CHOLESTEROL CONTENT AND FOOD PROPERTIES OF THREE EDIBLE AQUATIC MOLLUSCS FOUND IN LAGOS, NIGERIA

LAWAL-ARE, A.O.[1], MORUF, R.O.[2]*, OLALUSI, O.P.[1] AND OGUNLADE, A.S.[1]
[1]*Department of Marine Sciences, University of Lagos, Akoka, Lagos State- Nigeria*
[2]*Department of Fisheries and Aquaculture, Bayero University, Kano, Kano State- Nigeria*
**tunjimoruf@gmail.com, +2348022429983*

ABSTRACT

Aquatic molluscs play significant roles in human nutrition and public health, hence the need to be more scientifically explored. This research aimed at estimating the cholesterol content and food properties of three edible aquatic molluscs (periwinkle, oyster and cuttlefish) commonly retailed in Lagos using standard methods. The highest crude cholesterol content of 1.02±0.05 mg/100g was obtained from cuttlefish in the month of June while periwinkle and oyster had lower values (0.1±0.01 mg/100g) of cholesterol throughout the three months (April to June) study. Oleic acid contents of cuttlefish (1.64 – 5.15%) and periwinkle (1.69 – 3.83%) were significantly higher than oyster's oleic acid content value (1.06 – 2.96%). Among the three edible molluscs, cuttlefish showed the best food properties (except in oil absorbing and foam capacity) with 206.93±4.29 % water absorbing capacity; 2.4±0.24 g/ml emulsion capacity; 50.97±1.31 % emulsion stability and 50±1.37 % foam stability. The values of oil absorption capacities were significantly different ($p<0.05$) among the molluscs with periwinkle being highest (292.59±2.0 %), followed by oyster (235.29±1.59 %) while cuttlefish showed lowest value (134.65±3.75%). The highest foam capacity was found in periwinkle (6.9±0.57 %), followed by cuttlefish (5.06±0.42 %) while the least in oyster (4.7±0.63 %). These molluscs, especially cuttlefish will be highly desirable for preparing comminuted sausage products due to its good functional qualities.

Keywords*: Cuttlefish, functional properties, cholesterol, periwinkle, oyster*

INTRODUCTION

Aquatic molluscs are important resource that contribute considerable economic value to the world's fisheries. The global production of aquatic mollusc for human consumption is more than 17 million tonnes in the year 2018, with China as the major producer with relatively highest percentage of production (FAO, 2020; Moruf *et al*. 2020a). They are highly diverse in size, anatomical structure as well as in behavior and habitat. Aquatic molluscs are generally soft-bodied invertebrates, usually with an exoskeleton in the form of a shell. The shells provide protection for the soft-bodied inhabitants against predators. Still other molluscs such as the cuttlefish, octopus, squid, and the sea slug have no external shells but they evolve their own survival strategies, for example, having complex brain to replace their protective armour (Ituen, 2015). Edible shellfish (crustaceans and molluscs) constitutes one of the major sources of nutritious food for human consumption, providing an important amount of dietary protein and lipid diet in many countries (Moruf, 2020). Despite recommendations by dieticians, mollusc shellfish consumption is low in several African countries. One of the many relevant factors that influence shellfish consumption is the quality of the meats (Afolayan *et al*., 2020; Moruf *et al.*, 2020b).

Mollusc, caught from fresh, marine and brackish waters, and ponds of various types, are becoming delicacies in Nigeria. They serve as food and as a natural resource of economic importance for crafts making, dye for cotton, yarn and clothes, making them receive special attention (Flores-Garza *et al*., 2012). Cuttlefish, oyster and periwinkle are commercially available in Lagos, Southwestern part of Nigeria. Their values compare favourably with those of finfish.

Literature reports are scarce on the chemical composition and functional properties of molluscs in Nigeria. Ademolu *et al*. (2015) reported the traditional utilization and biochemical composition of six mollusc shells; Moruf and Akinjogunla (2018) evaluated the macro-micro minerals of common periwinkle inhabiting the Lagos Lagoon; Moruf and Durojaiye (2020) gave a report on the health risk appraisal of heavy metals in edible aquatic molluscs of Lagos, while Lawal-Are *et al*. (2021) estimated weight yield factor and energy values of the common cuttlefish sold in Lagos, Nigeria.

