with a Buck Atomic Absorption Spectrometer (Buck Scientific, Model 200A/200, Inc. East Norwalk, Connecticut, U.S.A). Sodium was measured with a Corning 405 flame photometer (Corning Halstead, Essex, UK, Model 405) (AOAC) [16]. The detection limits had precisely been determined using the methods of Varian Techtron [17] as Mn 0.01, Cu 0.005, Co 0.05, Zn 0.005, Fe 0.02, Mg 0.002, Ca 0.04, Na 0.001, ppm (all for aqueous solutions). The optimum analytical range was 0.5 to 10 absorbance units with coefficient of variation of 0.05-0.40%. Phosphovanadomolybdate method using a spectronic 20 colorimeter (Galenkamp, London, UK) (AOAC) [16]. All chemicals were BDH analytical grade.

3. RESULTS AND DISCUSSION

The proximate content of smoked dried crayfish *Penaeus natialis* (shrimps) during twenty four weeks storage is shown in Table 1.

The mineral content of smoked dried crayfish *Penaeus natialis* (shrimps) during twenty four weeks storage is shown in Table 2.

The mycoflora isolated from smoked dried crayfish *Penaeus natialis* (shrimps) during twenty four weeks storage is shown in Table 3.

3.1 Proximate Analysis

There was a significant decrease in ash content (13.45-10.29 g/100 g), fat (5.10-3.89 g/100 g), moisture content (6.40-6.21 g/100 g), crude

protein (68.46-68.07 g/100 g) and there was an increase in carbohydrate (6.40-11.53 g/100 g) while crude fibre was not detected during the twenth four weeks storage of smoked dried crayfish *Penaeus natialis* (shrimps)as shown in Table 1. This result is in agreement with the findings of Girard [18] who reported a significant reduction in ash content of cattle hide from (1.67-0.83) mg/100 g after storage for months. Decrease in ash content indicates loss of nutrients as the storage progressed. Ash content in food contributes to the residue remaining after all the moisture has been removed as well as the organic material (fat, protein, carbohydrates, vitamins, organic acid etc.) have been incinerated at a temperature of about 500°C. Ash content is generally taken to be a measure of the mineral content of the original food [19]. However, this result contradicts that of Oladejo and Adebayo-Tayo [20] who reported an increase in crude protein (21.68-54.16) mg/100 g of "Banda" dried meat during storage and Rodolfo et al. [21] who found out that fungi increase the protein content of the samples on which they grow. This result is also different from the findings of Lawal et al. [22] who reported a decrease in the proximate content such as carbohydrate content of sundried coco yam chips during storage. Crude fiber was not detected in stored smoked dried crayfish (shrimps) which is similar to that of Eleazu [23] who reported that crude fiber was not found in the 10%, 30%, or 40% NRCRI cassava bread samples or in the 100% wheat bread. There was a reduction in the moisture content from 6.40 – 6.21 (g/100 g). This result is in agreement with the work of Ajai et al. [24] who reported a decrease in the moisture contents of milk samples after storage from (8.32-7.51) g/100g. It is known that products that have low fat values normally have high moisture contents. Decrease in water content in this study could be attributed to the fact that infecting fungus utilizes the moisture content for its survival and growth. The shelf life of any product is influenced by the amount of water present in it [25]. Moisture content is a widely used parameter in the processing and testing of food. It is an index of water activity of many foods and determines the shelf life or keeping quality of the food. The observed value in this study implies that smoked dried crayfish (shrimp) will have a long shelf life because of the low moisture content.

