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Technological Properties and Biochemical Studies of Bonga *Ethmalosa fimbriata*

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Size measurements, anatomical composition and biochemical evaluations of bonga (*Ethmalosa fimbriata)* muscle were carried out. The mean values of length and weight recorded for bonga over a period of 2 months were 22.12±1.27 cm and 136.82±13.27 g respectively. Size measurements as shown by length and weight data for the one-year period suggested a positive effect of season on size. The pattern of change in weight throughout the study period was similar to that of change in length and gave a correlation coefficient "r" of 0.82 significant at $p<0.05$. Anatomical fractionation showed that bonga contained on the average 61.1% trunk, 23.7% head and 16.3% viscera. Total wastes (head and viscera) derived from bonga were 39.9% of the total body weight. The proximate chemical composition analysis showed that the muscle of bonga contained between 74.14% and 77.54% moisture, 1.12-5.69% lipid, 18.73- 21.54% protein and 1.57- 2.14% ash. The chemical composition did not vary significantly except in lipid content where a significant ($p<0.05$) inverse relationship between moisture and lipid content was observed. Triglycerides accounted for over 5% of lipid in bonga. The major fatty acid component in the lipid of bonga were C 16:0, C 18:0, C 18:1, C 20:4, C 20:5and C 22:6.

Keywords : Weight, length, anatomical, yield, bonga, fatty acids

Bonga (*Ethmalosa fimbriata*) is a coastal and estuarine clupeid found on the West African coast from Mauritania to Angola, contributing up to 80% of the small pelagic fish landing (Jallow, 1994). However, the fish has lots of inter- and intra-muscular bones, and is seldom consumed in the fresh form but found major utilization in the smoked form (Egwele *et al.*, 1986). This work reports the technological properties and biochemical characteristics of bonga caught in the coastal waters of Lagos State, Nigeria. The chemical composition of the fillet is presented and the characteristics of the extractable oil of the bonga fish determined. The collected data is expected to provide a basis for better utilization of the fish.

Materials and Methods

Freshly caught bonga (*Ethmalosa fimbriata*) were collected on a monthly basis for one year from Makoko fish market in Lagos. Fish samples were then delivered to the Nigerian Institute of Oceanography and Marine Research cold store at –22°C and kept for subsequent use.

Specimens (25 no.) were randomly selected and examined for length and weight frequency measurements. The standard length (SL) was measured using standard graduated fish measuring board. The weight was measured using sartorius top loading electronic weighing balance.

Anatomical measurements were carried out by be-heading, removing the scales, fins and viscera, weighing them and relating these weights to the total body weight of the fish.

Moisture content of the fish was determined by drying samples to constant weight at 103±2°C using hot air convection oven. The nitrogen content was determined by Kjeldahl digestion as described by Vlieg (1982) and the crude protein was calculated by multiplying the nitrogen content by 6.25 (Pearson, 1981). Lipid content of flesh was determined by the Bligh and Dyer (1959) method. Ash was determined by incineration in a muffle furnace at 525°C until the sample was completely free from carbon particles. Calcium determination was carried out using a Perkin-Elmer 29 Atomic Absorption Spectrophotometer (AAS) at a wavelength of 432 nm while phosphorus was determined colorimetrically using the phosphoranado molybdate method (Pearson, 1981). Lipid class analysis was measured by separation of lipid classes on a single thin layer plate using the method of Freeman and West (1966). The spots on thin layer plates were scanned in a densitometer and the peaks identified as the various lipid fractions by comparison with those of known standards. Peak area was determined by triangulation. The amount of each component was calculated by expressing the peak area of each component as a percentage of the total peak area. Fatty acid analysis was on the lipid extracted by the Bligh and Dyer (1959) method. Methylation of the extracted lipid was carried out by the method of Metcalfe and Schmidt (1960). The dry heptane solutions of the methyl esters were then injected into a PYE 24 gas chromatograph. Operating conditions were as follows:

Column : 1.5m x 4mm glass packed with 25% diethylene glycol succinate. (DEGS on chromosorb 100/120 mesh

Column temperature	:	198°C.
Carrier gas	:	Nitrogen@37 ml/min
Detector	:	Flame ionization
Detector temperature	:	350°C
Attenuation	:	10 x 10^2
Chart speed	:	24s/cm
Solvent	:	n-heptane (chromatographically pure

Standard fatty acid methyl esters were run under the same conditions and subsequent retention times used to identify fatty acids. Measurement of peak areas was as described by Balogun and Fetuga (1985)

Linear regression analysis was used to determine correlation of parameters with storage time and t-tests used to test for significance at 5% level.

