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Sublethal Effects of Surfactants on Chemical Composition of Periwinkle (*Tympanotonus fuscatus*) Tissues Collected from the Lagos Lagoon

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Review Article

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ABSTRACT

The sublethal effects of surfactants on chemical composition in periwinkle (*Tympanotonus fuscatus*) tissues collected from the Lagos Lagoon were determined. The length and weight of the periwinkle varied from 3.5 cm-4.24 cm and 4.31 g - 6.96 g respectively. The periwinkles were subjected to different levels of surfactants contamination based on the derived toxicity indices of the probit analysis (96 hLC50=3.843 mg/l). The periwinkle samples were treated with the surfactant agent at different concentration of 0.1 ml, 0.17 ml and 0.35 ml for twenty one days. At every 7 days intervals the periwinkle tissues were taken for analysis. The chemical analysis was done in triplicate while the data obtained were analyzed using Duncan's multiple range tests. For 21 day at different concentration and days, the protein values ranged from 20.36 ± 03-25.97 ± 04, moisture content ranged from 60.00 ± 03 - 63.00 ±00, ash value ranged from 6.86 ± 01-8.76 ± 01, crude fiber ranged from 0.23 ± 00 - 0.27 ± 03, fat value ranged from 2.69 ± 000 - 3.26 ± 01 and the carbohydrate value ranged from 2.10 ± 01 - 6.47 ± 03 in the body tissues of the periwinkle. The mineral values of the periwinkle of the periwinkle tissues were high especially that of phosphorus (P) and magnesium (mg). The phosphorus value ranged from 319.25 ± 03 - 399.82 ± 02. Magnesium (mg) ranged from 172.70 ± 04 -180.60 ± 02. Calcium (C) ranged from 34.50±02-40.10±03. Zinc (Zn) values ranged from 0.77 ± 01 - 0.88 ± 01. Potassium (K) ranged from 36.30 ± 000 - 38.90 ± 00. The Ca, P, Zn, Mg and K were significantly different at P=0.05. The result obtained from this study suggested that estuarine organism such as *Tympanotonus fuscatus* can act appropriately as a biological indicator of pollution hence can be used to monitor the quality of coastal waters and they serve as a good source of protein which can be used for feed formulation and consumed by human. They also contain considerable amount of minerals that are low in crude fiber and fat.

INTRODUCTION

The environmental concern over the use of hazardous chemicals is increasing worldwide. There are many such chemicals polluting the environment, with the damage wrought depending on their exposure, persistence in the ecosystem, as well as the characteristics of the affected organisms [1]. Considerable amounts of cleansing materials (surfactants) used in domestic and industrial domains are directly discharged into waterways and on land. These may pose environmental problems in the ecosystem including toxicity of the surfactants to fish and invertebrates, foaming and euthrophication [2].

Most formulated products (detergents and corrosion inhibitors) contain surfactants linear alkylbenzene sulphonates (LAS). Anionic surfactants are reported to be acutely toxic to fish and other aquatic organisms at concentrations between 0.4 and 40 mg/l [2].

Other authors who have reported the harmful effects of different types of surfactants on biological indicators include; Schowanek et al., Madsen et al., Fuller et al., Edward et al., Britton et al., Ezemonye et al., have reported that the use, storage, transportation and disposal of chemicals into the environment point to a growing problem that threatens the health of the ecosystem and people [3-10].

Shellfish and other aquatic organisms suitable for food and feed are of worldwide importance. They are excellent sources of

high quality proteins which are superior to those in meat and poultry. Biochemical assays and nutrients play a vital role in physical growth, development, maintenance of normal body [11]. Generally, fish and shellfish meat is considered to be highly nutritious, owing to its content of essential amino acids and proteins, for example, shrimp meat is an excellent source of protein [12] and shrimp is one of the most popular species as it is a part of almost every nation's traditional meal rich in protein and minerals.

This study reports the proximate and mineral composition of *T fuscatus* exposed to sublethal effects of surfactant.

