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308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorpjn@gmail.com

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Effect of Freezing Length on the Physical Characteristics and Nutritional Value of Croaker Fresh Fish

E.A. Ukenye and O.Y. Kolade
Nigerian Institute for Oceanography and Marine Research, Lagos, PMB-12729, Lagos, Nigeria

Abstract: This study assessed the freezing length effect on the physical and chemical components of fresh croaker fish caught from Badagry beach, Lagos and frozen at -20°C with fresh sample (not frozen) as control. The experimental fish was subjected to different freezing periods of 2, 4 and 6 weeks, respectively. Samples of frozen croaker fish were assessed bi-weekly for physical attributes such as colour, odour, texture and eye colour. Proximate composition was determined using changes in moisture content, crude protein, ash and lipid as well as mineral content in both the frozen fish and the control. A general decline was observed in physical attributes of frozen samples when compared with the control. The result of the proximate composition showed that moisture content reduced (79-74%) after 2 weeks (at weeks 4 and 6) of freezing while lipid content increased (0.3-0.8%) at week 4 and 6 of freezing. Thus, moisture is inversely proportional to lipid. The Protein content reduced (18.69-17.52%) as freezing progresses (during weeks 4 and 6). However, freezing has no effect on ash content and no mineral losses were detected during the period of this study.

Key words: Croaker fish, freezing length, nutritional properties, physical characteristics

INTRODUCTION

Fish is an important protein food in the tropics. In Nigeria, fish constitutes 40% of the animal protein intake of the people (Olatunde, 1989). But 40% of the total fish catch in Nigeria are lost annually due to inadequate or poor preservation, processing and handling (Oladosun *et al*., 1996). Some preservation techniques currently used in the tropics include chilling, freezing, drying, salting and smoking. However, frozen foods are experiencing considerable competition from other post harvest sectors. The quality and nutritional aspects of frozen foods are critical and depend on the length of freezing. When fish is frozen, ice crystals will inevitably form in the flesh of the fish. Ice crystals come from the fish absorbing water during freezing. The crystals expand during freezing and this causes damage to the fish. Furthermore, sources of quality losses in frozen foods includes diffusion of water, denaturation of proteins and the oxidation of lipids and these challenge the entire frozen food chain. Time and temperature have been reported as the major factors affecting the rate of loss of quality and shelf life of fish (Whittle, 1997).

Moisture migration is the principal physical change occurring in frozen foods and has major effects on the chemical and biochemical properties of frozen foods. Moisture loss is a major factor sometimes the limiting factor of the shelf life of food stuff. Moisture migration during thawing results in drip, which reduces visual attraction and causes nutrient loss. Apart from appearance, loss of moisture will also affect the food's juiciness and texture. Arannilewa *et al*. (2005) stated that protein decreased with increasing duration of frozen storage with fresh samples not frozen having higher protein content. This study therefore aimed at determining the effect of freezing length on the physical characteristics and nutritional value of croaker fish.

MATERIALS AND METHODS

Source of experimental croaker fish: The experimental freshly harvested croaker fish used in this study were obtained from Badagry beach, Lagos State, Nigeria. The fish samples were freeze at -20°C in Chemistry laboratory of Nigerian Institute for Oceanography and Marine Research Lagos for different periods; 2, 4 and 6 weeks, respectively and one fresh croaker fish served as control.

Physical assessment: Physical assessment on flesh of fish samples (fresh and frozen) was carried out using a five-man trained panel through a 7-point hedonic scale (grading sheet) to evaluate changes in colour, odour, texture and eye colour.

Proximate composition determination: Oven drying (at 70°C) to constant weight of triplicates of 10 g diced fish samples (5 mm^3) from the fresh and frozen of each of the experimental samples (after random selections) was used for the moisture determination:

$$\text{Moisture (\%)} = \frac{\text{Final weight} \times 100}{\text{Fresh. weight}}$$

Corresponding Author: E.A. Ukenye, Nigerian Institute for Oceanography and Marine Research, Lagos, PMB-12729, Lagos, Nigeria

Powdered samples (in triplicates) of the dehydrated flesh of the experimental fish were used for the lipid, ash and protein determination using the standard AOAC methods (AOAC, 2000).

Mineral content determination: The mineral contents of fish flesh samples (fresh and frozen) were determined in triplicate by the acid digestion method involving microwave technology. A 0.5 g sample was placed in a vessel and 6 ml HNO_3 was added. The sealed vessel was heated until digestion was completed and the digested sample was cooled for 5 min. An inductively coupled argon plasma optical emission spectrometer (Model CIROS, SPECTRO Analytical Instruments) was used to analyze the mineral content.

Statistical analysis: The statistical analyses were done with SPSS version17 software.

