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Quality of Frozen Fish Sold in Some Selected Selling Points within Katsina Metropolis, Katsina State, Nigeria

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Abstract
A total of thirty six (36) samples of frozen fish species were procured within the six weeks study period from two reputable selling points (Karamchi and Kofar Kaura) in the Katsina metropolis. The samples were subjected to series of analysis to determine the quality of the products with a view to establishing the safety of what consumers buy on daily basis. Samples procured were analyzed for proximate composition, Total Volatile Basis Nitrogen (TVB-N) and Microbiological analysis on weekly basis for six weeks. The results of the proximate composition revealed that moisture, crude protein, lipid and NFE varied significantly (P<0.05). The values for moisture ranged from 54.00±O.71 to 61.75±3.18, crude protein ranged between 15.21±3.27 and 19.13±0.88. Lipid content ranged from 4.25±3.18 to 12.00±3.54 and the NFE ranged between 12.82±1.94 and 18.75±1.06 respectively. The ash content of the products were not significantly different (P>0.05), it ranged from 1.25±0.35 to 1.75±0.35. The Total Volatile Basis (TVB-N) ranged from 3.08mg/100g to 18.20mg/100g. Total bacterial count (TVC) ranged between $3x10^5$ and $5.4x10^6$ cfu/g. the study revealed that the sanitary and hygienic condition in which the frozen fishes were kept have a direct bearing on the quality of fish being sold at the selling points. Samples from Karamchi selling point were more prone to spoilage due to the inadequate storage facilities. Based on this, it is suggested that adequate cooling facilities be put in place to allow for proper preservation of the freshness of frozen fish.
Keywords: Frozen fish, Selling points, TVB-N, Microbiological analysis and cooling facilities

Introduction
Nigeria is endowed with numerous water resources both natural and man-made (rivers, lakes, creeks and about 200 nautical miles of marine water under the exclusive economic zone (EEZ).), the country has about seven maritime states which are Lagos, Delta, Rivers, Ondo, Ogun and Akwa-ibom states. The fishery industry has, however not attained the desired level of self-sufficiency in local fish production (Idachaba, 1991).

According to Olokor *et al*., (2007) fish is one of the most nutritious foods. It contributes a considerable proportion of the protein diet in the developing nations particularly those of Africa. The food potential of fish has appreciated increasingly in both developing and developed nations. Unfortunately, fish is among the most perishable food stuffs. This is especially so in the tropics where losses due to poor traditional handling accounts for 25-40% (Eyo, 2001)

Freezing is the one of most easiest and least time-consuming method of food preservation, which allows and retained their natural color, flavor, taste, texture and nutritional value in foods better than any other method (Olokor, *et al.,* 2007). The freezing process is a contribution of the beneficial effects of low temperatures at which micro -organism cannot grow, chemical reactions are reduced and cellular metabolic reactions are delayed (Delgado and Sun, 2000).

AFFI, (2003) reported that thousands of fish consumers patronize frozen fish markets for their domestic and commercial uses. This indicates that frozen fish products are cheaper than fresh fish from the wild and hence attracts more markets due to low income status of the citizenry. Information on the quality of the frozen fish sold in katsina is not available which necessitates the present research with a view to getting base line data on the quality of what the majority of the populace consumes. As a major fish product traded in katsina, the nutritive composition should be known with a view to establishing its quality and safety which will serve as a basis for continuous supply and suggest ways of improvement of the preservation method to increase quality and reduced health risks to consumers.

The object of this study is to determine the quality of frozen fish that are sold in katsina metropolis through determination of proximate components, total volatile bases and microbial analysis of the frozen products.

Materials and Methods
Study Area
Katsina state with a land area of 24,192km² is located in the North – Western region of Nigeria between latitude 12^O 15^0 north and longitude $7^0 30^0$ east. It is bordered in the east by Kano and Jigawa, in the south by

Kaduna, in the west by Zamfara state, in the north by Niger republic (Mamman *et al.,* 2000)

Sampling

The frozen shawa (Herring) *Clupea harengus scien,* Titus (Host mackerel) *Scomber scombrus,* Croaker *(Croaker) Johnius dussumeir,* packs in 1kg packets were purchased at regular intervals from two different reputable selling points in Katsina metropolis. The sampling stations are as follows; Karamchi frozen fish (A) and Kofar Kaura frozen fish (B). The samples were collected aseptically and were transported in an insulated container under chilled condition to the central laboratory, Faculty of Agriculture, Usmanu Danfodiyo University for analysis 3 to 4hours after purchase. Samples were randomly picked for biochemical, proximate and microbial analysis for a period of six weeks.

