

SEASONAL AND QUALITY CHANGES OF THE GHANAIAN ANCHOVY (*Engraulis encrasicolus*) DURING STORAGE IN ICE

by

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Abstract

Seasonal variations in the proximate composition, microbiological characteristics and ice storage of the Ghanaian anchovy which is genetically identical to the European anchovy *Engraulis encrasicolus*, syn. *Anchoa guineensis* were investigated. Significant variations in the proximate composition of the anchovy were observed from that of the peak season of August to October with protein contents of about 17.8% as compared to an average of 14% and fat contents of 3 to 8.8% with increased enzymatic activity as well in November to July. The storage life of the anchovies in ice was only two days.

1. INTRODUCTION

The Ghanaian anchovy *Engraulis encrasicolus*. Syn. *Anchoa guineensis* is genetically identical to the European anchovy. The local vernacular names are *Amobi*; *Abobi*; *Amoni*.

The anchovy is a small pelagic and littoral species found in the Ghanaian coastal waters. It occurs in large schools, mostly on sandy bottoms in shallow waters. Some are however found offshore in deep waters. The anchovy can grow to a maximum of 15 cm long, but the common size found in Ghanaian waters is 8-9 cm long (Anon. 1994). Figure 1 depicts the general structure and form of the Ghanaian anchovy.

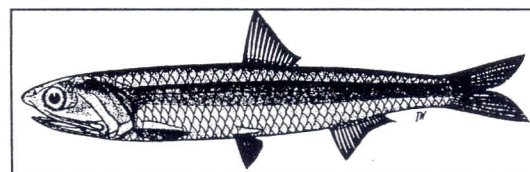


Figure 1. The Ghanaian anchovy (*Engraulis encrasicolus*, syn. *Anchoa guineensis*)

Catches of anchovies in Ghana amounted to 86,000 t in 1992 and 82,000 t in 1993.

Anchovy is caught all year round with poli nets, purse seines, beach seines and sometimes trawl nets. Figure 2 shows monthly landings for the years, 1992 and 1993. Most of the catches are produced in the Greater Accra, Central and Volta Regions of Ghana with a peak in the months of August, September and October (Figure 2).

Like all pelagic fish, anchovies are very active and have active enzymes in their tissues (Gildberg 1978). Most of these enzymes remain active after the death of the fish causing deteriorative changes that affect flavour, texture and other quality characteristics of the fish (Sikorski *et al* 1990).

In the artisanal fishery industry in Ghana, through which most of the catch are made, anchovies are not chilled in spite of the high ambient temperatures and because of their smallness, gutting is not carried out. Under these conditions autolysis is accelerated in the viscera releasing bacteria and enzymes which invade the flesh (Sikorski *et al*. 1990)

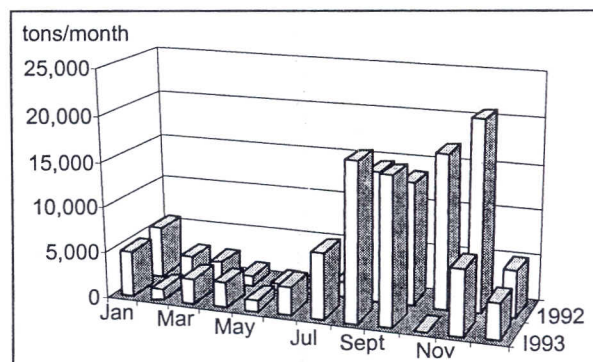


Figure 2. Monthly landings of anchovies, 1992-93

The aim of this study is to examine the physical and chemical characteristics of the Ghanaian anchovies as these relate to the handling and storage of the fish. This could provide information on the nutrient quality and storage stability of the fish which are essential in the development of products from the anchovies.

2. MATERIALS AND METHODS

Quantities of fresh anchovies were purchased twice in a month during the study period of 9 months from the landing beach at Tema. The anchovies were held in ice for physical and chemical analysis. These were length and weight measurements, proximate analysis and enzymatic activity in the guts.

The storage life of the anchovies in flake ice was investigated by monitoring the changes in free fatty acid, total volatile base nitrogen, microbiological quality and sensorial properties.

2.1 Proximate and physical analyses

Proximate analysis

Protein was determined by the method of Pearson (1970). Moisture, Fat and Ash were determined by the standard methods of AOAC (1990).