Table 1. Mean length (cm) and weight (g) by month of Bonga, *Ethmalosa fimbriata*

Month	Sample size (No.)	Mean length (cm)	Range (cm)	Mean weight (g)	Range (g)
January	20	23.13±2.61	17.50 - 28.20	153.16±29.61	106.88 - 240.00
February	20	24.14±2.42	18.80 - 28.00	157.24±28.59	110.42 - 190.88
March	20	22.41±1.96	20.50 - 29.00	136.53±19.77	100.63 - 178.50
April	20	22.19±1.99	18.80 - 25.80	135.16±24.58	100.65 - 185.80
May	20	19.86±2.19	19.80 - 27.50	119.92±31.01	90.33 - 172.50
June	20	20.50±2.85	17.80 - 29.00	120.06±41.42	68.90 - 179.50
July	20	20.40±2.18	17.50 - 25.50	117.13±38.59	70.95 - 186.50
August	20	21.44±1.46	19.00 - 24.00	136.93±26.09	102.88 - 194.64
September	20	22.61±3.08	18.00 - 28.00	158.31±12.23	145.00 - 185.80
October	20	22.31±1.76	19.60 - 27.80	133.62±24.17	98.25 - 220.98
November	20	23.71±2.32	19.00 - 27.50	137.46±35.98	98.78 - 184.34
December	20	22.71±2.45	19.50 - 27.00	136.28±31.44	105.50 - 190.44
Correlation Coefficient	"r" = 0.82	Mean length	22.12±1.27	Mean weight	136.82±13.27

Each result is mean ± standard deviation of sample size.

Results and Discussion

The mean length and weight of Bonga fish sampled are presented in Table 1. The mean length and weight obtained from January to December were 22.12±1.27 cm and 136.82±13.27 g respectively. There are variations in sizes of bonga with respect to lengths and weights over the 12-month study period. A linear regression analysis between the mean length and mean weight of bonga gave a correlation coefficient "r" of 0.82 and was significant at $p<0.05$. It is evident from the results that from September to April, larger sized bonga were caught while the smaller ones were caught between May and July. The former coincides with the dry season, which is the peak fishing season for bonga while the latter coincides with the wet season, which is the lean period for catching bonga. Growth has been described as a labile process affected by a host of nutritional, physiological, biotic and climatic factors, which varies in space and time (Weatherly, 1972). The result of this study with respect to sizes could therefore be said to be interplay of some of these factors. It became favourable for bonga to grow and flourish during the period between September and April, most especially January and February which is the peak of bonga fishing season when temperatures are high and there is heavy plankton bloom. The result agreed with observation by previous worker (Longhurst, 1961). Growth as a function of nutrients is also explained from the point that bonga has been known to move from the sea into the estuaries in the dry season and move out when it rains. There may therefore be more fertile water in the estuaries promoting growth during dry season.

Data related to the anatomical measurements are presented in Table 2. Monthly mean weights of trunk varied between 75.27 g and 93.06 g; head varied between 24.61g and 41.48g while that of scales, fins and viscera varied between 17.91g and 24.38g. The weight of both the head and viscera were regarded as wastes. Percentage yield of wastes varied between 36.74 and 41.4% with a mean of 38.79%. The anatomical measurements of bonga gave 39% and 61% for waste and trunk respectively. The yield of edible flesh of 61% will definitely make bonga a good source of raw material for canning and other value added products (Egwelle *et. al.*, 1986).

The importance of the monthly anatomical measurements lie on the ability to provide data in respect of edible flesh for further processing into value added products

Table 2. Mean anatomical composition of Bonga, *Ethmalosa fimbriata*

Month	Mean Body wt. (g)	Mean Wt of Trunk (g)	% Trunk to Body wt.	Weight of Head (g)	% Head to Body wt.	Wt of scales, Fins and Viscera (g)	% Visceral to Body wt.	% Total waste
January	153.16	90.65	59.19	38.11	24.88	23.26	15.19	40.07
February	157.24	93.06	59.17	40.57	25.79	24.38	15.50	41.29
March	136.53	84.08	61.80	32.25	23.70	19.91	14.64	38.34
April	135.16	84.91	62.82	30.87	22.84	19.58	14.49	37.33
May	119.92	75.79	63.20	25.98	21.67	18.07	15.07	36.74
June	120.06	75.27	62.70	25.57	21.30	19.61	16.33	37.63
July	122.07	76.98	63.06	24.61	20.16	20.73	16.98	37.14
August	136.93	83.11	60.69	33.34	24.35	19.44	14.20	38.55
September	158.31	91.98	58.10	41.48	26.20	24.06	15.20	41.40
October	133.62	82.45	61.70	32.72	24.49	17.91	14.00	38.49
November	137.46	80.95	58.90	34.58	25.15	21.11	15.36	40.15
December	137.46	80.95	58.90	34.58	25.15	21.11	15.36	40.15

