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Chemical Composition and Quality Changes in Bonga (*Ethmalosa fimbriata*) Canned in Oil and Tomato Sauce

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Changes in the quality of canned Bonga *Ethmalosa fimbriata* packed in deodourized vegetable oil and tomato sauce during various stages of processing and storage were examined using some indices of chemical spoilage. Proximate composition, total amino acids and available lysine content were determined for raw, precooked and canned bonga products. No significant differences ($p>0.05$) in the total amino acids composition was however observed among raw, precooked and canned bonga. There was a decrease in available lysine in the different phases of the process but no loss in total amino acid composition. TBA values gave good correlation of rancidity development with storage time. TMA and TVN levels were affected by precooking and thermal treatment and were found not to be useful as post canning indicators of quality.

Key Words : **Bonga, pre-cooking, canning, amino acids, available lysine, thiobarbituric acid value.**

Bonga (*Ethmalosa fimbriata*) is one resource whose utilization has a great potential. It is a coastal and estuarine clupeid that is found on the West African Coast from Mauritania to Angola and contributes significantly to the promotion of food self-sufficiency in the sub-region (Jallow, 1994). This species contributes 11 to 86 per cent of the small pelagic fish landings in these countries, with Nigeria having the highest contribution of 86 per cent. Bonga is of great economic importance in the coastal areas of Nigeria with an annual catch of 40,000 metric tones. The Bonga is the most important pelagic fish in the artisanal fishery of the coastal states in Nigeria, accounting for between 20 and 30 per cent of artisanal catches. However, bonga is a fish with lots of inter- and intra- muscular bones, seldom consumed in the fresh form but found major utilization in the smoked form. In the smoked form, the yield of edible portion is 39% (Egwele *et al.*, 1986).

Bonga is also a potential raw material for cottage level canning industry apart from the traditional hot smoking of the fish. Fish canning is a method for industrial processing of raw fish and other edible aquatic products, which are hermetically sealed in containers and obtain "commercial sterility" through the use of heat processing.

Fish quality is of utmost importance in canning, and good post-harvest handling, including the use of ice, refrigerated seawater or freezing immediately after harvest is required to maintain the quality of the catch. Commercially sterile canned foods generally have a shelf life of two or more years and any deterioration thereafter is generally due to texture or flavour changes rather than microbial growth (Cecil and Woodrof, 1963; Potter, 1970).

The stability of canned foods during storage is greater than that of other processed foods. This is mainly due to hermetically sealing nature of canned foods in airtight container and is therefore protected against subsequent microbial contamination and deterioration by oxygen and light.

Canned seafood undergoes changes in both chemical quality and nutritional value in long-term storage (Taguchi, *et. al*; 1982). These may result from chemical reaction within foods and with food and container metals. The quality of canned fish is also known to have a very close relationship with its lipid content and composition.

In this study, changes in quality indices of chemical spoilage of canned Bonga in oil and tomato sauce at different stages of processing and during long-term storage at ambient temperature were examined in relation to shelf life of the products.

Materials and Methods

Bonga used in this study were caught by the Nigerian Institute for Oceanography and Marine Research (NIOMR) Research vessel, M.V. OKION, frozen on-board at –30⁰C, landed within two weeks of capture and stored in the NIOMR cold store operating at –22⁰C. The fish were canned within one week of storage in the cold store. The canning process was carried out in the pilot plant of NIOMR.

Processing of Bonga

The following processing operations were adopted throughout the experimental canning of Bonga. Frozen Bonga fish were thawed in running tap water (27±2⁰C), washed thoroughly and then graded. The fish were eviscerated and again washed before brining in a saturated salt solution for 15 minutes. After brining, the fish were cut into size and filled by hand into 300/208 lacquered cans leaving a headspace of about 6.0mm. The filled cans were subjected to steam pre-cooking in a cooker at 105⁰C for 20 minutes. After pre-cooking, the cans were inverted and placed on perforated stainless grill to allow the exudates to run off and drain properly. The cans packed with pre-cooked fish were filled manually with 50g of deodorized vegetable oil or tomato sauce to give a net weight of 200g. The oil or the sauce was added at a temperature of approximately 80⁰C. Immediately after the addition of filler materials, the cans with lids on were fed to a vacuum seamer, which automatically evacuate any entrapped air and create a vacuum in the can. After seaming, the cans were thoroughly washed with hot water and were thereafter loaded into the crates of the horizontal still retort and sterilized at 115⁰C for 60 minutes.

