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The effect of food and frozen storage on the nutrient composition of some African fishes

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Abstract: Specimens of *Tilapia zillii*, *Clarias lazera*, *Channa obscura*, *Synodontis schall*, and *Scomberomus tritor* were collected between January and December 1990, covering the dry and rainy seasons. According to stomach analysis they were classified as either herbivorous, carnivorous, omnivorous, plankton consumers or invertebrate feeders. The crude protein, lipid amd moisture contents were determined both for pre- and post frozen storage, with the exception of *S. tritor* (only post storage data). The percentage of total lipid and protein decreased significantly after each succeeding frozen storage, and the moisture content shows a trend similar to other parameters in all the species. Fresh fish is of the highest nutritional value. The feeding habit had some relationship with the muscle protein, fat and moisture content.

Key words: Fish food, frozen storage, nutrients, food habits.

Nigeria is the largest importer of fish and fish and fish products in Africa. In 1987 a total of 209 042 metric tons (43.4% of the yearly fish supply) was imported. The actual fish demand for the year 1987 was estimated at 1 123 000 metric tons (Federal Departament of Fisheries, Lagos 1989). Efforts have to be geared towards increasing not only quantity, but also the quality of fish available in the market.

Much of the fish is spoiled due to poor post-harvest storage methods. As much as 15% of the total fish catch in the Kainji lake is lost because of spoilage and breakage between the source of supply and the consumers (Mayboom 1974). It has long been known that a decrease in the amount of protein soluble in solutions of neutral salts occurs during frozen storage.

The nature and quality of nutrients in most animals is dependent upon their food type. The feeding habit of an individual fish species has great effect on its nutrient composition (Laglar *et al.* 1962).

The primary aims of this paper, therefore are to determine the degree of nutritional changes that occur in frozen fish, and to determine any type of relationship that exists between these nutrients and the food habits of *Tilapia zillii* Gervais (Peciformes: Cichlidae), *Clarias lazera* Valenciennes: Cat fish (Siluriformes: Clarridae), *Channa obscura* Gunther: "Snake head"(Siluriformes: Channidae), *Synodontis schall* Bloch and Schneider (Siluriformes: Mocokidae), and *Scomberomorus tritor* Mitchill (Perciformes: Scombridae), some of the commonest fish species in Nigerian markets.

MATERIAL AND METHODS

Samples of *T. zillii, C. lazera, C. obscura,* and *S. schall* were collected alive from Asa Dam fishermen in Ilorin (Kwara State, Nigeria). Specimens of *S. tritor* were collected from the cold room of one of the frozen fish distributors in Ilorin.

All specimens were washed, measured and weighed to the nearest cm ang g respectively.

For nutrient analysis, ten healthy fish of each species were selected, a portion of the muscle from the widest part of the right fillet (devoid of scales and bones) was taken, weighed and dried overnight at 80°C to a constant weight. This process was carried out for every species before slow freezing in water for six weeks nad 12 weeks after which post- freezing analysis was done. According to Dyer and Dingle (1961), fast freezing techniques affect the extractibility of protein after storage. The fat content was estimated as described by Horwitz (1973). The percentage of moisture content was obtained from the difference between fresh and dry weights. The post- frozen determination of these parameters was after six and 12 weeks of frozen storage.

The stomach contents were emptied into labelled specimen bottles containing 10% formalin for subsequent food analysis. Numerical and frequency of occurrence methods were employed.

RESULTS

The relative sizes of the fish specimens are shown in Table 1, while Table 2 shows the analysis of food items of each species. *T. zillii* is mainly hervivorous and *C. lazera* is an omnivore. While *S. schall* feed mainly on invertebrates, *C. obscura* and *S. tritor* are carnivores and plankton feeders respectively.

The mean and percentage changes in the nutrient composition of all the fish samples are shown in Table 3.

After six weeks of freezing, *S. tritor* was the least susceptible to protein loss while *T. zillii* was the most susceptible; the reverse was the case after 12 weeks. Fat loss was lowest in *C. obscura* and *C. lazera* (six and 12 weeks respectively), while *S. schall* was most susceptible to fat loss after six weeks and *S. tritor* after 12.

After six weeks, *S. tritor* had the minimun moisture loss and *C. lazera* and *S. tritor* had the lowest and highest moisture losses, respectively. There was generally a gradual but significant decrease in protein, fat and moisture with longer freezing time (Fig. 1A & C and Tables 4 and 5). In Table 4, the numbers with asterisk indicate a 5% level of significance, suggesting that the length of freezing period is of significant importance in protein, fat and moisture content for the five species. In addition, none of the freezing periods was satisfactory. All the means with the same letter(s) in Table 5 are not significantly different (= 0.05) using Duncan's Multiple Range Test.

DISCUSSION

According to Woolfen (1975) the flesh of fish contains nutrients that can support the growth of a wide range of microorganisms. Alghough the flesh of a healthy newly caught fish is sterile, the skin, gills and intestine carry a considerable amount of bacterial load, depending on the environment of the fish at the time of capture. At death therefore, they start invading the tissues. The residual activity of enzymes which still remain active even after the death of the fish, is another contributing factor to fish spoilage. Freezing is a popular and relatively effective method of fish preservation.