3.2 Mineral Analysis

The summary of the mineral composition of smoked dried crayfish *penaeus natialis* (shrimps) during twenty four weeks storage showed a decrease in Sodium (58.90-56.56 mg/100 g), Potassium (66.30-60.39 mg/100 g), Calcium (86.65-81.29 mg/100 g), Magnesium (49.90-45.80 mg/100 g), Zinc (0.63-0.48 mg/100 g), Iron (6.33-5.55 mg/100 g), Copper (0.28-0.09 mg/100 g), Manganese (0.99-0.54 mg/100 g), cadmium (0.23-0.06 mg/100 g) and Phosphorous (106.10-100.89 mg/100 g) as shown in Table 2. This result supports the findings of Oladejo and Adebayo-Tayo [20] who reported a reduction in Sodium (0.35-1.55) mg/100 g in "Banda" dried meat during storage. This result is in contrast to the work of Hassan et al. (2005), who reported an increase in sodium content of *Vernonia amygdalina* leaf protein concentrates of (57.5±0.34 mg/100 g). High sodium content in food is of great concern for health because of its implication in high blood pressure [26]. The result of this study indicated that eating of smoke dried crayfish (shrimp) could not lead to high in blood pressure. Low sodium content is beneficial in the treatment of hypertension and renal diseases [27]. The manganese content of stored smoked

Table 1. Results of proximate analysis of smoked dried crayfish *Penaeus natialis* (shrimps) during 24 weeks storage (g/100 g)

Weeks of storage	Ash	MC	CP	FAT	CF	CHO
Fresh	13.45 ± 0.07^{E}	6.40 ± 0.14^{C}	68.46 ± 0.79^{A}	5.10 ± 0.28^{C}	ND	6.40 ± 0.57^{A}
4	13.38 ± 0.04^{E}	6.39 ± 0.02^{BC}	68.19 ± 0.03^{A}	5.40 ± 0.02^{C}	ND	6.66 ± 0.04^{A}
8	13.42 ± 0.01^{E}	6.36 ± 0.01^{B}	68.26 ± 0.01^{A}	5.36 ± 0.01^{C}	ND	6.62 ± 0.02^{A}
12	13.24 ± 0.02^{D}	6.42 ± 0.02^{BC}	68.36 ± 0.04^{A}	5.32 ± 0.01^{C}	ND	6.63 ± 0.05^{A}
16	12.25 ± 0.01^{C}	6.52 ± 0.02^{C}	68.13 ± 0.04^{A}	4.26 ± 0.02^{B}	ND	8.86 ± 0.01^{B}
20	11.68 ± 0.01^{B}	6.36 ± 0.01^{B}	68.21 ± 0.01^{A}	3.99 ± 0.03^{AB}	ND	9.79 ± 0.00^{C}
24	10.29 ± 0.01^{A}	6.21 ± 0.01^{A}	68.07 ± 0.01^{A}	3.89 ± 0.16^{AB}	ND	11.53 ± 0.16^{D}

MC: Moisture content, CP: Crude protein, CF: Crude Fiber, CHO: Carbohydrate, ND: Not Detected. Means for each treatment with the same alphabet in each row are not significantly different at 5% level of significance ($p< 0.05$), while different alphabets in each row are significantly different at 5% level

Table 2. Results of mineral analysis of smoked dried crayfish *Penaeus natialis* (shrimps) during twenty four weeks storage (mg/100 g)