RESULTS AND DISCUSSION

The result of the physical assessment presented in Table 1 indicated that there was a decline in colour change during freezing, odour, texture and eye colour became less firm as the weeks progressed. This deterioration in fish color, flavor and texture as the freezing length increased is in agreement with Obuz and Dikeman (2003) who reported that freezing caused deterioration in fish color, flavor and texture. It could be deduced that this change in the sensory properties might be as a result of dehydration and chemical changes which took place under poor storage conditions. Thus, the taste and appearance of fish determines the willingness to eat it.

The proximate composition of the experimental portentous fish in Table 2 shows that in weeks 2 and 4, moisture shows no significant difference ($p<0.05$) from the fresh (control) while significant difference ($p>0.05$) was seen at week 6, which shows that the moisture content reduces as the freezing length increased due to moisture migration during thawing. This moisture loss is a limiting factor of the shelf life and also reduces visual attraction and affects the food's juiciness and texture. Lipid content at week 6 is significantly different from other weeks and the control which shows that as moisture reduces in week 6, lipid increases and this concord with the statement of Omotosho and Olu (1995) who stated that moisture and lipids are known to be inversely proportional in fish tissue. However, the sudden drop in lipid content at 2 weeks could be attributed to oxidation of poly-unsaturated fatty acids (PUFA). The oxidation of the fat leads to objectionable flavours and odours. This can be particularly serious in fish of high fat content. The rate of oxidation can be reduced by reducing the exposure to oxygen. This can be achieved by introducing a barrier at the surface of the fish. Furthermore, protein shows no significant difference at week 2 compared to the control but as freezing progresses (weeks 4 and 6), protein content reduced which is explained by denaturation according to Reay (1993). The rate at which protein denaturation takes place in frozen fish depends largely on the temperature and will slow down as the temperature is reduced. Ash showed no significant difference from the control rather the low ash content in both frozen and fresh could be attributed to the lower bone to flesh ratio of the croaker fish. Therefore, freezing storage has no effect on ash content of this studied fish. In this study, frozen storage reduced the percentage protein, moisture and lipid content of the experimental fish which is in agreement with several studies that have similarly observed that protein, moisture and fat decreased with frozen storage (Arannilewa *et al*., 2005).

Furthermore, result of the mineral content in Table 3 shows that there are almost no mineral losses during the period of this study. The slight loses observed could be in the process of thawing because when fish thaws, some of the water content is lose and this water can contain some of the water soluble vitamins and minerals.

Conclusion: Although, it might seem that fresh fish would be a healthier choice than frozen, the truth is that both fresh and frozen fish can be healthy choices, as long as they are shortly stored and prepared properly. However, the freshness of the fish along with how long

Table 1: Physical assessment of 100 g of edible croaker fish (Scale: 1-7)

Physical qlty	Fresh	2 weeks	4 weeks	6 weeks
Colour	7.0	5.6	3.8	3.4
Odour	6.8	4.8	4.2	3.6
Texture	7.0	4.2	3.6	3.2
Eye colour	7.0	6.2	4.2	3.8

*Result: Mean of the evaluation scores

Table 2: Proximate composition of 100 g of edible Croaker fish

Freezing period	Moisture (%)	Lipid (%)	Protein (%)	Ash (%)
Fresh	80.03±0.21^{b}	0.79+0.05^{b}	18.72±0.18^{c}	1.13±0.35
2 Weeks	79.67±0.29^{b}	0.39+0.01^{a}	18.69±0.11^{c}	1.22±0.18
4 Weeks	79.67±0.76^{b}	0.78+0.02^{b}	18.19±0.27^{b}	1.22±0.19
6 Weeks	74.94±0.12^{a}	0.88+0.28^{c}	17.52±0.28^{a}	1.00±0.33

Different letters in superscript indicate means are significantly different ($p>0.05$). Data are displayed from mean values with three repeat ±SD

Table 3: Mineral content of 100 g of edible Croaker fish

Nutrient (mg)	Fresh	2 weeks	4 weeks	6 weeks
Potassium	340.00	338.55	340.55	335.90
Sodium	52.32	55.33	50.52	52.90
Magnesium	38.21	39.87	30.58	38.56
Calcium	10.15	9.25	10.40	9.55
Zinc	0.52	1.33	1.58	0.56
Copper	4.002	4.36	5.66	6.00
Iron	0.77	5.28	6.01	7.25
Cobalt	1.52	1.66	1.99	2.00
Manganese	0.028	0.056	0.058	0.056
Cadmium	0.12	0.12	0.09	0.08
Lead	0.80	1.24	1.11	0.98

it was frozen can impact its taste and texture as well as the nutritional content. The reduction in the nutritional value of the frozen fish was observed to be significant after two weeks of storage. It could therefore be deduced that frozen storage helps in extending the shelf life of the fish for a short period. Therefore, short freezing length (not more than two weeks) is most preferred. Finally, we can conclude that we may consume the fish after freezing. But we should try to consume the fish in fresh condition and frozen as early as possible as quality remain better in earlier stage of freezing.

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