The general decrease in moisture, protein and fat after succesive freezing could not be

TABLE 1

Relative size and weight of the fish species (mean in parenthesis, N = sample size)

Specimens	Standard length range (cm)	Weight range (g)
T. zillii	13.3 - 20.0 (15.2)	78.2 - 270.0 (117.1) N = 80
C. lazera	22.5 - 23.6 (23.0)	98.6 - 124.4 (113.7) N = 62
C. obscura	20.5 - 24.5 (20.8)	144.5 - 200.0 (75.9) N = 54
S. schaell	10.0 - 17.1 (14.5)	124.4 - 144.1 (134.5) N = 50
S. tritor	28.0 - 30.1 (29.2)	190.2 - 232.1 (212.7) N = 44

associated with bacterial or enzymatic activities. The activity of bacteria or enzyme is arrested at-100°C (Londahl 1981). Mills (1975) had earlier noted that there is protein denaturation during frozen storage, and that the most useful chemical method of examining frozen fish for quality is by meansurement of the level of protein that could be extracted.

The highest moisture content of *T. zillii* may be a result of its relatively low fat content. Moisture and lipids are known to be inversely proportional in fish tissue. *C. obscura* had the highest initial protein value, and lost 27 and 14% after frozen storage of six and 12 weeks respectively *T. zillii* and *S. schall* lost 33 and 31% of their protein respectively during the first six weeks on the freezing process and there was a 10% loss in both after the next six weeks (Figs. 1B & C and Table 3). The apparent low level of protein observed in *T. zillii* could be associated with its hervivorous feeding habit (Table 2). According to Laglar *et al*, (1962) freshwater fishes reflect group differences in their nutrient composition, particularly in their relative fat content.

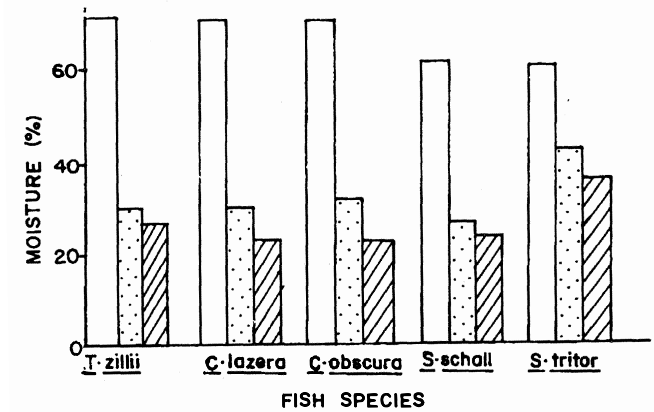
The food items of most of the species included fish, crustaceans, insects, oligochaete worms and diatoms (Table 2).

Occurrence of similar food items in all the species could be responsible for the little dis-

TABLE 2

The food items of several African fishes

Food items	*T. zillii (N = 80)* Numerical method (%)	Frequency of occurrence method (%)
Plant parts	30.2	38.2
Diatoms	40.0	27.3
Oligochaetes	6.6	10.9
Insects	16.6	20.0
Mud	6.6	3.6
Food Items	*C. lazera* (N=62) Numerical method (%)	Frequency of occurrence method (%)
Insects	40.7	25.6
Fishes	10.8	12.2
Plant remains	3.6	10.6
Crustacean	29.6	22.9
Detritus	12.1	19.6
Algae	3.1	9.0
Food items	*C. obscura* (N=45) Numerical method (%)	Frequency of occurrence method (%)
Fish	56.2	100.0
Worm	33.4	91.2
Insects	10.5	28.7
Food items	*S. schall* (N=50) Numerical method (%)	Frequency of occurrence method (%)
Copepods	40.0	50.6
Diatoms	34.3	82.4
Detritus	21.1	100.0
Oligochaetes	5.4	90.7
Food items	*S, tritor* (N=44) Numerical method (%)	Frequency of occurrence method (%)
Cladoceran	41	70
Cepepods	48	100
Phytoplankton	11	93



Fig· I (a) Moisture content for fresh and preserved fish samples (N= 10 for each species)