The present work therefore aimed to estimate the cholesterol content and food properties of three edible aquatc mollusc meats commonly consumed in Lagos, Nigeria. This study would provide some basic information useful in determining the applicability for mollusc meats and protein isolate in food products.

MATERIALS AND METHODS

Sample Preparation

Three edible aquatic molluscs (periwinkle, oyster and cuttlefish) used in this study were obtained from Ajeloro Fish Market in Apapa, Lagos State, Nigeria. The molluscs were thoroughly washed, cut into pieces (50 g) and washed again with distilled water. The head region was discarded. All samples were homogenized prior to analysis.

Analytical Procedures

Cholesterol content was estimated using Liebermann-Burchard reagent. Standard cholesterol solution used was 0.4 mg/ml. Liebermann-Burchard reagent was prepared with 0.2 mL concentrated sulfuric acid and 2 ml glacial acetic acid and was covered with aluminum foil. Fatty acid contents of fat extracted from samples was determined by gas chromatography (GC) of methyl esters. Methyl esters were prepared by transmethylation using 2 M KOH in methanol and n-heptane according to the method described by AOAC (2007).

For the determination of Free Fatty Acid (FFA) as Oleic, One (1) g of the test sample was poured into a conical flask with 20ml of solvent mixture (1:1 v/v ethanol: diethyl ether) and 0.2ml of phenolphthalein indicator solution. The mixture was then titrated while shaking with 0.1N KOH till pink colour appears and persists for at least 10sec. A blank titration was also carried out.

$$\%\ \text{FFA (as Oleic Acid)} = \frac{(\text{V} - \text{B})\ \text{x N x } 28.21}{W}$$

where,

V = Volume of titrant (KOH) consumed for sample

B = Volume of titrant consumed for blank

N = Normality of titrant (KOH)

W = Weight of sample

Water Absorbing Capacity was determined by the method of Diniz and Martin (1997), with slight modification. A 0.5 g sample (dry basis) was taken in pre-weighed centrifuge tube; 10 ml of distilled water was added to it and vortexed using Labnet, (Labnet International Inc., USA) for 30 sec. The dispersion was allowed to stand at room temperature (25^{o}C) for 30 min and then centrifuged at 3000 rpm for 25 min. The supernatant was decanted carefully. Difference between the weight of the centrifuge tube with sample after decanting the supernatant and the initial weight of the centrifuge tube with sample was noted.

Oil Absorbing Capacity was determined as the volume of edible oil held by 0.5 g of material according to the method of Shahidi *et al.* (1995). A 0.5 g of sample (dry basis) was taken in pre-weighed centrifuge tube; 10 ml of mustard oil was added to it and vortexed for 30 sec. The dispersion was allowed to stand at room temperature (25^{o}C) for 30 min and then centrifuged at 3000 rpm for 25 min. The supernatant was decanted carefully. Difference between the weight of the centrifuge tube with sample after decanting the oil and the initial weight of the centrifuge tube with sample is noted. The results were reported as gram of oil absorbed per gram of protein sample.

The modified methods reported by Souissi *et al*. (2007) were used to determine the emulsion capacity and emulsion stability. The foam formation and the foam stability were determined by optical measurements. The foams were produced with a homogenizer for 2 min at 17 500 rpm, in 3 ml of solution (50 mMTris–HCl – 0.5 M NaCl, pH 7.5), which contained 1.5% protein. The initial height of the solution and the foam height were recorded at intervals of 0, 2, 10, 20 and 30 min, using a caliper. The foaming capacity was expressed as the proportion of foam height at 0 min to solution height. The foaming stability (FS) was conveyed by the percentage of foam height at some time to 0 min. The measurement of the height was rapid and accurate to three digits after the decimal point.