Table 3. Proximate chemical composition of Bonga, *Ethmalosa fimbriata*

Months	Sample Size	MOISTURE Range	Mean	LIPID Range	Mean	PROTEIN Range	Mean	ASH Range	Mean
January	5	74.86-75.80	75.15±0.49	2.87-3.75	3.33±0.34	19.69-20.12	19.83±0.16	1.58-1.82	1.68±0.80
February	5	75.24-77.20	76.32±0.65	2.72-3.33	2.89±0.22	18.90-19.73	19.42±0.32	1.86-2.12	1.98±0.11
March	5	75.71-78.01	76.67±0.89	1.85-2.22	2.02±0.16	19.56-22.14	20.60±1.14	1.99-2.35	2.14±0.13
April	5	70.73-80.82	77.54±3.52	1.86-2.28	2.06±0.15	19.99-20.49	20.17±0.20	1.78-1.95	1.88±0.03
May	5	76.11-72.20	77.37±1.01	1.76-1.93	1.82±0.06	19.05-21.15	20.46±0.78	1.66-2.15	1.90±0.17
June	5	75.80-77.92	76.73±0.08	2.01-2.38	2.22±0.13	18.65-20.14	19.69±0.59	1.52-1.78	1.66±0.08
July	5	75.64-77.41	76.40±0.58	2.59-2.70	2.64±0.04	18.90-20.21	19.55±0.43	1.52-1.62	1.57±0.03
August	5	76.80-78.21	77.34±0.49	0.82-1.42	1.12±0.21	20.05-21.02	20.41±0.34	1.56-2.18	1.91±0.20
September	5	75.90-78.70	77.31±1.36	1.00-1.42	1.14±0.16	18.15-19.13	18.73±0.33	1.57-1.80	1.71±0.08
October	5	75.12-76.18	75.63±0.41	2.63-3.43	3.05±0.26	21.18-21.80	21.54±0.67	1.43-1.77	1.57±0.12
November	5	73.82-74.96	74.14±0.41	4.46-5.93	5.15±0.54	18.95-19.1	19.38±0.37	1.58-1.65	1.58±0.54
December	5	74.26-75.11	74.72±0.28	5.22-6.00	5.69±0.28	19.03-21.11	19.77±0.54	1.58-1.92	1.72±0.12

Each result is mean ± standard deviation of sample size.

and also the amount of wastes generated which could be converted into other by products such as fish meal and silage. The yield of edible flesh is a function of the fish anatomical structure (Miyauchi and Steinberg, 1970). Bonga with large head structure and large viscera was found in this study to produce low yield compared to those of average head and viscera weights. Finnie *et.al* (1980) reported similar observation for black drum (*Pogonias cromis)* and mullet (*Mugil cephalus)*.

The mean percentage proximate composition of bonga fish from January to December of the year of study is presented in Table 3. The trend was that of a general variation in moisture and the lipid content of the muscle. The correlation coefficient between moisture and lipid contents of all the samples of bonga fish analysed was very strong, "r"= -0.93. This shows a significant ($p<0.05$) inverse relationships between moisture and lipid contents in bonga fish, which can be used to predict the lipid content of the fish once its moisture content has been determined. Such prediction should be sufficiently accurate to meet most industrial requirement as suggested by Vlieg, Habib and Clement (1983). Apart from wide variations in moisture and lipid contents of bonga flesh, the protein and ash are relatively constant and appear to be in the same range with literature values for other marine fish species.

The values of calcium and phosphorus content of the bonga during the period of study are presented in Table 4. The results showed that bonga is a good source of calcium and phosphorus. The range of calcium and phosphorus were between 19-30 mg/100g and 184 – 220mg/100g respectively. The calcium and phosphorus in bonga fish flesh showed significant ($p>0.05$) seasonal variations with peaks from September to

Table 4. Mineral content (mg/100g) of edible flesh of Bonga, *Ethmalosa fimbriata*