Weeks of storage	Na	K	Ca	Mg	Zn	Fe	CU	Mn	CD	P
Fresh	58.90±0.14^{F}	66.30±0.14^{A}	86.65±0.01^{A}	49.90±0.14^{E}	0.63±0.01^{D}	6..33±0.11^{C}	0.28±0.04^{E}	0.99±0.01^{E}	0.23±0.04^{EF}	106.10±7.35^{AB}
4	57.89±0.03^{D}	65.40±0.04^{A}	76.90±14.15^{A}	49.29±0.08^{D}	0.62±0.01^{C}	6.62±0.01^{E}	0.24±0.01^{DE}	0.91±0.01^{D}	0.24±0.02^{F}	113.63±3.55^{BC}
8	58.12±0.02^{E}	65.49±0.02^{A}	87.03±0.03^{A}	49.43±0.04^{D}	0.68±0.02^{D}	6.55±0.01^{D}	0.19±0.01^{C}	1.12±0.02^{F}	0.19±0.02^{DE}	116.22±0.02^{C}
12	57.97±0.05^{D}	60.46±0.09^{A}	85.67±0.03^{A}	49.35±0.02^{D}	0.61±0.01^{C}	6.49±0.01^{D}	0.15±0.02^{C}	0.99±0.02^{E}	0.16±0.01^{CD}	115.14±0.02^{C}
16	56.88±0.04^{B}	64.81±0.38^{A}	83.63±0.01^{A}	48.78±0.33^{C}	0.54±0.01^{B}	5.68±0.01^{B}	0.11±0.01^{A}	0.59±0.01^{C}	0.12±0.01^{BC}	112.68±0.01^{BC}
20	55.65± 0.21^{A}	60.39±0.02^{A}	81.52±0.02^{A}	47.39±0.01^{B}	0.48±0.04^{A}	5.52±0.01^{A}	0.07±0.01^{A}	0.50±0.00^{A}	0.08±0.01^{AB}	100.98±0.15^{A}
24	56.56±0.02^{B}	60.39±0.01^{A}	81.29±0.03^{A}	45.80±0.01^{A}	0.48±0.04^{A}	5.55±0.01^{A}	0.09±0.08^{A}	0.54±0.01^{B}	0.06±0.01^{A}	100.89±0.01^{A}

Na: Sodium, K: Potassium, Ca: Calcium, Mg: Magnesium, Zn: Zinc, Fe: Iron, Cu: Copper, Mn: Manganese, CD: Cadmium, P: Phosphorus. Means for each treatment with the same alphabet in each row are not significantly different at 5% level of significance (p< 0.05), while different alphabets in each row are significantly different at 5% level

Table 3. Mycoflora isolated from smoked dried crayfish *Penaeus natialis* (shrimps) during twenty four weeks storage (mg/100 g)

Mycoflora	Week of storage													
	0	0	4	4	8	8	12	12	16	16	20	20	24	24
	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Aspergillus niger	+	+	+	+	+	+	+	+	-	-	-	-	-	-
Aspergillus fumigatus	-	-	+	+	+	+	-	-	-	-	-	-	-	-
Aspergillus flavus	-	-	-	-	-	-	+	+	+	+	-	-	-	-
Rhizopus sp.	+	+	+	+	+	+	-	-	-	-	-	-	-	-
Phytophthora siskiyouensis	-	-	-	-	-	-	+	+	+	+	+	+	-	-
*Penicillum*sp.	-	-	-	-	-	-	-	-	+	+	+	-	-	-
Mucor sp.	-	-	-	-	-	-	-	-	-	-	-	-	+	+

1: Dilution method, 2: Direct plating method, (+): isolated, (-): not isolated

dried crayfish (shrimp) observed in this study significantly decreased from 0.99-0.54 mg/100 g. The result of this work is different from that of Mensah, [28], who reported a significant increase in Mn from (2.7 - 20.1) mg/kg for meat hides. Thus, certain trace elements such as copper, iron and manganese constitute essential part of any balanced diet. The RDA for manganese varies between 2.7 mg/kg to 3.1 mg/kg (RDA, 2001). However, the manganese content observed in this study was low when compared to the RDA value for manganese.