Statistical Analysis

Data obtained was subjected to analysis of variance (ANOVA). Microsoft Excel 2010 was used to perform descriptive statistic while SPSS software (Version 21; IBM; USA) was used for Duncan Multiple Range Test (DMRT) to sort out the differences in the means at P≤0.05 significant level.

RESULTS AND DISCUSSION

Cholesterol Level in Edible Aquatic Molluscs

As indicated in Figure 1, the cholesterol level in cuttlefish was higher than the values in periwinkle and oyster throughout the study period. The highest crude cholesterol content of 1.02 ± 0.05 mg/100g was obtained from cuttlefish while periwinkle and oyster had same values as 0.1 ± 0.01 mg/100g. According to Sampaio *et al.* (2006), the differences in cholesterol content could be caused by several factors, such as species, food availability, age, sex, water temperature, geographic location, and season. The cholesterol content of periwinkle and oyster in this study is similar to that of apple snail (0.103 mg/100 gr) as reported by Purwaningsih *et al.* (2015), but higher than mixed clam (0.034 mg/100 gr), blue mussel (0.023 mg/100 gr), Japanese oyster (0.076

mg/100 gr), scallop (0.050 mg/100 gr), crab (0.053 mg/100 gr), tuna (0.050 mg/100 gr), and beef (0.054 mg/100 gr) reported by Okuzumi and Fujii (2000).

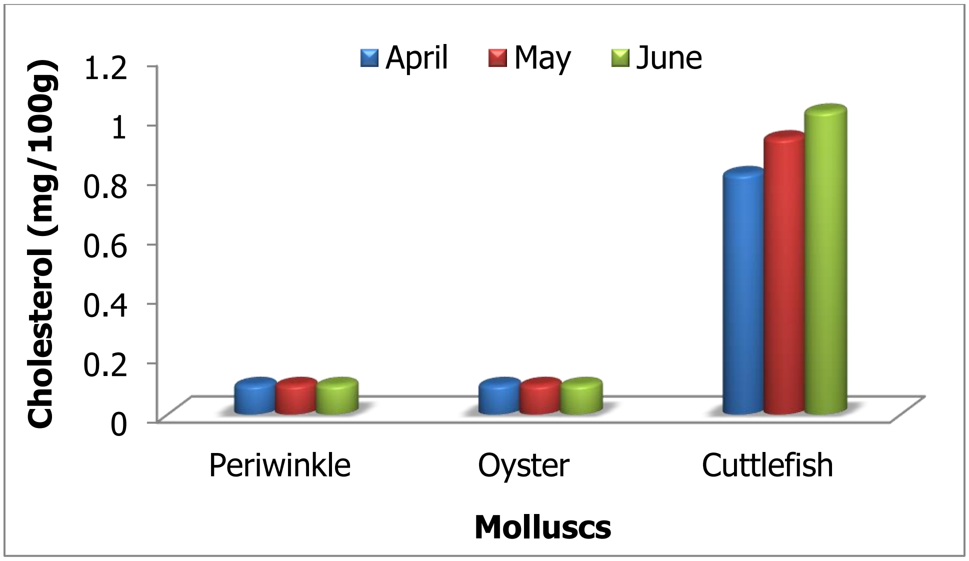

Figure 1: Cholesterol level in Three Edible Aquatic Molluscs found in Lagos, Nigeria

Free Fatty Acid Content of Edible Aquatic Molluscs

The oleic acid content of the three edible molluscs in percentage can be seen in Figure 2. The concentration obtained in cuttlefish (1.64-5.15%) and periwinkle (1.69 - 3.83%) were significantly ($P < 0.05$) higher than oyster (1.06-2.96%) while the highest value was obtained in cuttlefish for the month of June. Higher values were recorded by Lawal-Are *et al* (2018) for raw and fried cuttlefish as 3.95±0.10 % and 4.47±0.10 % respectively. According to the authors, processing method influenced the level of oleic acid in cuttlefish.