Microbiological Analysis

Bacterial count was carried out using standard plate count. 1g of the frozen sample was diluted into 9mls of distilled water (1g:9mls) in sterilized universal tubes for each of the treatments. From this dilution, further serial dilutions were made up by 1ml transfer from tube 1 through tube 5. Plates already prepared were allowed to set before incubating for 24hours and colony counts were carried out on plates (Fung *et al.,* 1987)

Proximate Composition

All the proximate components; moisture, crude protein ash, ether extract were determined using the methods of AOAC, (2002) method of analysis.

Biochemical Analysis

The total volatile base (TVB) and trimethylamine (TMA) was determine by the micro – diffusion method of Conway (1968) free fatty acid (FFA) content of the samples was analyze as described by Shearer (1994)

Statistical Analysis

The data obtained were analyzed using T – test technique and the mean were separated using Duncan's multiple range tests (Steal and Torrie, 1960).

Results

Table 4.1 shows the overall mean proximate composition of frozen products from the two sampling locations. The overall mean moisture content ranged from 54.81% in samples of *clupea harengus scien* (Shawa) obtained from Karamchi frozen fish selling point which has the lowest value to 59.67% in the frozen products purchased from kofar Kaura selling point. The moisture and crude protein were significantly different ($p<0.05$). The protein content ranged from 16.19% in samples of *Scomber scombrus* (Titus) obtained from Karamchi frozen fish selling point to 18.45% in the frozen *Clupea harengus scien* (shawa) purchased from the same fish selling point which has the highest value. However, the lipid, ash content and NFE were all not significantly different ($p>0.05$).

The result of the overall moisture and crude protein content of the products are depicted on Table 4.1. The result indicated high significant difference ($P<0.05$) between sample obtained from Kofar Kaura frozen fish selling point and that of Karamchi frozen fish selling point. However, the other samples were not significantly different ($P>0.05$).

Table 4.2; shows the weekly result of the frozen products from the two locations for the six weeks. In terms of moisture content, the *Scomber scombrus* (Titus) obtained from Karamchi frozen fish selling point had the highest value of 61.75% in the 1st week of the research while *Scomber scombrus* (Titus) obtained from Karamchi frozen fish selling point had the least value of 45.00% in the 4th week of the research. Crude protein content ranged from 19.13% in the sample of Johnius dussumeir (Croaker) obtained from Karamchi frozen fish selling point in the 4th week of the research.

TABLE 4.1: Overall Mean Proximate Composition of the Frozen Fish

Weeks	**Parameter**				
Samples	**Moisture**	**Crude protein**	**Lipid**	**Ash**	**NFE**
Clupea harengus scien (Shawa) A	54.81±1.49^{b}	18.45±1.14^{a}	9.16±2.49	1.52±0.42	16.23±2.96
Scomber Scombrus (Titus) A	57.58±3.43^{ab}	16.19±1.13^{b}	8.06±1.36	1.67±0.26	16.50±2.18
Johnius dussumeir (Croaker) A	56.92±2.04^{ab}	17.64±1.78^{ab}	8.83±0.75	1.58±0.38	15.03±1.08
Clupea harengus scien (Shawa) B	57.33±2.34^{ab}	16.92±1.65^{ab}	9.08±2.84	1.42±0.38	15.25±2.21
Scomber scombrus (Titus) B	58.17±3.50^{ab}	16.62±1.28^{ab}	7.00±2.79	1.75±0.27	16.47±1.92
Johnius dussumeir (Croaker) B	59.67±2.93^{a}	17.52±1.15^{ab}	7.42±1.02	1.58±0.38	13.81±3.05

Key: A= Karamchi selling point
B=Kofar Kaura selling point

TABLE 4.2: Proximate composition of frozen products for the six weeks from the two locations
Week treatment parameter