3.3 Mycoflora of smoked dried crayfish *P. natialis*

The mycofloral associated with smoked dried crayfish *Penaeus monodon* (shrimps) during twenty four weeks storage were *Aspergillus niger, Aspergillus fumigates, Aspergillus flavus, Rhizopus* sp*., Phytophthora siskiyouensis, Penicillum* sp*.,* and *Mucor* sp*.* This result supports that of Adebayo-Tayo et al. [29] who reported the isolation of *Aspergillus flavus, Aspergillus tereus, Aspergillus fumigatus, Abisidia sp., Rhizopus sp., Aspergillus niger, Mucor* sp*., Cladosporum* sp*., Penicillium viridatus, Candida tropicalis* and *Fusarium moniliformis* from selected smoked fish from different markets sites in Uyo, Akwa Ibom state. The implication of mycofloral in these products could be attributed to the ever increasing demand for smoked dried crayfish *Penaeus monodon* (shrimps) and in the quest of the retailers to meet this need the fish are overloaded on the smoking kiln during processing; as a result they are exposed to a reduced intensity of heat for short period of time. This leads to improper processing and vulnerability of the fish to fungal contamination [30]. The market place where the smoked dried crayfish products are displayed for sale most times are not clean or hygienic, such as in open trays without coverage Hassan et al. [26] Fungi found in stored food are divided into two groups namely the field fungi and the storage fungi. Most at times it is difficult to distinguish between the two as fungal growth may start both in the field and during storage. Species of *Aspergillus, Rhizopus* and *Penicillum* have been reported as storage fungi which infect crops on the field and may persist and proliferate in storage [31].

4. CONCLUSION

This current study indicated that the stored smoke dried crayfish (shrimps) were contaminated with fungal species with significant loss of nutrients during the twenty four weeks storage. Therefore, special attention should be paid to the microbial investigation to minimize the threats posed to public health. The crayfish (shrimps) must be properly dried to reduce the moisture content before packaging to prevent fungal invasion and enhance the good keeping and storage quality. Good sanitary practices including good storage practices must be followed and micro biological standards must be adhered to by checking production procedures and handling until the stored smoke dried crayfish (shrimps) reach the consumer's table. Stored smoke dried crayfish (shrimps) sellers should be sensitized on the importance of good hygienic practices, good housekeeping and proper storage conditions to prevent deterioration of their product.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Robert P, Romaire W, Ray M, Mark G, Shirley H, Greg L. Crawfish aquaculture. Southern regional aquaculture center Belgium. Marketing (SRAC Publication No. 2402); 2005.
2. Davis JT. Common white grubs. USDA Farmer's Bull USA. No 940. 1994;28-32.
3. Romaire W, Ray-McClain M, Mark G, Greg L. Crawfish aquaculture. Southern Regional Aquaculture Center Belgium. Marketing (SRAC Publication No. 2402; 2005.
4. Okonta AA, Ekelemu JK. A preliminary study of micro-organisms associated with fish spoilage in Asaba, Southern Nigeria. Proceedings of the 20th Annual Conference of the Fisheries Society of Nigeria (FISON), Port Harcourt, Nigeria. 2005;557–560.
5. Eyo AA. Fish processing technology in the tropics. University of Ibadan Press, Ibadan Nigeria. 2000;165-168.
6. Kumolu - Johnson CA, Aledetohun NF, Ndimele PE. The effect of smoking on nutritional qualities and shell-life of *Clarias gariepinus* (BURCHELL 1882). African

Journal of Biotechnology. 2010;9(1):073-076.