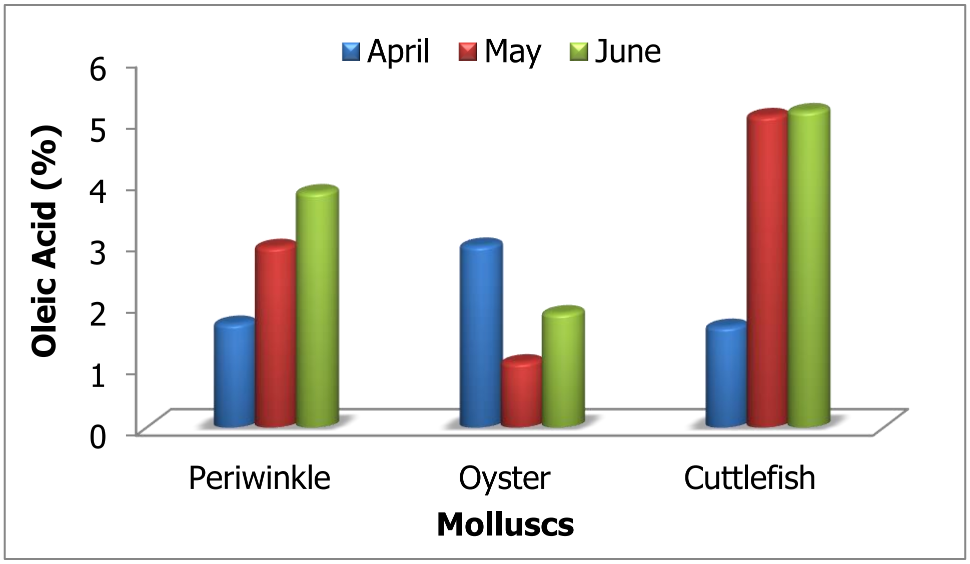

Figure 2: Free Fatty Acid level in Three Edible Aquatic Molluscs found in Lagos, Nigeria

Food Properties of Edible Aquatic Molluscs

Table 1 shows the food properties of three edible aquatic molluscs found in Lagos, Nigeria. The Water Absorption Capacities (WAC) in % (198.13±3.08 for periwinkle; 192.16±1.18 for oyster; 206.93±4.29 for cuttlefish) were higher than the value of 125.00 % reported for Land Crab (Omotosho, 2005) and 98.45 % reported for Jumbo Lump of smooth swim crab (Lawal-Are *et al*., 2020). The observed values were however lower than the values obtained from the larva of *Cirina forda* (300%) (Omotosho, 2006). Proteins have both hydrophilic and hydrophobic properties, and therefore, can interact with water and oil absorption capacities in foods (Butt and Batool, 2010). WAC is affected by pH and ionic strength (i.e. salt) reflecting the extent of denaturation of the protein.

The Oil Absorption Capacities (OAC) showed significant differences (P<0.05) among the molluscs under study, with cuttlefish having the lowest value (134.65±3.75 %). The values are however higher than what was reported for crabmeats (102.81-109-22%) by Moruf *et al*. (2021). OAC is important, as oil acts as a flavour retainer and improves the mouth feel of foods, so the molluscs would be better in these respects. According to Lone *et al*. (2015), the OAC depend on the amount of non-polar amino acids in the side chain and structure of the proteins.

TABLE 1: FOOD PROPERTIES OF THREE EDIBLE AQUATIC MOLLUSCS

Property	Periwinkle	Oyster	Cuttlefish
Water Absorbing Capacity %	198.13±3.08[ab]	192.16±1.18[a]	206.93±4.29[b]
Oil Absorbing Capacity %	292.59±2.07[a]	235.29±1.59[b]	134.65±3.75[c]
Emulsion Capacity (g/ml)	1.9±0.25[a]	2.1±0.39[a]	2.4±0.24[a]
% Emulsion Stability @ 3hrs	48±1.72[a]	48±1.10[a]	50.97±1.31[a]
Foam Capacity (%)	6.9±0.57[a]	4.7±0.63[a]	5.06±0.42[a]
Foam Stability (%)	25±1.42[a]	32±1.77[a]	50±1.37[b]

Keys: Mean ± S.E (Standard Error). [a,b,c] values in same row are significantly different