Analytical procedures

Three samples each of raw, precooked and canned products were homogenized in a warring blender into a smooth paste. The paste was used to prepare extracts for the following analysis in triplicates. Moisture was determined by oven drying to constant weight at 103±3⁰C (Pearson, 1981). Total lipid content was determined on a 10g sample of the paste by the Bligh and Dyer (1959) method. Crude protein was calculated by multiplying the nitrogen content by 6.25 (Pearson, 1981), the nitrogen content was determined by Kjeldahl digestion as described by Vlieg (1982).

Calcium and phosphorous were determined by Atomic Absorption Spectophotometry (AAS) using a Perkin-Elmer 209 at a wavelength of 425nm and colorimetrically using the phosphoranado molybdate method (Pearson, 1981) respectively. The pH of the canned products was determined on a 2:1 ratio of water: fish homogenate using a glass electrode.

Amino acid content was determined by ion exchange chromatography (Beckman H.P. Amino Acid Analyser System 6300). The fish samples were defatted with ether at room temperature prior to hydrolysis for 24 h at 110⁰C, followed by performic acid oxidation for 16 hours for the conversion of cystine to cysteic acid and methionine to metionine sulphone and followed by hydrolysis for 24 h at 110⁰C with 6N HCl under vacuum. Beckman standard amino acid solution was used to calibrate the analyser. Chemical estimates of available lysine of the samples were made by the 1-fluoro-2, 4-dinitrobenzene (FDNB) extractive method of Carpenter (1960).

Thiobarbituric acid (TBA) values were determined by the distillation method of Tarladgis *et. al.* (1960). Malonaldehyde standards were prepared as described by Sinnhuber and Yu (1977). Acid value was measured by the conventional alkali titration method (Pearson, 1981). Total volatile nitrogen (TVN) and Trimethylamine (TMA) were determined using Conway (1968) microdiffusion method.

Statistical Analysis

The data were analysed using one-way analysis of variance (ANOVA) and significance between means was determined using Duncan's (1955) multiple range test at $p < 0.05$ levels. The software used was SPSS Inc. 1995.

Results and Discussion

The results of proximate chemical composition and pH of raw, pre-cooked and canned bonga in oil and tomato sauce are presented in Table 1. The protein content increased after pre-cooking presumably because of loss of moisture leading to concentration of protein. The lipid content of canned bonga in oil was higher than raw, pre-cooked and canned bonga in tomato sauce. The absorption of oil used as filler material into the flesh of the bonga may have accounted for the 6.02% lipid recorded for canned bonga in oil. During pre-cooking, water, oil and other solubles were lost, which explains why the oil content was lowest in pre-cooked bonga. Ash content increased from 1.83% for raw bonga to 3.46% in canned bonga in tomato sauce. Proximate chemical composition of raw, precooked and canned bonga showed similar trends as reported by various workers for other species (Seet *et. al.* 1983, Castrillon *et. al.* 1996). The high moisture observed in canned bonga in tomato sauce may be as a result of hydration of bonga with water as the same. This result agrees with Mai *et. al.* (1988) which suggests that during cooking, food may loose or gain weight by dilution of components or by absorption of water from the cooking medium.

Calcium and phosphorous were much higher in canned product than in raw and pre-cooked stages due mainly to the fact that analysis were performed on the flesh of raw and precooked bonga while in the case of the canned products it was on the whole chunk inclusive of the bones. Both canned bonga in oil and canned bonga in tomato sauce were found to be very rich in calcium and phosphorous. The pH in all samples was 6.0 and above except for the bonga in tomato sauce with a pH of 5.6. The pH values of bonga in oil and in tomato sauce showed that the latter was more acidic. The higher acidity of bonga in tomato sauce was due to the acidic nature of the tomato puree used in the preparation of the sauce.

The results of the amino acid profile of canned bonga products (Table 2) showed that the process of canning does not have any adverse effect on the amino acid composition. Generally, the major amino acids; arginine, aspartic acid, glutamic acid, leucine and lysine were comparable in all samples. Increase in amino acids after pre-cooking and canning operations as observed in this study have been reported to be due the facilitation of protein hydrolysis (Castrillion *et al*, 1996). Any increase in the amino acid profile of canned bonga in tomato sauce compared to that of bonga in oil is presumed to be as a result of

Table 1. Proximate chemical composition and pH of raw, precooked and canned Bonga, (*Ethmalosa fimbriata*)