WK	Sample	Moisture	Crude protein	Lipid	Ash	NFE
1	Shawa A	55.00±0.00^{ab}	18.57±0.26^{ab}	6.75±1.06^{cd}	1.25±0.35^{a}	18.44±0.45^{ab}
	Titus A	61.75±3.18^{a}	15.22±0.13^{b}	6.00±0.71^{cd}	1.50±0.00^{a}	15.53±2.60^{abc}
	Croaker A	58.25±1.06^{ab}	15.97±0.31^{ab}	7.25±1.06^{bcd}	1.75±0.35^{a}	16.78±0.04^{abc}
	Shawa B	55.13±0.12^{ab}	17.19±3.27^{ab}	6.12±0.14^{cd}	1.31±0.28^{a}	18.37±0.52^{ab}
	Titus B	59.51±2.13^{ab}	15.71±0.13^{ab}	6.50±0.91^{cd}	1.75±0.35^{a}	15.88±1.94^{abc}
	Croaker B	58.12±2.00^{ab}	16.65±0.23^{ab}	6.00±0.71^{cd}	1.75±0.35^{a}	16.13±2.65^{abc}
2	Shawa A	55.75±1.06^{ab}	17.19±3.27^{ab}	12.00±3.54^{a}	1.25±0.35^{a}	13.18±0.44^{bc}
	Titus A	59.50±0.71^{ab}	17.25±1.41^{ab}	4.25±3.18^{d}	1.75±0.35^{a}	17.25±0.71^{abc}
	Croaker A	57.75±4.60^{ab}	18.59±1.03^{ab}	9.00±0.71^{abc}	1.50±0.00^{a}	12.92±2.51^{c}
	Shawa B	55.68±0.45^{ab}	16.66±0.23^{ab}	6.75±1.11^{cd}	1.31±0.28^{a}	15.91±3.21^{abc}
	Titus B	55.50±3.54^{ab}	17.88±0.53^{ab}	6.50±0.71^{cd}	1.75±0.35^{a}	16.56±2.21^{abc}
	Croaker B	57.00±4.24^{ab}	17.63±2.65^{ab}	7.25±1.06^{bcd}	1.25±0.35^{a}	15.82±0.03^{abc}
3	Shawa A	56.50±4.95^{ab}	17.44±3.27^{ab}	8.00±2.12^{abcd}	1.30±0.28^{a}	13.06±1.85^{c}
	Titus A	59.25±2.47^{ab}	16.13±0.53^{ab}	9.00±0.70^{abc}	1.75±0.35^{a}	14.96±2.54^{abc}
	Croaker A	58.00±4.24^{ab}	15.97±0.31^{ab}	8.75±1.07^{abc}	1.50±0.10^{a}	13.57±3.44^{bc}
	Shawa B	55.75±1.06^{ab}	15.22±0.13^{ab}	11.00±3.54^{ab}	1.25±0.35^{a}	14.85±2.34^{abc}
	Titus B	59.50±0.71^{ab}	17.91±0.57^{ab}	7.92±0.11^{bcd}	1.50±0.00^{a}	18.75±1.06^{a}
	Croaker B	57.75±4.60^{ab}	16.50±1.41^{ab}	9.00±0.71^{abc}	1.75±0.35^{a}	12.88±1.94^{c}.
4	Shawa A	57.00±1.41^{ab}	17.90±0.57^{ab}	9.00±0.71^{abc}	1.75±0.35^{a}	18.37±0.53^{ab}
	Titus A	45.00±0.71^{b}	16.50±1.41^{ab}	9.00±071^{abc}	1.75±0.35^{a}	15.87±1.93^{abc}
	Croaker A	59.00±3.54^{ab}	19.13±0.88^{a}	7.25±1.06^{bcd}	1.31±0.28^{a}	16.13±2.65^{abc}
	Shawa Bs	55.68±0.45^{ab}	15.71±0.13^{ab}	11.00±3.52^{ab}	1.25±0.35^{a}	14.84±2.34^{abc}
	Titus B	57.00±4.24^{ab}	15.97±0.31^{ab}	7.92±0.12^{bcd}	1.50±0.00^{a}	18.45±1.06^{ab}
	Croaker B	55.50±3.54^{ab}	16.65±0.23^{ab}	9.00±0.61^{abc}	1.74±0.35^{a}	12.82±1.94^{c}
5	Shawa A	55.00±0.00^{ab}	15.21±3.27^{b}	8.00±2.12^{abcd}	1.75±0.35^{a}	15.91±3.13^{abc}
	Titus A	57.75±3.18^{ab}	15.45±0.09^{b}	9.00±0.71^{abc}	1.75±0.35^{a}	16.56±2.21^{abc}
	Croaker A	58.25±1.06^{ab}	15.98±1.09^{ab}	8.75±1.06^{abc}	1.25±0.35^{a}	14.27±0.03^{abc}
	Shawa B	56.50±4.95^{ab}	17.19±3.27^{ab}	11.00±3.53^{ab}	1.31±0.28^{a}	15.82±0.03^{abc}
	Titus B	57.25±3.18^{ab}	15.71±0.13^{ab}	7.92±0.11^{bcd}	1.75±0.35^{a}	16.71±0.21^{abc}
	Croaker B	59.75±2.47^{ab}	16.66±0.23^{ab}	9.00±0.70^{abc}	1.25±0.35^{a}	15.91±3.13^{abc}
6	Shawa A	55.68±0.45^{ab}	16.66±0.23^{ab}	7.99±0.02^{abcd}	1.30±0.28^{a}	18.37±0.52^{ab}
	Titus A	55.50±3.54^{ab}	17.88±0.53^{ab}	9.00±0.71^{abc}	1.75±0.35^{a}	15.88±1.94^{abc}
	Croaker A	57.00±4.24^{ab}	17.63±2.65^{ab}	7.50±1.41^{bcd}	1.50±0.10^{a}	16.13±2.65^{abc}
	Shawa B	56.50±4.95^{ab}	18.57±0.26^{ab}	7.92±0.12^{bcd}	1.30±0.28^{a}	13.06±1.85^{c}
	Titus B	59.25±2.47^{ab}	17.88±0.53^{ab}	9.00±0.61^{abc}	1.75±0.35^{a}	14.96±2.54^{abc}
	Croaker B	57.75±4.60^{ab}	15.97±0.31^{ab}	9.00±0.71^{abc}	1.75±0.35^{a}	13.57±3.45^{bc}