The ability of proteins to form emulsion is important owing to the interactions between proteins and lipids in the food systems (Lone *et al.*, 2015). The difference observed in the Emulsion Capacities (OEC) of the three edible aquatic molluscs (1.9±0.25 g/ml, periwinkle; 2.1±0.39 g/ml, oyster; 2.4±0.24 g/ml, cuttlefish) were not significant (Table 1). The emulsion stability of the aquatic molluscs (48±1.72 %, periwinkle; 48±1.1 %, oyster; 50.97±1.31 %, cuttlefish) were higher than values obtained for the larva of *Cirina forda* (36.67 %) (Omotosho, 2006) and Smooth Swim Crab (38.40 %) (Lawal-Are *et al.*, 2020). This suggests that mollusc meats may be useful as an additive for the stabilization of fat emulsions in production of sausages, soups and cakes.

Foamability is an important food property by which proteins form a flexible cohesive film to entrap air bubbles (Lone *et al.*, 2015). Products that rapidly unfold and adsorb at the freshly formed air/liquid interface during bubbling exhibit improved foamability (Damodaran, 1997). In this study, the foaming capacities (6.9±0.57 for periwinkle; 4.7±0.63 for oyster; 5.06±0.42 for cuttlefish) and stabilities (25±1.42, periwinkle; 32±1.77, oyster; 50±1.37, cuttlefish) (Table 1) are in close agreement with the foaming capacity of *Cirina forda* larva (7%) (Omotosho, 2006) and foaming stability of raw cuttlefish (46%) (Lawal-Are *et al.*, 2018). Foams are used to improve the texture, consistency and appearance of food.

CONCLUSION

The three aquatic edible molluscs assessed in this study, especially cuttlefish will be highly desirable for preparing comminuted sausage products due to their good cholesterol content and better functional qualities.

REFERENCES

Ademolu, K. O., Akintola, M. Y., Olalonye, A. O. and Adelabu, B. A. (2015). Traditional utilization and biochemical composition of six mollusc shells in Nigeria. *Revista de Biologia Tropical*, 63 (2): 459 – 464.

Afolayan, O. A., Moruf, R. O. and Lawal-Are, A. O. (2020). Bacterial contamination and heavy metal residues in frozen shellfish retailed within Lagos Metropolis, Nigeria. *Science World Journal*, 15(1): 11 - 14.

AOAC (Association of Official Analytical Chemist) (2007). *Official Methods of Analysis*. 18th Edition. Arlington VA 2209, USA. AOAC 09, chap 32, 1-2.

.

Butt, M. S. and Batool, R. (2010). Nutritional and functional properties of some promising legumes protein isolates. *Pakistan Journal of Nutrition*, 9 (4): 373-379.

Damodaran, S. (1997). Food proteins: an overview. *In*: *Damodaran S, Paraf A, editors. Food proteins and their applications*. New York: Marcel Dekker. pp. 1–24.

Diniz, F. M. and Martin, A. M. (1997). Effects of the extent of enzymatic hydrolysis on functional properties of shark protein hydrolysate. *LWT-Food Science and Technology*, 30(3): 266 – 272.

FAO (Food and Agricultural Organization of the United Nations). The State of World Fisheries and Aquaculture, (2020). Sustainability in action. Rome. 224pp.

Flores-Garza, R., García-Ibáñez, S., Flores-Rodríguez, P., Torreblanca-Ramírez, C., Galeana-Rebolledo, L., Valdés-González, A., and Violante-González, J. (2012). Commercially important marine mollusks for human consumption in Acapulco, México. *Natural Resources*, 3(01): 11 – 19.

Ituen, E. U. (2015). Mechanical and chemical properties of selected mollusc shells in Nigeria. *International Journal of Agricultural Policy and Research*, 3(1): 53 – 59.

Lawal-Are, A. O., Moruf, R. O., Junaid, D. A. and Oke, M. O. (2018). Chemical bio-compounds and functional properties of raw and processed cuttlefish, *Sepia officinalis* (Mollusca: Cephalopoda). *Food and Environmental Safety*, 17(3): 332 – 340.