7. Shehu LA, Ayodele B, Abubakar B, Oluwafemi DO, Omolola BB. Effects of hot smoking and sun drying processes on nutritional composition of Giant Tiger Shrimp. Poland Journal of Food Nutritional science. 2013;63(4):227-237.
8. Abou-Zaid AM, Mohammed ASE. Production and quality evaluation of nutrition, of high quality biscuits and potato puree tablets supplemented with crayfish (*Procambarus clarkia*) protein products. Journal of Applied Science Research. 2014;10(7):43-53.
9. Omomo DE, Kareem I. Effect of smoke drying techniques on the proximate and mineral composition of *Macrobranchium vellenhovenic* African River Prawn. Inter-national Journal of Biological, Bimolecular, Agricultural, Food and Biotechnological Engineering. 2014; 8(2):189-192.
10. Amusa NA, Kehinde IA, Ashaye OA. Biodeterioration of the Africa star apple (*Artocarpus communis*) in storage and its effects on the nutrient composition. African Journal of Biotechnology. 2001;1(2):57-60.
11. Egbebi AO, Anibijuwon II, Fagbohun ED. Fungi associated with dry cocoa beans during storage in Ekiti State, Nigeria. Pakistan Journal of Nutrition; 2007.
12. Tuite J. Fungi isolated from unstored corn seed in Indian in 1956-1988. Plants Diseases Report. 1961;45:212-215.
13. Crowley N, Bradley JM, Darrell JH. Practical bacteriology. Butterworth and Co., Ltd. London. 1969;164-168.
14. Fagbohun ED, Aribijuwon I, Egbebi O, Lawal OU. Fungi associated with spoilage of dried cocoa beans during storage in Ekiti State, Nigeria. Journal of Microbial Biotechnology and Food Science. 2011; 1(2):204-214.
15. Pearson DH. Chemical analysis of foods. Churchhill: London. 1976;335-336.
16. AOAC. Official method of analysis. 14th Ed. Association of Official Analytical Chemist, Washington DC; 2005.
17. Techtron V. Basic atomic absorption spectroscopy: A modern introduction. Domican Press, Victoria: Australia. 1975; 104–106.
18. Girard JP. Smoking technology of meat and meat products. Ellis Horwood, New York USA. 1992;165–201.
19. Onwuka GI. Food analysis and instrumentation; theory and practice. Naphthalic prints, Surulere, Lagos, Nigeria. 2005;219-230.
20. Oladejo DA, Adebayo-Tayo BC. Moulds, proximate, mineral composition and mycotoxin contamination of Banda ("Kundi/ Tinco") sold in Ibadan, Oyo State, Nigeria. Assumption University Journal of Technology. 2011;15(1):32-40.
21. Rodolfo AD, Teresa MA, Valdez SJ, Mariano CM. Feeding value of protein enriched sweet potato for broilers. Research Abstract 1997–2000; 2000.
22. Lawal OU, Fagbohun ED, Olajide HA. Nutritive value and mycoflora of sun dried cocoyam chips during storage. International Journal of Agronomy and Agricultural Research. 2012;2(2):1-7.
23. Eleazu OC. Effect of partial replacement of wheat flour with high quality Cassava flour on the chemical composition, antioxidant activity, sensory quality, and microbial quality of bread. Preventive Nutritional Food Science. 2014;19(2):115–123.
24. Ajai AL, Ochigbo SS, Jacob JO, Ndamitso MM, Abubakar U. Proximate and mineral compositions of different species of Kolanuts. European Journal of Applied Engineering and Scientific Research. 2012;1(3):44–47.
25. Pearson DH. Chemical analysis of foods. Churchhill: London. 1976;335-336.
26. Hassan AA, Hassan MA, El Shafei HM, El Ahl RM, Abd El-Dayem RH. Detection of aflatoxigenic moulds isolated from fish and their products and its public health signify-cance. Nature and Science. 2011;9(9):106- 114.
27. Mensah JK, Okoli RI, Ohaju-Oboto JO, Eifediyi K. Phytochemical, nutritional and medicinal properties of some leafy vegetable consumed by Edo People of Nigeria. African Journal Biotechnology. 2008;7:2304-2308.
28. Mensah L. Heavy metal contamination of sheep and goat skin hide from the singeing process. A dissertation submitted to the Department of Chemistry, Faculty of Science, KNUST, Kumasi: Ghana. 2001;9.

29. Adebayo-Tayo BC, Onilude AA, Ukpe GP. Mycoflora of smoke-dried fishes sold in Uyo, Eastern Nigeria. World Journal of Agricultural Sciences. 2008;4(3):346-350.

30. Olajuyigbe OO, Akande GR, Ezekiel CN, Ezekiel MO. Aflatoxigenic moulds and aflatoxin contamination of retailed fishery products in Lagos markets. Mycotoxicology. 2014;1:57-63.

31. Nair LN. Topics in mycology and plant pathology. New Central Book Agency, Kolkata, India. 2007;i-xxii.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle3.com/review-history/50617