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THE EFFECT OF ACTELLIC DUST TREATMENT ON THE PROXIMATE AND MINERAL COMPOSITION OF *SYNODONTIS NIGRITA* AND *TILAPIA MARIAE*

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Abstract: *The high susceptibility of harvested fresh fish to immediate deterioration has resulted in the fundamental need for fish preservation to maintain its nutritional quality, minimize changes in its physical appearance, taste and lengthen shelf life. The insecticide, pirimiphos methyl (actellic dust) has been utilized in the storage of dried products against insect infestation, thereby increasing their shelf life. This study investigated the effect of pirimiphos methyl on the proximate and mineral composition of Synodontis nigrita and Tilapia mariae in Jamieson River which were purchased from the fish landing site in Sapele Delta State, Nigeria. The fish samples were divided into three batches of fresh samples (batch I), oven – dried samples (batch II) and actellic dust treated samples (batch III). The proximate composition (moisture, protein, fat, ash, crude fibre, and carbohydrate) and mineral content (sodium, potassium, calcium, and magnesium) of the samples were determined using the AOAC standard methods. Results showed that actellic dust treatment greatly increased the protein (19.35 to 23.31%), fat (8.12% to 22.31%), and raw fibre content (0.69 to 8.03%) in S. nigrita and protein (7.09 to 25.46%), fat (5.13 to 11.70%), and raw fibre content (3.40 to 14.23%) in T. mariae. The mineral elements analyzed showed no well-defined order across the treatment levels with potassium being the most abundant mineral element in all fish samples. Actellic dust has been shown to improve the proximate composition and shelf life of both fish species studied, and its use as a fish preservative is therefore recommended.*

Keywords: *Pirimiphos methyl, Proximate composition, Mineral content, Synodontis nigrita, Tilapia mariae, fish preservation, Jamieson River.*

1. Introduction

Fish production plays an important role in food security and nutrition especially in many developing countries. Fish is one of the healthiest and inexpensive sources of animal protein and other important nutrients required in human diets in Africa [1]. The importance of fish in human nutrition as attributed to its nutrient profile which is superior to all terrestrial meats such as beef, pork, chicken, etc. [2].

It is an excellent source of high quality animal protein and highly digestible energy, with a good source of sulphur and essential amino acids such as lysine, leucine, valine and arginine, and therefore suitable for supplementing diets of high carbohydrates contents. Beyond its approval as a balanced source of animal protein and vitamins, it also provides polyunsaturated fatty acids (PUFAs) and minerals required for optimal health [3], [4]. The fishery sector is estimated to supply 3.5% of Nigeria's gross domestic product (GDP) and provides direct and indirect employment to over six million people [5].

Fishes are highly perishable and they spoil rapidly if not properly handled. Fish deterioration is a complex process brought about by action of enzymes, bacteria and chemical constituents. The main principle involved in fish preservation is the prevention of microbial spoilage by reduction in moisture content or simply creating unfavourable environment for microbial growth [6], [7]. Various food preservation techniques such as freezing, chemical preservation, salting/brining, sun-drying and smoking have been used to improve the microbial safety, extend the shelf life of fish and increase fish availability to the consumers [6], [8], [9]. Despite these preservation methods, processed fish products are still susceptible to bio-deterioration due to microbial attack and insect infestation during storage or distribution. Control measures against insect infestation of dried and smoked fish include the use of chemical insecticides such as dichlorvos, actellic dust, synergized pyrethrins DDT and heptachlor to keep away insects and other pests [10], [11].

Pirimiphos-methyl (actellic dust) is a broad-spectrum organophosphorus insecticide with both contact and fumigant action. When applied to stored agricultural commodities (such as grain and nuts) it provides longer-lasting pest control. It is also effective in controlling various mites on vegetables and fruits. At high doses, pirimiphos-methyl show a mechanism of toxicity similar other organophosphorus insecticides and produce acute symptoms such as nausea, vomiting and cholinergic effects in humans [12]. Insecticides have been used extensively on dried fish samples to prevent insect infestation and improve the organoleptic properties of fish samples but very little information on its effects on the proximate and mineral composition of fish is available.

Therefore, this study aims to examine and compare the effect of actellic dust (pirimiphos methyl) on the nutrient and mineral composition of *Synodontis nigrita* and *Tilapia mariae* from Jamieson River, Sapele, Delta State.