MATERIALS AND METHODS

Collection and acclimatization of test organisms

Periwinkles (*Tympanotonus fuscatus var radular*) of 4.23 – 4.5 cm were collected from a muddy habitat area of the University of Lagos Lagoon (Unilag Lagoon) in the early hours of the day to avoid heat stress. They were placed in the polythene bag and then transported to the Environmental biology laboratory at Yaba College of Technology. The organisms were acclimatized to laboratory conditions in holding tank. The tank was half filled with brackish water and sediments collected from the same source to serve as substrate and food source to organism. The acclimatization was done for seven days.

Test chemicals

The test compound used was a liquid detergent known as morning fresh manufactured by PZ cusson Nigeria Plc. The composition as stated by the manufacturers includes; anionic surfactants, hydrotropes salts, perfume, preservatives and colours; It was bought from a local market and introduced into the test organism.

Experimental bioassay procedure

Bioassay studies were conducted in which the test media was set up using varying concentration of Morning Fresh and a preliminary investigation was also carried out to determine the definitive concentrations suitable for the chemical. The acute test was allowed to stand for four days (96 hrs) which made it possible to monitor the behavior and mortality responses of the test organisms to varying concentration of Morning Fresh (surfactant). The corresponding values (0.35 mg/L, 0.17 mg/L and 0.1 mg/L) were used while the concentration used for control was 0.00 mg/l. The treatment was done in triplicate with fifteen (15) test organisms in each bioassay bowl. The bioassay went on for 21 days in order to investigate the proximate and mineral composition of the periwinkle tissues. At pre-determined time intervals (days 7, 14 and 21), five live *T.fuscatus* per replicate including control were randomly selected. The selected periwinkles were broken with a small rod and the tissues were then taken to the laboratory for mineral and proximate analysis.

Determination of chemical composition of periwinkle tissues

The mineral composition such as protein, moisture content, crude fiber and ash content were determined using the method of Association of Official Analytical Chemist (AOAC, 2000). Carbohydrate was determined by difference. All determinations were performed in triplicates. Minerals (Mg, Ca, Zn, K and P) were determined using the atomic absorption spectrophotometer (AAS). All analysis were carried out at Federal Institute of Industrial Research Oshodi.

Statistical analysis

The results obtained were subjected to descriptive statistics and tested using Duncan's multiple range test analysis to derive the means and standard deviation using SPSS version 21.

RESULTS

Table 1 shows the sublethal effects of surfactants on the proximate analysis of periwinkle; *Tympanotonus fuscatus tissues*. The protein content of the tissue shows that the protein value increases on introduction of periwinkle into the surfactants compared to the control which was 17.23 ± 02. The edible portion of *T. fuscatus* had higher moisture content when compare with other nutritional composition. The lowest moisture content was obtained in day 21 at 0.17 ml. The fat content of the periwinkle tissues were low compared to the control. The highest value of fat was found in day 21 at 0.35 ml and the lowest in day 7 at 0.17 ml. The ash content has a higher value in day 14 at 0.1 ml and the lowest value in day 21 at 0.1 ml. The crude fiber was less than 1.0 mg/100 g in all the other nutrient composition. The carbohydrate content of the periwinkles tissues were lower at some certain concentrate compared with the control and the highest carbohydrate content was in day 21 at 0.1 ml.

The results of the mineral analysis are shown in Table 2. The periwinkle tissues has the highest minerals in phosphorus ranging from 319.25 ± 03 - 399.82 ± 02 and it had the lowest mineral composition in Zinc (ppm,g) ranging from 0.77 ± 01 - 0.88 ± 01. The highest calcium content was observed in day 7 at 0.1 ml and the lowest in day 21 at 0.35 ml. The potassium content has the highest value in day 21 at 0.35 ml and the lowest in day 7 at 0.1ml. The magnesium content of the periwinkle tissues were not significantly different (P=0.05) from each other.

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Table 1. Proximate (%) Analysis of Periwinkle (*Tympanotonus fuscatus*) tissue.