Key: A = Karamchi selling point
B = Kofar Kaura selling point

The result of the Total Volatile Bases Nitrogen (TVB-N) is presented in Table 4.3. The TVB-N value was lower (3.08mg/100g) in the *Scomber scombrus* (Titus) obtained from Karamchi frozen fish and higher values (18.20mg/100g) in the *Johnius dussumeir* (croaker) sample purchased from the same selling point during the first and fourth week of the research. The results of the 1st,4th and 5th weeks of the research indicated higher values which ranged from 10.60mg/100g to 18.20mg/100g but they were all significantly different ($p<0.05$) between and within the species of both weeks.

Table: 4.3; Show the Interaction betwseen the species from the two locations of (TVB-N) values for the six week

Week	Species/Location	TVB-N
1	*Clupea harengus scien* (Shawa) A	15.40 ± 3.96^{gh}
	Scomber scombrus (Titus) A	14.70 ± 0.99^{gh}
	Johnius dussumeir (Croaker) A	18.20 ± 1.98^{a}
	Clupea harengus scien (Shawa) B	10.60 ± 1.98^{de}
	Scomber scombrus (Titus) B	13.19 ± 0.49^{cd}
	Johnius dussumeir (Croaker) B	14.15 ± 1.88^{bc}
2	*Clupea harengus scien* (Shawa) A	6.58 ± 0.59^{bcd}
	Scomber scombrus (Titus) A	3.08 ± 0.40^{i}
	Johnius dussumeir (Croaker) A	5.74 ± 1.39^{abc}
	Clupea harengus scien (Shawa) B	5.16 ± 0.49^{hi}
	Scomber scombrus (Titus) B	4.06 ± 0.40^{hi}
	Johnius dussumeir (Croaker) B	5.49 ± 0.59^{fg}
3	*Clupea harengus scien* (Shawa) A	6.72 ± 0.40^{bcd}
	Scomber scombrus (Titus) A	3.50 ± 0.20^{ab}
	Johnius dussumeir (Croaker) A	5.60 ± 0.40^{abc}
	Clupea harengus scien (Shawa) B	6.58 ± 0.54^{fgh}
	Scomber scombrus (Titus) B	3.64 ± 0.20^{hi}
	Johnius dussumeir (Croaker) B	6.02 ± 0.47^{gh}
4	s *Clupea harengus scien* (Shawa) A	13.30 ± 0.99^{fg}
	Scomber scombrus (Titus) A	16.80 ± 1.98^{hi}
	Johnius dussumeir (Croaker) A	18.20 ± 1.98^{a}
	Clupea harengus scien (Shawa) B	13.19 ± 0.49^{cd}
	Scomber scombrus (Titus) B	10.60 ± 1.98^{de}
	Johnius dussumeir (Croaker) B	14.15 ± 1.88^{bc}
5	*Clupea harengus scien* (Shawa) A	14.05 ± 0.49^{gh}
	Scomber scombrus (Titsus) A	14.05 ± 0.49^{gh}
	Johnius dussumeir (Croaker) A	14.95 ± 1.77^{gh}
	Clupea harengus scien (Shawa) B	13.07 ± 0.50^{cd}
	Scomber scombrus (Titus) B	13.07 ± 0.50^{cd}
	Johnius dussumeir (Croaker) B	13.07 ± 0.50^{cd}
6	*Clupea harengus scien* (Shawa) A	10.60 ± 0.57^{ef}
	Scomber scombrus (Titus) A	9.37 ± 0.18^{de}
	Johnius dussumeir (Croaker) A	$8.86\pm0.50c^{de}$
	Clupea harengus scien (Shawa) B	11.60 ± 0.60^{de}
	Scomber scombrus (Titus) B	9.18 ± 0.19^{ef}
	Johnius dussumeir (Croaker) B	9.33 ± 0.18^{ef}