2. Materials and Methods

2.1 Study area

This study was carried out in Jamieson River which is located in the Niger-Delta region of Nigeria. The region has two prevailing climatic seasons: wet season (May-October) and dry season (November-April). Jamieson River a tributary of the Benin River lies between Longitudes $5^0$41' to $5^0$58''E and Latitudes $5^0$54' to $6^0$08''N. The total length of the river is estimated to be 70km. The depth and width of the river is estimated to be between 1.7-2.1m and between 17m and 25m respectively [13].

2.2 Fish Collection and identification

The fish species chosen for this study are *Synodontis nigrita* and *Tilapia mariae*. The fish samples were procured fresh from landing sites at Jamieson River. A total of 54 fish specimens were collected over a period of three months, February to April, 2017. The samples were preserved in ice blocks and transported to the laboratory, where they were properly identified using taxonomic guides [14], [15]. Routine measurements of standard length, total length and body weight of all fish samples were taken to the nearest 0.1cm and 0.1g using a metre rule and digital electronic weighing balance [Mettler Toledo (PL203 model)] respectively. The fish samples were thoroughly washed with distilled water to remove any adhering contaminants and drained under folds of filter paper. The head was also discarded and the samples were stored in a deep freezer prior to analysis.

2.3 Experimental set-up

The fish samples were divided into three batches. This is important for valid conclusions to be drawn. Each batch contained 9 fish specimens of *Synodontis nigrita* and *Tilapia mariae*.

- Batch I were made up of fresh fish samples
- Batch II samples were oven-dried at a temperature of 105^{o}C for 6 hours using an electric oven [Bran drying oven (DHG-9023A model)].
- Batch III fish samples were treated with pirimiphos methyl (actellic dust)

2.4 Actellic dust treatment

Fresh fish samples were washed thoroughly with distilled water and submerged in 1 litre of actellic V solution for 15 seconds after which they were oven-dried for 6 hours in an electric oven at 105^{o}C. After drying, they were sprayed with 5 mL of actellic solution, sun-dried for 3 hours and stored in a desiccator for 3weeks at 28^{o}C . At the end of 3 weeks, they were analysed for their proximate and mineral composition. The insecticide solution was prepared by adding 12mL of actellic dust to 10 litres of distilled water.

2.4 Proximate analysis

The proximate composition (moisture, fat, ash, protein, crude fibre, and carbohydrate) and minerals content of *Synodontis nigrita* and *Tilapia mariae* were determined using the standard methods [16].

2.5 Data analysis

All statistical analysis was computed using Microsoft Excel and Statistical Package for Social Sciences (SPSS) version 21. The proximate values arising from fish samples in batches I – III were analysed for their range values, mean and standard errors. One-way analysis of variance (ANOVA) was used to test for significant difference (p<0.01) between means and the source of significant differences identified using Duncan's Multiple Range (DMR) test.

3. Results and Discussion

The total length ranged from 17.50 to 27.90cm, standard length (12.7 to 19.50cm) and body weight from (31.30 to 209.08g) for *Synodontis nigrita.*
The total length for *Tilapia mariae* ranged from 12.50 to 21.00cm, standard length (10.20 to 17.80cm) and body weight (41.29 to 233.12g) for *Tilapia mariae.* The results of the proximate and mineral composition of fresh, oven-dried and actellic treated samples of *Synodontis nigrita* and *Tilapia mariae* are presented in Table 1 and 2. The variations observed in all the values recorded in all parameters examined showed high significant different between the means of the different treatments.

In Tables 1 and 2, the highest mean moisture content of (79% and 78.87%) were observed in fresh samples while the lowest (0.18 and 2.19%) were observed in oven-dried samples of *Synodontis nigrita* and *Tilapia mariae*. The moisture content of the muscles of fresh samples for *Synodontis nigrita* and *Tilapia mariae* in this study were within acceptable levels of 60% to 80% [17]. The observed high significant (p<0.01) reduction in moisture content in oven dried samples of *Synodontis nigrita* and *Tilapia mariae* is consistent with reported observed reduction in moisture content from 67.33 to 4.11%, 58.50 to 15.60% and 66.33 to 4.97% in oven-dried samples of *Tilapia zilli* and

Synodontis clarias [18], [19], [20]. Actellic treated fish samples recorded higher moisture content of 22.00% and 19.75% in *S. nigrita* and *T. mariae* after storage. In contrast, low moisture content of 8.89%, 10.11% and 16.62% in actellic treated samples were recorded for Heterobranchus *longifilis, Heterotis niloticus* and *Chrysichthys nigrodigitatus,* respectively [21]. Increase in moisture content after storage can be attributed to variation in relative humidity and optimum temperature during the period of storage which led to oxidation of carbohydrate and yield carbon dioxide, water and energy.

