

Impact of freezing on nutritional composition of some less known selected fresh fishes in Iran

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Abstract

The study was designed to investigate the effect of duration of frozen storage on the proximate profile of fishes *lizadussmieri*, *sparidae*, *sciaenide* and *platycephalidae*. The fishes were subjected to sixty days of frozen storage. Protein decreases with increasing duration of frozen storage; with the fresh samples (not frozen) having the highest protein content ($13.02 \pm 0.09\%$), while the least (10.13 ± 0.06) was recorded for fish samples that were frozen for sixty days. Similar results were obtained for the fat content where the highest fat content ($0.25 \pm 0.20\%$) was recorded for the fresh samples and the least value was recorded for those stored for sixty days. Ash content and moisture content also decreased during storage. The most susceptible fish to protein loss during frozen storage was fish *sparidae* ($13.02\% - 12.74\%$) respectively. Frozen storage lead to a loss of nutrient quality in Iranian fishes during the processing.

Keywords

Frozen period
nutritive quality
fishes *lizadussmieri*,
sparidae, *sciaenide* and
platycephalidae

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Introduction

Fish is one of the most important sources of animal protein available in the tropics and has been widely accepted as a good source of protein and other elements for the maintenance of healthy body (Andrew, 2001). The less developed countries capture 50% of the world harvest and a large proportion of the catch are consumed internally (FAO, 1985). In many Asian countries over 50% of the animal protein intakes comes from fish (Williams *et al.*, 1988). Storage time and temperature are the major factors affecting the rate of loss of quality and shelf life of fish (Whittle, 1997). In spite of some disadvantages associated with frozen storage, freezing is accepted as effective way of preserving fish.

Fish is a highly perishable commodity recording considerable losses in quantity before consumption. Estimates of 40% post harvest losses of total fish landings have been reported in Iran (Akande, 1996). Locally fish spoilage has been known to be influenced to a large extent by high ambient temperatures, considerable distances of landing ports to points of utilization and poor and inadequate infrastructure for post harvest processing and landing. Investigations into such losses revealed sorting from artisanal fishing nets, limitation of processing equipment, absence of cold storage on small fishing craft and poor water

transport system as prevalent factors (Opele, 2002). Freezing are the most common methods used by fish processors in Iran. Though processing provides a higher production, less waste and low production costs (Andrade and Oliveira, 2000). Processing has been known to affect the chemical composition of the fish processed. Several workers have linked the availability of vital nutrients in fish to the method of storage (Ryder *et al.*, 1993). Storage time and temperature are major factors implicated in the loss of quality and shelf life of fish (Whittle, 1997). Most processing methods serve not only to conserve the fish but also to alter their nutrient levels either positively or negatively. Reports exist in the agro industry that smoking is not only a conservation method but also a flavour, aroma and coloration improving method which are attributes sought by consumers. Arannilewa *et al.* (2005) noted that protein decreased with increasing duration of frozen storage with fresh samples not frozen having higher protein content. Disadvantages such as product dehydration, rancidity, drip loss and product bleaching have an overall effect on the quality of frozen food (Kropf and Bowers, 1992). For the fishing industry to be sustainably developed the resources have to be as widely used as possible and not only traded as capture. A knowledge of the nutrient composition of fresh water fished and the relationship between

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their chemical composition, food value and stability while being processed into acceptable products is of significant practical interest. This study therefore is aimed at determining the acceptable storage life of frozen fishes and the freezing effects on the chemical (proximate composition) and quality of the fishes, commonly consumed in southern Iran.

Materials and Methods

Sample collection

Fishes *lizadussmieri*, *sparidae*, *sciaenide* and *platycephalidae* were randomly selected and purchased from fish mongers in southern Iran. Fresh fish samples were washed with tap water several times, rinsed with distilled water and were cut into slices. Some were used fresh while the remaining portions were stored in a plastic container in a refrigerator. A representative and homogenous sample was taken from the front, rear and the middle of the fish from both the fresh and refrigerated samples at intervals of 30 and 60 days, respectively, for analysis proximate composition. The fishes were frozen at a temperature of -18°C for duration of two months. The 4 categories of fishes and fresh frozen were analyzed for fat and protein content as described by association of official analytical chemists (2000). The chemicals used were of analytical grade, while the water used was glass distilled.