	Raw Bonga flesh	Precooked Bonga flesh	Canned Bonga in Oil	Canned Bonga in tomato sauce
PH	6.6 ± 0.10	6.2 ± 0.04	6.0 ± 0.02	5.6 ± 0.11
Moisture (g/100g)	77.28 ± 0.27	66.55 ± 0.44	68.47 ± 0.39	70.15 ± 0.25
Protein (g/100g)	20.38 ± 0.64	26.49 ± 0.41	23.44 ± 0.34	23.14 ± 0.25
Lipid (g/100g)	2.49 ± 0.37	2.18 ± 0.26	6.02 ± 0.44	2.41 ± 0.18
Ash (g/100g)	1.83 ± 0.15	2.12 ± 0.20	2.24 ± 0.23	3.46 ± 0.14
Calcium (mg/100g)	24.77 ± 0.56	70.07 ± 0.29	397.44 ± 0.75	409.32 ± 1.2
Phosphorous (mg/100g)	198.06 ± 0.78	342.31 ± 1.53	498.83 ± 0.77	521.32 ± 1.53

Note: Values are mean ± SD of four samples.

contribution from the tomato puree/sauce. No significant difference ($p>0.05$) was however, observed in the amino acid profiles between raw, precooked and canned bonga.

Available lysine of Bonga (Table 2) decreased with both pre-cooking and heat sterilization. After pre-cooking in steam, the available lysine decreased by 1.61% compared to 7.10% and 11.39% loss of available lysine in canned bonga in oil and tomato sauce respectively. The results obtained in this study agreed with those reported by Seet *et. al.* (1983) and Castrillon *et. al.* (1996). Loss of available lysine may be due to free amino groups of proteins reacting with sugars or by-products of lipid oxidation known as Maillard reaction. This may have accounted for higher loss of available lysine in canned bonga in tomato sauce. Through a process of hydrolysis, the carbohydrate in tomato sauce may have been broken down to simple sugars during sterilization and storage.

Thiobarbituric acid values (TBA) and acid values (AV) are presented in Table 3. TBA of raw bonga increased on pre-cooking before canning. The TBA increased from 2.4mgMA/kg to 6.16mgMA/kg. These figures are within the limits of 0-39 mgMA/kg suggested as being noticeable levels of rancid taste in foods for TBA (Shamberger, *et al*, 1977). TBA levels are indices of lipid degradation. High values of this indices of rancidity indicate poor quality. It is therefore obvious from this study that the TBA measurement gave a good correlation of rancidity development with storage time. A steady increase was observed for the TBA throughout the 3-year storage period (Table 3). TBA measures one of the breakdown product of hydroperoxide, viz malonaldehyde, hence the consistently lower figures reported for TBA values. Increase in TBA with time of storage suggests that partial oxidation can still occur in the course of storage at ambient temperature as hydroperoxide which is decomposed to produce malonaldehyde.

Table 2. Amino acid composition and available lysine of raw, pre-cooked and canned Bonga, *Ethmalosa fimbriata*

Amino Acid	g amino acid/100g protein			
	Raw Bonga	Pre-cooked Bonga	Canned Bonga in oil	Canned Bonga in tomato sauce
Alanine	5.98 ± 0.17	6.02 ± 0.16	6.00 ± 0.04	6.03 ± 0.10
Arginine	5.43 ± 0.11	5.64 ± 0.26	5.75 ± 0.10	5.64 ± 0.14
Aspartic acid	9.35 ± 0.47	9.21 ± 0.38	9.51 ± 0.36	9.59 ± 0.26
Cysteine	1.11 ± 0.02	1.12 ± 0.02	1.15 ± 0.06	1.18 ± 0.06
Glutamic acid	12.80 ± 0.30	12.85 ± 0.34	12.94 ± 0.06	13.00 ± 0.04
Glycine	5.61 ± 0.45	5.68 ± 0.50	5.73 ± 0.52	5.69 ± 0.48
Histidine	2.51 ± 0.27	2.40 ± 0.33	2.54 ± 0.41	2.51 ± 0.35
Isoleucine	4.47 ± 0.07	4.57 ± 0.15	4.58 ± 0.18	4.60 ± 0.10
Leucine	7.80 ± 0.22	7.86 ± 0.21	7.88 ± 0.22	7.81 ± 0.21
Lysine	8.31 ± 0.41	8.44 ± 0.43	8.53 ± 0.29	8.42 ± 0.32
Methionine	2.83 ± 0.10	2.82 ± 0.12	2.91 ± 0.04	2.90 ± 0.02
Phenylanine	3.74 ± 0.17	3.85 ± 0.07	3.86 ± 0.15	3.88 ± 0.08
Proline	4.47 ± 0.21	4.64 ± 0.10	4.69 ± 0.04	4.59 ± 0.24
Serine	3.74 ± 0.22	3.49 ± 0.20	3.76 ± 0.15	3.71 ± 0.40
Threonine	4.69 ± 0.15	4.81 ± 0.18	4.94 ± 0.05	4.81 ± 0.13
Tryptophan	0.95 ± 0.04	1.01 ± 0.03	1.06 ± 0.13	1.13 ± 0.05
Tyrosine	3.38 ± 0.33	3.44 ± 0.37	3.56 ± 0.29	3.80 ± 0.34
Valine	4.85 ± 0.14	4.80 ± 0.14	4.86 ± 0.12	4.86 ± 0.07
Available Lysine	**7.46 + 0.73**	**7.34 + 0.63**	**6.93 + 0.17**	**6.61 + 0.46**

Note: Values are mean ± SD of four samples.