Fish lipids are rich in polyunsaturated fatty acid particularly omega-3-fatty acids which have important role in disease prevention and health promotion [20] [22], [23]. The fat content was higher in oven-dried and actellic treated samples of *S. nigrita* and *T. mariae.*

Table 1.
Summary of the proximate composition of fresh, oven-dried and actellic treated *Synodontis nigrita* from Jamieson River

Proximate composition	Fresh			Oven-Dried			Actellic			P-value
	$\bar{X}$+ SD	Min	Max	$\bar{X}$+ SD	Min	Max	$\bar{X}$+ SD	Min	Max	
Moisture	79.00±2.35^{c}	76.65	81.35	2.19±0.86^{a}	1.33	3.05	22.00±1.46^{b}	20.54	23.46	<0.01
Fat	3.43±0.46^{a}	2.97	3.89	8.12±0.36^{b}	7.71	8.34	22.31±1.10^{c}	21.20	23.40	<0.01
Ash	6.22±1.05^{b}	5.17	7.27	30.10±0.93^{c}	29.17	31.03	1.89±0.16^{a}	1.70	2.00	<0.01
Protein	7.09±0.16^{a}	6.93	7.25	19.35±0.39^{b}	18.96	19.74	23.31±0.70^{c}	22.83	24.12	<0.01
Raw Fibre	0.40±0.02^{a}	0.38	0.42	0.69±0.03^{a}	0.66	0.72	8.03±0.45^{b}	7.58	8.48	<0.01
Carbohydrate	3.86±0.70^{a}	3.16	4.56	39.55±0.76^{c}	38.93	40.39	22.46±3.46^{b}	18.84	25.72	<0.01

Note: Similar superscripts – a, b, c indicate values that are not significantly different from each other ($p < 0.01$), while dissimilar superscripts – a, b, c indicate values that are significantly different from each other ($p < 0.01$)

Table 2.
Summary of the proximate composition of fresh, oven-dried and actellic treated *Tilapia mariae* from Jamieson River

Proximate composition	Fresh			Oven-Dried			Actellic			P-value
	$\bar{X}$+ SD	Min	Max	$\bar{X}$+ SD	Min	Max	$\bar{X}$+ SD	Min	Max	
Moisture	78.87±0.66^{c}	78.21	79.53	0.18±0.04^{a}	0.14	0.22	19.75±1.15^{b}	18.60	20.90	<0.01
Fat	0.67±0.04^{a}	0.63	0.71	5.13±0.58^{b}	4.55	5.71	11.70±0.70^{c}	11.00	12.40	<0.01
Ash	6.68±0.56^{b}	6.12	7.24	22.10±0.70^{c}	21.46	22.85	4.90±0.30^{a}	4.60	5.20	<0.01
Protein	8.84±0.40^{a}	8.44	9.24	7.09±0.30^{a}	6.79	7.39	25.46±2.34^{b}	23.12	27.80	<0.01
Raw Fibre	1.80±0.20^{a}	1.60	2.00	3.40±0.42^{a}	2.98	3.82	14.23±2.02^{b}	12.21	16.25	<0.01
Carbohydrate	3.14±1.06^{a}	2.08	4.20	62.10±0.29^{c}	61.77	62.32	23.96±4.51^{b}	19.45	28.47	<0.01

Note: Similar superscripts – a, b, c indicate values that are not significantly different from each other ($p < 0.01$), while dissimilar superscripts – a, b, c indicate values that are significantly different from each other ($p < 0.01$)

The observed increase in fat content of oven-dried samples of *S. nigrita* and *T. mariae* supports the reported increase in fat content from 12.85 to 20.25% (*Oreochromis niloticus*) and 2.73 to 13.34% (*Synodontis clarias*) in oven-dried samples [23], [20]. Actellic dust treatment greatly increased fat content from 8.12% to 22.31% and 5.13% to 11.70% in *S. nigrita* and *T. mariae*. In contrast, low fat content of 3.60%, 3.03% and 3.00% were recorded in actellic treated samples of *Heterobranchus longifilis*, *Heterotis niloticus* and *Chrysichthys nigrodigitatus* respectively [21]. In comparison, the mean fat content of fresh and oven-dried samples of *S. nigrita* was higher than *T. mariae*. Fresh samples of *S. nigrita* and *T. mariae* in this study belong to the low and lean fat categories respectively.