Physical measurements

Weight of the anchovies was determined by weighing 20 whole pieces sample lots and the average weight calculated in grams. Length in centimetres was taken for 20 whole pieces sample lots and the range of length noted.

Enzymatic activity

Enzymatic activity in the gut of the fresh anchovy was determined by examination of the gut contents for the presence and relative amount of undigested seaweed.

2.2 Chemical analysis of stored anchovy in ice

Free fatty acids (FFA)

Free fatty acids (FFA) were determined by the method described by Pearson (1970).

Total volatile base nitrogen TVB-N and trimethylamine (TMA)

Total volatile base nitrogen and trimethylamine levels were determined by the procedures outlined by Pearson (1970).

Hydrogen ion concentration (pH)

The pH of the anchovies under storage was monitored by a pH meter PHM 92 (Radiometer analytical A/S-Denmark). Approximately 5 g of a representative sample of anchovy tissue was weighed and thoroughly macerated using a stomacher in a 5 ml carbon dioxide-free distilled water. The mixture was left to stand for 2 min before readings were taken with the pH meter which had been previously calibrated.

Microbiological examination

Microbiological examination of the stored anchovies held in ice was carried out by the following standard methods.

Total viable count (pour plate technique)

Ten grams of a representative sample of whole anchovies was macerated with 90 ml of saline peptone solution in a sterile stomacher bag. Serial dilutions of 10^{-1} - 10^{-6} were prepared, pipetted into plate count agar and then incubated for 72 h at 30°C (Anon. 1986).

Culture identification

Smears of growth from the plates were made on clean slides with sterile loop. These were Gram-stained and viewed under a microscope for Gram reaction and identification of the morphology.

2.3 Sensory evaluation

Ice stored anchovies

Ten to 15 untrained panellists of the Food Research Institute familiar with anchovies evaluated the freshness quality of the raw and cooked fish. The quality of the raw fish was assessed by means of a descriptive score card based on a modified Torry Sensory Scheme for freshness quality assessment (Appendix 1) by employing the 5-point hedonic scale as follows: E (extra) - 5 points, A - 3 points, B - 2 points and C - 0 point. Raw fish evaluation involved general appearance, firmness, belly walls, gills, eyes and external odour.

Whole anchovies were steamed for 15 minutes. Samples were coded and served hot to the panellists. Cooked sensory attributes assessed were fish odour and flavour based on the Torry 10 to 0 hedonic scale (Appendix 2). Texture was assessed on a 5-point hedonic scale.

3. RESULTS AND DISCUSSIONS

3.1 Seasonal variations in physical measures and proximate composition

Table 1 shows the physical and chemical changes recorded over a 9 month period beginning from March. Figure 3 is a graphical representation of the results of Table 1 where the absolute values have been indexed for easy comparison.

Whilst for a greater part of the season (November to July), there were not significant variations in the weight, length and proximate compositions of the anchovies, significant variations were observed from August to October (Figure 3, Table 1). Within this period, protein content was 17.8% as compared to an average of 14% determined between November and July.

Table 1. Seasonal physical measures and proximate composition of anchovies (*Engraulis encrasicolus*)

Month	Length (cm)	Weight (g)	Moisture (%)	Protein (Nx6.25)	Fat (%)	Ash (%)	Enzymatic activity
March	5-7	2.3	78.4	15.5	2.9	2.9	Very little
April	6-7	2.3	78.7	14.8	3.2	3.1	Little
May	6-8	2.6	77.9	14.9	3.2	3.1	Little
June	6-9	2.7	75.8	15.9	4.3	3.0	Active
July	6-9	2.7	73.9	16.4	6.5	2.9	Active
Aug.	6-10.3	3.2	70.5	17.5	8.8	2.7	Active
Sept.	6-11.2	3.9	70.9	17.9	8.3	2.6	Little
Oct.	6-10.1	2.6	71.9	17.3	7.3	2.8	Very little
Nov.	6-9	2.3	73.7	16.5	6.7	2.9	None