Table 3. Changes in Thiobarbituric Acid values and Acid Value (AV) of raw, pre-cooked and canned Bonga, *Ethmalosa fimbriata* during storage.

Storage Time (months)	TBA Value mg MA/kg		Acid Value %	
Raw Bonga	2.40±0.27		4.19±0.51	
Precooked	6.16±0.43		7.42±0.41	
Canned Bonga	**BO**	**BT**	**BO**	**BT**
0	2.85±0.16	2.45±0.23	6.20±0.19	8.37±0.32
3	3.30±0.29	3.01±0.16	6.65±0.52	9.02±0.24
6	5.26±0.28	4.91±0.23	7.09±0.14	9.14±0.28
12	6.19±0.38	4.98±0.43	7.61±0.33	10.89±0.41
24	6.29±0.52	5.58±0.26	11.79±0.46	15.28±0.51
36	7.04±0.15	6.00±0.14	12.78±0.65	17.00±0.51

Notes:
Values are mean ± SD of four samples.
BO = Canned Bonga in oil
BT = Canned Bonga in tomato sauce

The initial peak of TBA recorded during pre-cooking may be as a result of preferential oxidation of the higher polyunsaturated fatty acids. These hydroperoxides in turn decompose to give malonaldehyde, which is measured as the TBA values. Lipid oxidation is a free radical chain reaction involving uptake of O_2 and the change of unsaturated fatty acid chains. On the other hand, when the fish is canned, the concentration of oxygen is markedly reduced, thereby decreasing the rate of initiation and as decomposition of hydroperoxides occurs, there is a corresponding increase in the formation of malonaldehydes, hence the trend exhibited by TBA values.

The acid value of the raw bonga flesh increased from 4.2 to 7.4 on pre-cooking and decreased moderately in the case of canned bonga in oil and a rather steady increase in the case of bonga in tomato sauce (Table 3). During the first 12 months of storage, the acid values increased steadily. Thereafter, significant increases were observed especially in the bonga canned in tomato sauce. High acid values may be as a result of decomposition by lipid hydrolysis and other reactions such as Maillard brought about by the high temperature of the thermal process.

Changes in TMA and TVN during canning of Bonga and subsequent storage are presented in Table 4. The TMA of raw Bonga flesh increased from 5.68mg TMA-N/100g to 18.65mg TMA-N/100g flesh on pre-cooking at 105^{0}C for 20 minutes and thereafter a steady increase for both canned Bonga in oil and tomato sauce over the storage period. The TVN showed similar trend, increasing from 18.82mg TVN/100g to 35.85mg TVN/100g of flesh and then subsequent steady increases with storage time in both canned products. TMA and TVN are widely considered to be useful indicators of the degree of spoilage in fish and fishery products. Pre-cooking and canning of bonga increased the two volatile nitrogeneous compounds. TMA and TVN are produced mainly by bacteria induced mechanism and as such, heating by pre-cooking and sterilization should have had a decreasing effect, since bacteria, which convert TMAO to TMA, may have been destroyed. However, in the process of canning of bonga, the heat treatment in the cooking and sterilization may have caused irreversible changes in the muscle resulting in the higher contents of these nitrogenous compounds. Increase in TVN after pre-

Table 4. Changes in Total Volatile Nitrogen (TVN) and Trimethylamine (TMA) of raw, pre-cooked and canned Bonga, *Ethmalosa fimbriata* during storage

Storage time (months)	Mg-N/100g			
	TVN		TMA	
Raw Bonga	18.82±0.27		5.86±0.51	
Pre-cooked Bonga	35.85±0.80		18.65±0.81	
Canned Bonga	**BO**	**BT**	**BO**	**BT**
0	25.94±0.13	22.17±0.16	21.36±0.34	21.36±0.24
3	35.35±0.58	32.98±0.55	27.05±0.22	23.88±0.36
6	36.20±0.26	34.85±0.26	31.76±0.71	27.74±1.10
12	41.04±0.17	39.70±0.38	31.09±0.62	30.84±0.91
24	38.69±0.58	40.72±0.80	29.14±0.47	33.00±0.41
36	45.63±0.49	42.37±0.37	34.92±0.54	32.41±0.59

Notes:
Values are mean ± SD of four samples.
BO = Canned Bonga in oil
BT = Canned Bonga in tomato sauce

cooking have been attributed to loss of catabolites (NH_3) by elution with tissue and regeneration as a result of high temperature (Rodriguez et al, 1997). Subsequent increases of TVN after canning of Bonga may also be due to non-enzymic degradation since bacteria and enzymes are destroyed during cooking and sterilization.