	Days	7	14	21
	Control	0.1 ml 0.17 ml 0.35 ml	0.1 ml 0.17 ml 0.35 ml	0.1 ml 0.17 ml 0.35ml
Moisture	66.03 ± 03	61.90 ± 02^{b} 61.00 ± 01^{b} 60.00 ± 03^{c}	63.00 ± 01^{a} 60.08 ± 03^{c} 60.03 ± 02^{c}	63.00 ± 00^{a} 63.00 ± 03a 61.08 ± 01^{b}
Ash	8.76 ± 03	7.73 ± 01 ^{b} 7.98 ± 02^{b} 7.66 ± 00^{b}	8.51 ± 02^{a} 7.21 ± 03^{bc} 8.76 ± 01^{a}	6.86 ± 02^{c} 8.75 ± 00^{a} 8.50 ± 02^{a}
Fat	4.25 ± 01	2.86 ± 03^{b} 2.69 ± 00^{c} 2.81 ± 02^{b}	2.85 ± 01^{b} 2.73 ± 03^{c} 2.90 ± 00^{b}	3.10 ± 01^{a} 3.20 ± 02^{a} 3.26 ± 01^{a}
Protein	17.23 ± 02	24.29 ± 05^{ab} 25.12 ± 03^{a} 25.97 ± 04 ^{a}	22.57 ± 01^{b} 25.03 ± 00^{a} 25.38 ± 01^{a}	20.36 ± 03^{c} 22.06 ± 00^{b} 23.79 ± 05^{ab}
C. fibre	0.32 ± 00	0.25 ± 02^{a} 0.23 ± 01^{a} 0.23 ± 03^{a}	0.25 ± 02^{a} 0.25 ± 01^{a} 0.23 ± 00^{a}	0.27 ± 03^{a} 0.25 ± 01^{a} 0.26 ± 02^{a}
CHO	3.16 ± 03	2.95 ± 00^{c} 3.30 ± 01^{bc} 3.10 ± 03^{bc}	2.57 ± 00^{c} 3.96 ± 04^{b} 3.15 ± 00^{bc}	6.47 ± 03^{a} 2.11 ± 00^{d} 2.10 ± 01^{d}

Table 2. Mineral composition of Periwinkle (*Tympanotonus fuscatus*) tissues.

	Days	7	14	21
	Control	0.1 ml 0.17 ml 0.35 ml	0.1 ml 0.17 ml 0.35 ml	0.1 ml 0.17 ml 0.35 ml
Mg(ppm,g)	179.00 ± 00	176.50 ± 03^{bc} 180.60 ± 02^{a} 175.50 ± 00^{c}	177.60 ± 05^{b} 179.70 ± 01^{a} 175.30 ± 02^{c}	176.70 ± 00bc 178.40 ± 03b 172.70 ± 04d
Ca(ppm,g)	42.50 ± 00	40.10 ± 03^{a} 38.40 ± 04^{b} 37.20 ± 02^{c}	39.00 ± 03^{ab} 36.60 ± 02^{c} 37.30 ± 04^{c}	35.40 ± 03d 34.60 ± 01d 34.50 ± 02
Zn(ppm,g)	0.79 ± 00	0.85 ± 02^{a} 0.77 ± 01^{ab} 0.81 ± 00^{ab}	0.78 ± 03^{ab} 0.78 ± 01^{ab} 0.84 ± 04^{a}	0.83 ± 00ab 0.82 ± 03ab 0.88 ± 01a
K(ppm,g)	35.60 ± 00	36.30 ± 00^{bc} 37.30 ± 04^{b} 37.60 ± 00^{b}	36.80 ± 02^{bc} 38.20 ± 05^{a} 38.50 ± 03^{a}	37.90 ± 01b 38.50 ± 04a 38.90 ± 00a
P(ppm,g)	294.02 ± 00	319.25 ± 03^{e} 339.65 ± 00^{d} 344.39 ± 02^{d}	338.92 ± 02^{d} 372.91 ± 01^{b} 385.24 ± 03^{a}	352.56 ± 01c 392.37 ± 00a 399.82 ± 02a

Each value represents the mean from three independent experiments and the overall mean ± standard error. Proximate composition (values) of the mineral composition of periwinkle tissue in the same row having different letters are significantly different at P=0.05.