Key A: Karamchi selling point
B= Kofar Kaura selling point

Microbiological Analysis

In the present study, the total viable count (TVC) for all the frozen fishes analyzed ranged from 3×10^5 to 5.4×10^6 shown in Table 4.4; Kofar Kaura frozen fish selling point (B) had the least viable count while Karamchi frozen fish selling point (A) had the highest viable count. In 2nd week *Scomber scombrus* (Titus) obtained from Karamchi frozen fish selling point had the highest viable counts of 5.4×10^6 while *Scomber scombrus* (Titus) obtained from Kofar Kaura frozen fish selling had the least viable count of 5×10^5. In 4th week the *Clupea* *harensgus scien* (Shawa) obtained from Kofar Kaura frozen fish selling point had the least viable count of 3 x 10^5 while *Johnius dussumeir* (croaker) which were obtained from Kofar Kaura frozen fish selling point had the highest viable count of 1.0x 10^6.

Table 4.4: Mean weekly bacterial count of the frozen product in 10^5 dilution

Week	Fish species/location	Mean count	Standard (cfu/g)
1	*Clupea harengus scien* (Shawa) A	12	$1.2x10^6$
	Scomber scombrus (Titus) A	17	$1.7x10^6$
	Johnius dussumeir (Crocker) A	18	$1.8x10^6$
	Clupea harengus scien (Shawa) B	16	$1.6x10^6$
	Scomber scombrus (Titus) B	40	$4.0x10^6$
	Johnius dussumeir (Croaker) B	06	$6x10^5$
2	*Clupea harengus scien* (Shawa) A	30	$3.0x10^6$
	Scomber scombrus (Titus) A	54	$5.4x10^6$
	Johnius dussumeir (Croaker) A	10	$1.0x10^6$
	Clupea harengus scien (Shawa) B	13	$1.3x10^6$
	Scomber scombrus (Titus) B	05	$5x 10^5$
	Johnius dussumeir (Croaker) B	08	$8x 10^5$
3	*Clupea harengus scien* (Shawa) B	17	$1.7x10^6$
	Scomber scombrus (Titus) A	18	$1.8x10^6$
	Johnius dussumeir (Croaker) A	13	$1.3x10^6$
	Clupea harengus scien (Shawa) B	22	$2.2x10^6$
	Scomber scombrus (Titus) B	28	$2.8x10^6$
	Johnius dussumeir (croaker) B	31	$3.1x10^6$
4	*Clupea harengus scien* (shawa) A	08	$8x 10^5$
	Scomber scombrus (Titus) A	04	$4x 10^5$
	Johnius dussumeir (Croaker) B	11	$1.1x10^6$
	Clupea harengus scien (shawa) B	03	$3x 10^5$
	Scomber scombrus (Titus) B	07	$7.x10^5$
	Johnius dussumeir (croaker) B	10	$1.0x10^6$
5	*Clupea harengus scien* (shawa) A	09	$9x 10^5$
	Scomber scombrus (Titus) A	18	$1.8x10^6$
	Johnius dussumeir (Croaker) B	16	$1.6x10^6$
	Clupea harengus scien (shawa) B	31	$3.1x10^6$
	Scomber scombrus (Titus) B	20	$2.6x10^6$
	Johnius dussumeir (croaker) B	12	$1.2x10^6$
6	*Clupea harengus scien* (shawa) A	30	$3.0x10^6$
	Scomber scombrus (Titus) A	25	$2.5x10^6$
	Johnius dussumeir (Croaker) B	19	$1.9x10^6$
	Clupea harengus scien (shawa) B	09	$9x10^5$
	Scomber scombrus (Titus) B	18	$1.8x10^6$
	Johnius dussumeir (croaker) B	13	$1.3x10^6$