Considering all the quality attributes and processing parameters, it may be concluded that the development of commercially sterile canned products in order to stimulate the utilisation of Bonga fish outside the traditionally smoked form was found to be feasible. The market for locally canned fish is also established since majority of the canned fish in the market is imported into the country and any introduction of locally canned fish will reduce the inflow of such products and at the same time reduce the pressure on foreign exchange.

References

Bligh, E.G. and Dyer, W.J. (1959) A rapid method for total lipid extraction and purification. *Can. J. Biochem. and Physiol.* **37**, pp. 911-917

Carpenter, K.J. (1960) Determination of FDNB – available lysine: a modified procedure. *J. Sci. Food. Agric.* **22**

Castrillon, A.M., Pilar Navarro, M., Trimidad Carcia-Arias, M. (1996) Tune protein nutritional quality changes after canning. *J. Food Sci.* **61**: pp 1250-1253

Cecil, S.R. and Woodrof, J.G. (1963) The stablity of canned foods in long-term storage. *Food Technol.* **17**, pp 39-646

Conway, E.J. (1968) Microdiffusion Analysis and Volumeric Error. London, Crosby, Lockwood and son. 467p

Duncan, D.B. (1955) New multiple range and multiple F-tests. *Biometrics*, **11**, pp 1-42

Egwele, A.U., Sorinmade, S.O. and Talabi, S.O. (1986) Nutritional evaluation of traditonally smoked Bonga (*Ethmalosa doralis*) and Sawa (*Sardinella aurita*) obtained from different markets in Lagos, Nigeria: A preliminary investigation. In: *Proceedings of the FAO Expert Consultation on Fish Technology in Africa.* Lisaka, Zambia, 21-25 January, 1885

Jallow, A.M. (1994) Utilisation of Bonga (*Ethmalosa fimbriata*) in West Africa. FAO Fisheries Circular No. 870. Rome, FAO. 28p

Mai, J., Shimp, J., Weihrauch, I. and Kinsella, J.E. (1978) Lipids of fish fillet: Changes following cooking by different methods. *J. of Food Sci.* **43:** pp 1669-1674

Pearson, D. (1981) *The Chemical Analysis of Foods.* 8th Edition. Churchill Livingstone, London

Potter, N.N. (1970) *Food Science*, 2nd edition. AVI Publishing Company, Inc. Westport, connecticut, 812p

Rodriguez, C.J.V., Villar- Estalote, Besterio, I. and Pascual, C. (1997) Biochemical indices of freshness during processing of sardine (Sardina pilchardus) for canning. In: *Seafood from producer to consumer, integrated of approach to Quality* (Luten, J.B., Borrensen, T., and Oelilenschlager, J. Eds), Elsevier Science, B.V.

Seet, S.T. and Brown, D.W. (1983): Nutritional quality of raw, precooked and canned albacore tuna. *J. Food Sci.* **48**, pp 288-289

Shamberger, R.J., Shamberger, B.A. and Willis, C.E. (1977): Malonaldehyde content of food. *J. Nutrition*, **107**, pp 1049-1049

Sinnhuber, R.O. and Yu, T.C. (1977): The 2-Thiobarbituric acid reation: An objective measure of the oxidative deterioration occuring in fats and oils. *J. Japan Oil Chem. Soc.*, **2b**, pp. 259-267

Taguchi, T., Tanaka, M., Okubo, S. and Suzuki, K. (1982) Changs in quality of canned tuna during long-term storage. *Bull. Jap. Soc. Sci. Fish.* **48 (6)**, pp. 855-859

Tarladgis, G.S., Watts, B.M., Younathan, M.T. and Dugan, L. (1960) A distillation method for the quantitative determination of malonaldelhyde in rancid foods. *J.A. O.C.S* **37**, pp. 44-48

Vlieg, P. (1982) The proximate and fatty acid composition of the flesh of New Zealand red Cod, hoki and jack mackerel. New Zealand *J. Sci.*, **25 (2)**, pp 155-158