DISCUSSION

From the result the protein content of 0.1 ml for the 3 days (days 7, 14 and 21) ranges from 20.36 ± 03 - 24.29 ± 05 with the highest percentage protein found in day 7. This shows that the protein content decreases as the periwinkle stays longer in the toxicant. For 0.17 ml, the protein content ranges from (22.06 ± 00 -25.12 ± 03). For 0.35 ml, the protein content ranges from (23.79 ± 05 - 25.97 ± 04). This shows that the highest protein value is found in the periwinkle tissues exposed to 0.35 ml of toxicant. The protein content in the 3 days at different concentration were high compared to the control in respect to the other nutrient composition and this agreed with [13] which states that protein is the most prominent biochemical component of crustaceans.

The ash content of the periwinkle tissue at 0.1 ml was higher in day 14 compared to day 7 and 21. At 0.17 ml, day 21 has the highest ash content while day 7 and 14 has no significant difference (P=0.05). At 0.35 ml the ash content in day 14 and 21 has no significant difference compared to day 7 that has the lowest ash content. The high ash content suggests high mineral composition of the species [14].

The crude fiber of the periwinkle tissues for the 21 days at different concentration does not have any significant difference (P=0.05) but the highest crude fiber content was recorded in day 21 at 0.1 ml and the lowest was recorded in day 14 at 0.35 ml. The fiber content of the periwinkle tissues were low and agreed with that recorded by Bukola et al. [15] and that recorded by Babu et al. [16]. The low fiber is not a surprise as animal products contain lower fiber than plants hence needs supplementation in diets [17].

The lowest carbohydrate value was recorded in day 21 at 0.35 ml. At 0.1 ml, day 7 and 14 has no significant difference but the highest carbohydrate value is in day 21. At 0.17, there is also no significant difference between day 7 and 14 while day 21

has the lowest carbohydrate content compared to the control. At 0.1 in day 7, the carbohydrate content went extremely higher than the control. The high carbohydrate content of the *T. fuscatus* makes it a good quality food.

At 0.1, day 14 and 21 has no significant difference but day 7 has the lowest moisture content. At 0.17 ml, the highest moisture content was recorded at day 21 and the lowest was obtained at day 14. At 0.35 ml, the highest moisture content was recorded at day 14 while day 7 and 21 has no significant difference (P=0.05). According to Bassey et al. [17] knowledge of the moisture content of food stuff serves as a useful index of their keeping qualities and susceptibility to fungi infection and low moisture content in all concentration is advantageous in terms of their shell life.

The phosphorus content was the most abundant and this agreed with Oksuz et al. [18] which states that phosphorus and calcium are the most abundant in fish, followed by the magnesium content which is the second most abundant mineral in the periwinkle tissues. The phosphorus content is higher than the calcium content and this is in agreement with Babu et al. [16]. The values of phosphorus and calcium in the periwinkle tissues were similar to that reported by Adeyeye et al. [19] Phosphorus is an essential component in the nucleic acid and the nucleoproteins responsible for cell division, reproduction and the transmission of hereditary trait [20]. It also acts as a key substance for energy release.

The magnesium content in this study is higher than that recorded by Adeyeye et al. [19] and Hambidge et al. [21] records that magnesium is an activator of the enzyme system which functions in the metabolism of carbohydrates to produce energy. The zinc content was closely related to that recorded by Sudhakar et al. [22] and that recorded by Fasakin et al. [23]. The levels of zinc in the periwinkle tissues studied were lower than the permissible limits [24]. Zinc is present in all tissues of the body and is a component of more than 50 enzymes [25]. Meat is the richest source of zinc in the diet and supplies one-third to one-half of the total zinc intake of meat-eaters. The observation in dietary minerals suggests that *T.fuscatus* could provide a significant proportion of calcium if consumed regularly. Calcium in conjunction with phosphorus, magnesium, manganese, vitamin A, C and D, chlorine and protein are involved in bone formation but calcium is the principal contributor. It also plays important role in blood clotting, muscles contraction and in certain enzymes in metabolic processes [26].

CONCLUSION

In conclusion, the present work revealed that *Tympanotonus fuscatus* are good sources of protein; hence, they can be used as substitute for meat and fish and for feed formulation for animals. Also, it can provide significant proportion of calcium, phosphorus, zinc and magnesium for important metabolic processes. They are low in fat and are considered to belong to a low fat class group. They are also low in carbohydrates and fiber. In order to maintain the quality of food, it is important to regularly monitor and evaluate the pollution level in periwinkles.

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