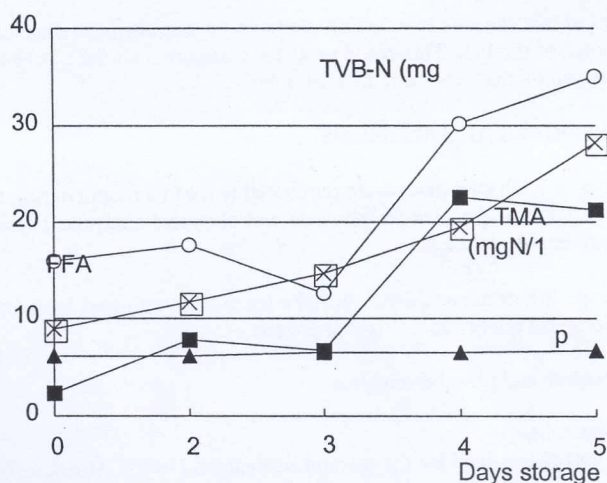


Figure 3. Chemical changes of anchovies during storage in ice

Comparative increases from 3 to 8.8% were also observed for the fat content during this short period. Moisture content dropped to 70% from a high value of almost 79% obtained from November to July, together with slight decreases in the ash content (3 to 2.6%). This short period understandably, was the peak season of the anchovies which could have ended in November according to a 1992 and 1993 data from the Fisheries Department of Ghana (Figure 2). During this period of August to October, much enzymatic activity was noted in the guts of the anchovies indicating a period of feeding.

3.2 Chemical and microbial analysis of anchovies during ice storage

The results of the chemical and microbiological analysis obtained during the ice storage are presented in Figure 3 and Table 2.

Changes in TVB values were quite significant. The TVB value increased to 30.1 mgN/100g on the fourth day from an initial value of 15 mgN/100g. The rapid increases in the TVB values could be positive indications of the high rate of deterioration associated with anchovies especially when not chilled. TMA values also showed marked increases during the storage period. Fluctuations in the value for the TVB and TMA which were minimal and may be due to the leaching effects of the melting ice flakes (Reilly *et al.* 1984). Drip losses which were excessively high especially during thawing, could also be attributed to the fluctuations in the values of the parameters. The drips could be a result the decreased water-holding capacity of the protein due to protein denaturation (Seagran 1958).

The pH value which could be used as an indicator of spoilage did not vary significantly during the storage period and the highest value attained was 6.7 (Figure 3 and Table 2).

Free fatty acids liberated by lipolysis (Toyomizu *et al.* 1985), increased significantly from the onset of the studies attaining a value of 28.1% on the fifth day (Figure 3 and Table 2). This degradation of fats leads to decrease in consumer appeal for the fish (Ranke *et al.* 1957).

Microbiological counts increased steadily from 1.7×10^3 /g at the onset of the studies to 2.3×10^6 /g on the fifth day (Table 2). The composition of the microflora as observed were micrococci and short rods which could be *Pseudomonas spp.* These organisms are believed to have a short generation time even at chill temperatures (Morita, 1975; Devaraju and Setty, 1985) and could be found on tropical as well as temperate-water fish. The sensory attributes of the anchovies during the ice storage are presented in Tables 3 and 4.

There were considerable changes in the physical characteristics of the anchovies at the end of the third day of the ice storage (Table 3). Typical indications leading to the loss of freshness included bleached skin with belly burst, grey eyes and the absence of the familiar sea weedy odour (Amu and Disney 1973).

The sensory evaluation of the cooked anchovies are presented in Table 4. The anchovies were acceptable for their freshness for the first and second days until panellists noticed significant changes in the flavour. The rancidity flavours could have been produced by the high amounts of fatty acids liberated which might have undergone a form of lipid oxidation (Toyomizu *et al.* 1985).

Textural as well as flavour changes (Table 4), which were very rapid may have been promoted by the enzymatic degradation of trimethylamine oxide (Connell and Shewan 1980).

The rather short storage life of the anchovies could be related to the relative small size of the fish (Whittle *et al.* 1990). In their studies with other species in ice, Lahiry *et al.* (1963) reported that the shelf life of *Wallato atu* was affected by size, with bigger fish (800-1000 g) spoiling after 21 days of storage and smaller ones (450-500 g) in 16 days.

The sensorial changes appeared to correlate with the physical, chemical and microbiological changes observed during the storage period, though the anchovies lost their freshness after the first two days.