In this study, high ash content (30.10% and 22.10%) was recorded in oven-dried samples of *S. nigrita* and *T. mariae*, due to moisture loss and concentration of chemical components in the fish samples. Similar trend of high ash content in oven-dried samples were reported in *T. zilli* [18], *C. gariepinus* [19] and *S. clarias* [20]. High ash content has been reported to lower bacterial and fungal activities leading to better shelf life in fishes. The mean percentage ash content of actellic treated samples of *S. nigrita* (1.89%) and *T. mariae* (4.90%) were significantly low. Similar trend was observed in actellic treated samples of *Heterobranchus longifilis* (5.99%), *Heterotis niloticus* (4.00%) and *Chrysichthys nigrodigitatus* (3.03%) [21].

Protein is one of the major nutrients in fish and their levels define the nutritional status of a particular animal. The proximate composition of *S. nigrita* and *T. mariae* in this study revealed low protein content in fresh samples of *S. nigrita* (7.09%) and *T. mariae* (8.84%). The differences in protein content may be attributed to variation in fish size, age, seasonal variations i.e spawning, migration and starvation, level of assimilation of essential nutrient from their diets and the conversion rates of these nutrients for various metabolic activities. Actellic dust treatment increased protein content from 19.35% to 23.31% and 7.09% to 25.46% in *S. nigrita* and *T. mariae* respectively. This agrees with the reported high protein content in actellic treated fish samples of *Heterobranchus longifilis* (50.42%), *Heterotis niloticus* (58.64%) and *Chrysichthys nigrodigitatus* (67.32%) [21].

Actellic treated samples had the highest crude fibre content in *S. nigrita* (14.23%) and *T. mariae* (8.03%). While in a similar experimental setup, highest crude fibre content was reported in fresh samples of *Heterobranchus longifilis*, *Heterotis niloticus* and *Chrysichthys* [21]. Increase in crude fibre content could be attributed to the oxidation of poly-unsaturated fatty acids (PUFA) components, contained in their tissues to products such as peroxides, aldehydes, ketones and free fatty acids [24].

The highest carbohydrate content values (39.55 and 62.10%) in this study were recorded in oven-dried samples and lowest (3.86 and 3.14%) in fresh samples of *S. nigrita* and *T. mariae*. Similar trend of high carbohydrate content in oven-dried samples of *Tilapia zilli* and *Synodontis clarias* has been reported [20], [18]. The low carbohydrate values observed in fresh samples could be attributed to the fact that glycogen does not contribute significantly to the reserves in the fish body tissue [25].

The study of mineral elements present in living organisms is of biological importance; since many of such elements take part in some metabolic processes and are known to be indispensable to all living things [26]. Although fish is very unlikely

to be the only source of an essential mineral in the diet, fish provide a well-balanced supply of minerals in a readily usable form [27]. The mineral elements analyzed showed no well-defined order across the treatment levels, as the most abundant mineral element present in *S. nigrita* and *T. mariae* across the treatment levels was potassium. Previous investigation observed a similar trend [28].
Sodium and potassium were greatly reduced in actellic treated samples of *S. nigrita* and *T. mariae*. Similar trend of low sodium and potassium concentration was observed in actellic treated samples of *C. nigrodigitatus* [21]. Oven-dried samples of *S. nigrita* and *T. mariae* had higher sodium (47.70 mg/kg and 15.80 mg/kg) and calcium (42.90 mg/kg and 13.20 mg/kg) content than values recorded in fresh samples. The concentration of sodium in fresh samples of *S. nigrita* and *T. mariae* could be attributed to the concentration of sodium in the water body.
Calcium content in actellic treated samples was significantly high ($p < 0.01$) in *T. mariae* (32.70 mg/kg) but significantly low ($p < 0.01$) in *S. nigrita* (3.10 mg/kg). The observed higher calcium content in fresh samples of *Synodontis nigrita* over *Tilapia mariae,* can be attributed to its benthic nature and its relative preference for consumption of fish scales, crustaceans, insect parts and larvae. Magnesium function as a cofactor of many enzymes involved in energy metabolism, (proteins, RNA and DNA) synthesis and maintenance of the electrical potential of nervous tissues and cell membranes [29]. In both fish species, magnesium was almost completely eroded in actellic treated samples. This corroborates with the reported findings that magnesium content in actellic treated samples of *Chrysichthys nigrodigitatus* was almost completely eroded [21]. The differences observed in the content of magnesium could be due to variation in individual species, season and temperature.

4. Conclusion

The use of actellic dust insecticide in fish preservation and its effects on the proximate and mineral composition of fish has been studied. In general, there was noticed a significant influence of actellic dust on improving the proximate and mineral composition, and shelf life of *S. nigrita* and *T. mariae*. Therefore, the use of the insecticide as a fish preservative is recommended.

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