Lawal-Are, A. O., Moruf, R. O., Sanni, M. A. and Chukwujindu, C. M. (2020). Food Properties of Minced and Whole Jumbo Lump of the Smooth Swim Crab, *Portunus validus* (Herklot, 1851). *Journal of Scientific Research and Development*, 19(1): 126 – 137. 33.

Lawal-Are, A. O., Moruf, R. O., Ojeah, F. L., Taiwo, L. O. and Aligbeh, O. E. (2021). Weight yield factor, chemical composition and energy value of three imported shellfish species in Nigeria. *Nigerian Journal of Animal Production*, 48(3): 63 - 70.

Lone, D. A., Wani, N. A., Wani, I. A. and Masoodi, F. A. (2015). Physico-chemical and functional properties of Rainbow trout fish protein. *International Food Research Journal*, 22(3): 1112 – 1116.

Moruf, R. O. and Akinjogunla, V. F. (2018). Photometric determination of macro-micro minerals in the West African Mud Creeper, *Tympanotonus fuscatus* var radula (Linnaeus, 1758). *Journal of Experimental Research*, 6(3): 35 – 40.

Moruf, R. O. (2020). Sustainability in life below water: Managing the exploitation of Nigerian shellfish resources. *Proceedings of the Nigerian Academy of Science*, 13(1): 126 – 135.

Moruf, R. O. and Durojaiye, A. F. (2020). Health risk appraisal of selected heavy metals in edible aquatic molluscs of Lagos, Nigeria. *FUDMA Journal of Agriculture and Agricultural Technology*, 6(1): 42 – 48.

Moruf, R. O., Okunade, G. F. and Elegbeleye, O. W. (2020a). Bivalve Mariculture in Two – Way Interaction with Phytoplankton: A Review of

Feeding Mechanism and Nutrient Recycling. *Bulletin UASVM Animal Science and Biotechnologies*, 77(2): 1 – 8.

Moruf, H. A., Ogunbambo, M. M. and Moruf, R. O. (2020b). The relevance of information of shellfish quality on consumers' purchase decision in Lagos metropolis, Nigeria. *Journal of Agricultural Economics, Environment and Social Sciences*, 6(1): 71 – 79.

Moruf, R. O., Taiwo, M. A. and Adebayo, Q. (2021). Nutritional and functional attributes of raw and grilled crabmeat. *Agricultural Science and Technology*, 13 (1): 83-90.

Okozumi, M. and Fujii, T. (2000). *Nutritional and functional properties of squid and cuttlefish*. Japan: National Cooperate Association of Squid Processors. 35th anniversary of commemorative publication. 223 pp.

Omotosho, O.T. (2005). Chemical composition and nutritive significance of the Land Crab, *Cardiosoma armatum* (Decapoda). *African Journal of Applied Zoology and Environmental Biology*, 7: 68 – 72.

Omotoso, O. T. (2006). Nutritional quality, functional properties and antinutient compositions of the larva of *Cirina forda* (West Wood). *Journal of Zhejiang University of Science*, 8: 51 – 55.

Purwaningsih, S., Suseno, S. H., Salamah, E., Mulyaningtyas, J. R. and Dewi, Y. P. (2015). Effect of boiling and steaming on the profile fatty acids and cholesterol in muscle tissue of molluscs. *International Food Research Journal* 22 (3): 1087 – 1094.

Sampaio, G. R., Bastos, D., Soares, R., Queiroz, Y. and Torres, E. (2006). Fatty acid and cholesterol oxidation in salted and dried shrimp. *Journal of Food Chemistry*, 96: 344 – 351.

Shahidi, F., Han, X. Q., and Synowiecki, J. (1995). Production and characteristics of protein hydrolysates from capelin (*Mallotus villosus*). *Food Chemistry*, 53(3): 285 – 293.

Souissi, N., Bougatef, A., Triki-Ellouz, Y. and Nasri, M. (2007). Biochemical and functional properties of sardinella (Sardinella aurita) by-product hydrolysates. *Food Technology and Biotechnology*, 45(2): 187 – 194.