4. CONCLUSIONS AND RECOMMENDATIONS

Though anchovies are harvested throughout the year in Ghana, significant seasonal variations were noted in the weight, length and proximate compositions of the anchovies. These significant variations were observed from August to October being the peak season of

Table 2. Chemical and microbial changes of Anchovies during ice storage

Storage days	TVB-N (mgN/100g)	TMA (mgN/100g)	pH	FFA (%)	Total viable count/g	Culture
0	15.9	2.3	6.2	8.9	1.7×10^3	Micrococci, short rods
2	17.5	7.8	6.3	11.6	1.5×10^4	Micrococci, short rods
3	12.6	6.7	6.5	14.6	2.5×10^4	Micrococci, short rods
4	30.1	22.4	6.6	19.4	6.0×10^4	Micrococci, short rods
5	35.0	21.2	6.7	28.1	2.3×10^6	Short rods

Table 3. Physical changes* of fresh anchovies during ice storage

Days in ice	Skin	Gills	Eyes	Odour	Grade
1	Glossy, firm	Bright red	Convex	Strong seaweedy	E
2	Loss of bloom	Dark red	Plane	Seaweedy	A
3	Heavily bleached Belly burst	Brown	Pupil grey	Neutral	B-C

* Assessment were based on the average score of 20 whole anchovy pieces per batch

Table 4. Mean* sensory scores and changes of anchovies during ice storage

Days in ice	Sensory attribute of cooked anchovy		
	Odour	Texture	Flavour
1	9.0±0.7 Fresh odour	4.2±0.7 Firm	9.2±1.0 Slight loss of flavour
2	8.7±0.7 Fresh odour	2.9±0.6 Slightly soft	6.6±0.8 Loss of flavour
3	4.3±1.1 Odour neutral	1.2±0.4 Soft/mushy	5.3±1.2 Stale and aftertaste rancid

* Means are scores of 17 panellists

the anchovies. Within this period, protein content was about 17.8% as compared to an average of 14% from November to July. Comparative increases from 3 to 8.8% were also observed for the fat content during this short period. Moisture content dropped to 70% from a high value of almost 79% obtained from November to July. Ash content decreased slightly from 3 to 2.6%. Much enzymatic activity was noted in the guts of the anchovies indicating a period of feeding during the peak harvest season.

The storage life of the anchovies in ice was rather short. The anchovies were acceptable for their freshness for the first and second days which appeared to correlate with the physical, chemical and microbiological changes observed during the storage period. It was observed that there was much leaching of vital biochemical components of the anchovies as result of the melting ice. Hence long periods of icing may not preserve the fish adequately.

It is recommended that ice storage of anchovies should be a temporary measure probably for a few hours. However freezing could offer a better storage means. Processing of anchovies must at all times be carried out quickly to obtain quality products.

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Appendix 1. Description of the characteristics belonging to different freshness grades (modification of the EU scheme, based on proposals by Torry Research Station)

Elements	Characteristics			
	E	A	B	C
Skin	Bright, shining, iridescent or opalescent, no bleaching, full bloom, clean	Waxy, slight loss of bloom, very slight bleaching, slight dullness	Dull, some bleaching, loss of bloom	Dull, gritty, marked bleaching and shrinkage, no bloom
Outer slime	Transparent or water white	Milky	Yellowish-grey, some clotting, brownish	Yellow-brown, very clotted and thick
Gills	Bright red, mucus translucent	Pink, mucus slightly opaque (dark red for saithe)	Grey and bleached, mucus opaque and thick (brown for saithe)	Brown or bleached, mucus yellowish grey and clotted
Eyes	Convex, black pupil, translucent cornea	Plane, slightly opaque pupil, slightly opalescent cornea	Slightly concave, grey pupil, opaque cornea	Completely sunken, grey pupil, opaque discoloured cornea
Peritoneum (gutted fish)	Glossy, brilliant, difficult to tear from flesh	Slightly dull, difficult to tear from flesh.	Gritty, fairly easy to tear from flesh	Gritty, easily torn from flesh
Gill odour	Fresh, strong seaweedy, (fresh oil, metallic, freshly cut grass, peppery for plaice)	No odour, neutral odour, trace musty, mousy, milky, capryllic, garlic or peppery (oily, seaweedy, aromatic citric for plaice)	Definite musty, mousy, milky, capryllic, garlic or peppery, malty, beery, lactic or slightly sour (oily, definite musty, slightly rancid, painty for plaice)	Acetic, butyric, fruity, turnipy, amines, sulphide, faecal (muddy, grassy, rancid for plaice)