Key: A= Karamchi selling point
B= Kofar Kaura selling point

Discussion

The Proximate Composition, Bacteriological and Total Volatile Bases of the frozen fish sold in Katsina metropolis were studied. The variations in moisture content was due to the time taken in freezing the fish and the temperature of fish flesh from which heat is steadily removed from the freezing point of water. The temperature then remains almost stationary until most of the water turn to ice, when it again begins to fall rapidly as the frozen flesh is further cooled. The percentage moisture content were higher than the percentage recorded by Eyo (2001) but the moisture content of the species was within the range as previously reported by (Gallagher *et al.,* 1991) moisture and lipid contents in fish fillets are inversely related. Freezing of fish lowers the temperature and thus slow – down spoilage so much that when the product is thawed after cold storage it is virtually indistinguishable from fresh fish (Lilabati *et al*., 1997).

The mean weekly protein content for each of the frozen products differs significantly ($p<0.05$). There is inverse relationship between moisture and protein content in the fish. Arannilewa *et al*., (2005) noted that protein decreased with increasing duration of frozen storage with fresh samples not frozen having higher protein content. Disadvantage such as products dehydration, rancidity, drip loss and product bleaching have overall effect on the quality of frozen food (kropf and Bowers 1992). In spite of some disadvantages associated with frozen storage freezing is accepted as effective way of preserving fish (Arannilewa *et al*., 2005).

Increase of protein may be due to the dehydration of water molecule present between the proteins thereby, causing aggregation of protein and thus resulting in the increase in protein content of the fish (Niname and Rathnakumar, 2008).

Similarly, the percentage protein content of the fish product exceeded the limit given by Stansby (1962) on fish fillet. The lipid content of the products were not significantly different (p>0.05) both between weeks and samples. According to FAO, (1999), moisture and lipid contents in fish fillets are inversely related and the range for the ash content gave an indication that the fish samples may be good sources of minerals such as calcium, potassium and magnesium.

The percentage ash content of the frozen products remained almost the same throughout the 6 weeks as similar findings by Arannilewa *et al.,* (2005) and were also not significantly different (p>0.05). Various researchers also reported similar findings; Abdullahi *et al*., (2001); Magawata and Oyelese, 2000. Ash content of dried fish was higher than that of fresh fish. (Clucas and Ward, 1996).

The presence of moisture in fish permits the growth of bacteria and mould in fish flesh during storage (Eyo, 2001). Sample from Karamchi selling point had the highest count of bacteria and this was attributed to inadequacy of efficient cold rooms, thereby making the environment favorable for bacterial growth. Similar increment on total bacterial load in muscle at low temperature storage was reported by Obemeata *et al.,* (2011).These authors stated that freezing of fish at -18^{0}c created an unfavorable environmental condition for the growth and the survival of the micro-organisms, while freezing at 4^{0}c allows the rapid proliferation of the micro-organisms. The value of TVB was observed to be fluctuating during the study period. The TVB values ranged from 3.08mg/100g to 18.20mg/100g. Generally, the fluctuation of the TVB values indicated that the products were subjected to factors influencing deterioration at a certain period where the values were higher but the whole values were within the acceptable limits as reported/recommended by Connell (1980) and Olatunde (1998).

Conclusion

The results of the crude protein, moisture and lipid of the composition for *Johnius dussemeir* (croaker) obtained from the two selling points were high. The total coliforms limit per gram of the frozen fish were within the acceptable range of 11-500 cfu/g as reported by the International Commission on Microbiological Specifications food (ICMSF, S1986). Similarly, the observed values of TBV-N were within the acceptable limits reported by Connel (1980). Therefore, the frozen species examined in this study from the different reputable selling points were safe for consumption and utilization.

Recommendations

Because of malhandling of the frozen products in the two sampling locations and more especially at Karamchi selling point, the following recommendations are hereby suggested to ensure good quality products for consumers; the cold rooms should be well equipped with adequate storage facilities in order to prolong the shelf life of the fish products. An undisrupted power supply should be ensured whether in cold rooms or during transportation of the fish to a far distant locations. Quality control units of the concerned agencies should ensure regular checking of the products safety through analysis of bacterial counts and TVB values.

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