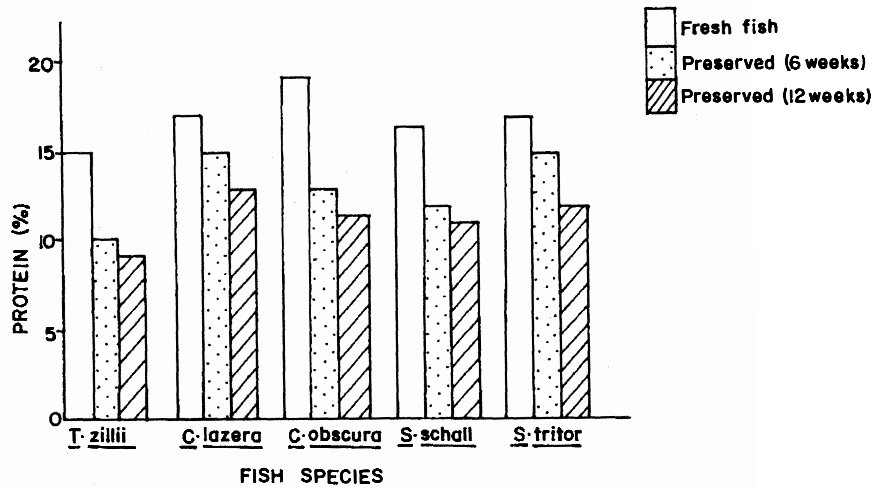
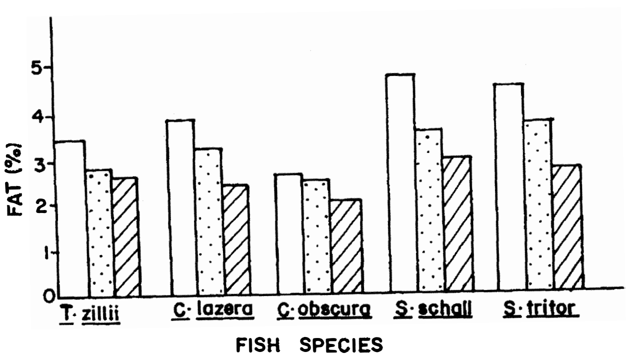


Fig · I (b) Protein values for fresh and preserved fish samples



Fig· I (c) Fat values for fresh and preserved samples

TABLE 3

Mean changes in nutriant content of fish samples after frozen storage (N = 10 for each species)

	Six	weeks	Twelve	weeks	Six	weeks	Twelve	weeks	Six	weeks	Twelve	weeks
Fish species	Amount of loss	% of loss	Amount of loss	% of loss	Amount of loss	% of loss	Amount of loss	% of loss	Amount of loss	% of loss	Amount of loss	% of loss
T. zillii:	5.02	33.22	0.99	9.78	0.68	19.43	0.23	8.29	40.27	51.26	3.89	13.43
C. lazera	2.56	14.83	2.01	13.77	0.69	17.61	0.77	5.19	40.13	56.31	8.28	25.42
C. obscura	5.08	27.39	1.94	14.46	0.29	9.89	0.23	7.69	42.18	59.33	4.21	15.69
S. schall	5.26	30.82	1.20	10.12	1.21	25.18	0.66	18.96	34.95	56.86	3.02	11.45
S. tritor	2.12	12.20	2.73	18.05	0.68	15.53	0.89	23.43	19.37	31.70	2.90	6.90

TABLE 4

Analysis of Variance

Source of Variance	d.f.	Protein	Fat	Moisture
Method	2	438.29*	21.46*	24352.90*
Type	4	70.27*	11.05*	388.45*
Method & Type	8	6.54*	0.76*	363.70*
Residual	135	1.16	0.25	4.70

* = P < 0.05

crepancies observed in both protein and fat composition. Ayinla and Akande (1988) had noted that fishes are affected by source of nutrients, and the protein and fat content of *Sarothèrodon mossambicus* muscle has been found to be related to the dietary composition of the fish (Jauncey 1982).

Therefore fish which feed on food containing lower amounts of protein will have a lower amount of muscle protein as well as higher lipid and moisture contents than those with higher amounts of protein in their diet. The relatively high protein value in *C. obscura* and the high fat content diet appears in Fig. 1B, C.

Enzymes, bacteria and oxidative changes are the main factors responsible for spoilage in unfrozened fish, and denaturation, oxidation and dehydratation have been recognised to be the main changes that ocurred during frozen storage (Merritt 1969). The general decrease in nutrient content during freezing could be traced to denaturation, oxidation and dehydration.

A knowledge of the degree of loss nutrient with period of freezing viz-a-viz the shelf-life of the commercial fishes would not only be of academic interest but nutrionally rewarding and economically more profitable to fish consumers and retailers.

TABLE 5

Table of means

Type	Protein Method			Fat Method			Moisture Method		
	1	2	3	1	2	3	1	2	3
1	15.01f	10.00ab	9.09a	3.48bcde	2.80abc	2.57abc	70.28c	30.01b	26.12ab
2	17.38fg	14.69def	12.72bcde	3.85abcd	3.15abcd	2.38ab	71.36e	31.25b	22.97a
3	18.55h	13.35cde	11.47abc	2.6ab	2.47abc	1.97a	71.11e	26.77ab	22.72a
4	17.03fg	11.88abcd	10.66abc	4.84e	3.64bcde	2.98abc	61.49d	26.56ab	23.55a
5	17.25fg	15.13e	12.42bcde	4.53de	3.83cde	2.94abc	61.03d	41.57c	38.68c
		SE = 1.08			SE = 1.08			SE = 2.17	

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