Months	Calcium (mg/100g) Range	Mean	Phosphorous (mg/100g) Range	Mean
Jan.	28.75-30.45	29.89±0.67	216.12-224.21	220.00±2.87
Feb.	27.41-30.20	28.70±1.27	208.45-216.72	193.18±3.59
Mar.	22.55-24.62	23.46±0.75	199.30-215.72	180.37±1.29
Apr.	19.20-23.82	21.33±1.87	188.77-190.25	189.60±0.53
May	19.70-22.98	21.20±1.38	186.50-186.99	186.70±0.19
June	17.86-21.24	19.13±1.30	203.95-206.27	205.41±0.88
July	18.21-21.12	19.95±1.14	197.00-198.05	197.50±0.39
Aug.	20.93-21.87	21.34±0.38	182.95-185.60	184.71±1.07
Sept.	22.18-24.13	23.33±0.74	198.62-200.72	199.5±0.83
Oct.	23.75-25.10	24.21±0.53	187.42-190.90	189.12±1.31
Nov.	27.34-30.40	28.57±1.16	189.75-191.50	190.58±0.63
Dec.	27.75-28.85	28.43±0.41	190.10-191.50	190.56±0.55

Each result is mean ± standard deviation of triplicates.

March, which coincide with the dry season and the period of abundance of bonga. Calcium and phosphorus are constituents of bone and teeth and as such, eating bonga fish will be good for the body most especially the young ones. In addition, phosphorus is also an essential component to many enzymes and other proteins necessary for the release and utilization of energy in the body. The lipid class composition and fatty acid profile of bonga are presented in Table 5. Triglycerides accounted for 52.3% of the oil followed by phospholipids and diglycerides with 17.4 and 13.7% respectively. Cholesterol esters and hydrocarbons were 2.9 and 0.7% respectively. Free fatty acids were 2.7 while iodine value was 153. The principal fatty acids were the following: C14:0, C16:0, C16:1, C18:0, C18:1, C: 20:1, C20:4, C20:5 and C22:6. Three fatty acids, viz., C16:0, C18:0 and C18:1, constituted about 60% of the total while another three other fatty acids, viz., C14:0, C16:1 and C20:5 constituted about half of the remaining fatty acids.

The result of lipid classes showed that the lipid of bonga contained the highest proportion of triglycerides, which agreed

Table 5. Lipid classes and fatty acids composition of Bonga, *Ethmalosa fimbriata* fish oil

Lipid Classes	% Composition	Fatty acids	% Composition
Phospholipids	17.40±1.76	C14: 0	7.40±0.45
Diglycerides	1370±1.06	C16: 0	32.80±2.14
Triglycerides	52.30±4.02	C16: 1	8.20±0.56
Cholesterol esters	2.90±0.74	C18: 0	9.40±0.98
Hydrocarbons	0.70±0.10	C18: 1	14.80±0.12
		C18: 2	1.60±0.87
		C18: 3	1.00±0.09
		C18: 4	1.2±0.49
		C20: 1	0.9±0.42
		C20: 4	1.2±0.13
		C20: 5	8.90±1.07
		C22: 1	2.00±0.33
		C22: 5	1.30±0.11
		C22: 6	4.90±1.15
Free fatty acids	2.70±0.52		
Iodine value of Bonga Oil	153±0.07		

Each result is mean ± standard deviation of triplicates.

with earlier studies by Hardy and Mackie (1970) and Talabi (1971) that the depot lipids of fish are notably composed of triglycerides. The presence of hydrocarbon in bonga fish lipid may be a natural component of the fish flesh or as a result of the migratory habit of bonga from estuaries to the open sea and may have acquired it due to oil pollution.

The 2.7% free fatty acids (FFA) obtained may have resulted from the enzymatic hydrolysis of either triglycerides or phospholipids. With most oils acidity begins to manifest when the FFA is about 0.5–1.5% (Pearson, 1981). The iodine value of 153 recorded for bonga lipid is an indication of the degree of unsaturation, which is the ability of the lipid to become rancid. The implication of this is that greater care must be taken in ensuring proper handling and processing of the fish to minimize rancidity in the final product.

The lipid of bonga showed characteristic fatty acid pattern of marine clupeids with high incidence of highly polyunsaturated fatty acids (PUFA) C20:4 and C22:6, and the autoxidation characteristic of the lipid is evidenced by the iodine value of 153. The importance of PUFA in nutrition and health has been extensively discussed (Suzuki, 1993). PUFA are generally referred to as essential fatty acids and of significant importance in reducing blood cholesterol, heart diseases while promoting good memory and learning ability (Nettleton, 1992; Suzuki, 1993).

The technological properties and compositional data presented in this study have highlighted the suitability of bonga as potential industrial material for possible utilization for different products. These parameters are decisive as to meet consumers' interest in local and export markets.

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