Analyses

The proximate composition (ash, fat and moisture) of the fish samples were evaluated using the standard AOAC procedure (AOAC, 1984). The protein (N x 6.25) content was determined using the micro-Kjedal method.

Statistical analysis

Experiments were performed in triplicate and results were expressed as mean \pm SD and were analyzed by oneway ANOVA test using SPSS statistical programme.

Results and Discussion

Results showed that amounts of protein, fat, moisture and ash in all species fishes decreased in freezing process. The processing method, frozen storage altered the percentage fat and protein of the mentioned four species (Tables 1,2,3 and 4). The vital nutrients of fishes have been known to depend largely on the methods of storage. Apendi *et al.* (1974) and Ojewola (2003) reported that processing methods and storage may have accounted for the differences observed in composition and gross energy content

Table 1. Proximate composition (wet weight basis) of *Lizadussmieri* subjected to different Freezing periods (Mean \pm SD)

Freezing Periods (Days)	Ash (%)	Fat (%)	Protein (%)	Moisture (%)
0	^a 1.36 \pm 2.20	^a 0.25 \pm 0.05	^a 10.13 \pm 2.22	83.77 \pm 0.20
30	^b 0.87 \pm 0.30	^b 0.24 \pm 0.03	^b 10.11 \pm 1.30	87.18 \pm 0.18
60	^c 0.81 \pm 1.34	^b 0.24 \pm 0.03	^c 10.06 \pm 1.19	81.15 \pm 0.19

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

Table 2. Proximate composition (wet weight basis) of *Sparidae* subjected to different Freezing periods (Mean \pm SD)

Freezing Periods (Days)	Ash (%)	Fat (%)	Protein (%)	Moisture (%)
0	^a 0.71 \pm 1.10	^a 0.24 \pm 0.03	^a 13.02 \pm 2.28	80.00 \pm 0.13
30	^b 0.66 \pm 1.20	^a 0.24 \pm 0.03	^b 12.98 \pm 2.30	78.80 \pm 0.18
60	^c 0.81 \pm 1.34	^b 0.23 \pm 0.03	^c 12.74 \pm 2.19	77.30 \pm 0.19

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

Table 3. Proximate composition (wet weight basis) of *Platycephalidae* subjected to different Freezing periods (Mean \pm SD)

Freezing Periods (Days)	Ash (%)	Fat (%)	Protein (%)	Moisture (%)
0	^a 0.68 \pm 1.20	^a 0.20 \pm 0.05	^a 10.66 \pm 2.18	83.00 \pm 0.21
30	^b 0.65 \pm 1.30	^b 0.18 \pm 0.04	^b 10.61 \pm 2.33	73.50 \pm 0.16
60	^c 0.53 \pm 1.34	^b 0.18 \pm 0.04	^c 10.59 \pm 2.29	64.00 \pm 0.17

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

Table 4. Proximate composition (wet weight basis) of *Sciaenide* subjected to different Freezing periods (Mean \pm SD)

Freezing Periods (Days)	Ash (%)	Fat (%)	Protein (%)	Moisture (%)
0	^a 0.97 \pm 1.22	^a 0.22 \pm 0.05	^a 12.84 \pm 2.19	80.00 \pm 0.26
30	^b 0.59 \pm 1.20	^b 0.21 \pm 0.04	^b 12.79 \pm 2.16	78.00 \pm 0.18
60	^c 0.47 \pm 1.24	^b 0.21 \pm 0.04	^c 12.73 \pm 2.14	76.50 \pm 0.15

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

of all test samples. Although freezing as a common practice in the meat and fishing industry, has been known to preserve the quality for an extended time, and offer several advantages such as minimum deterioration in product, colour, flavour and texture (Obuz and Dikeman, 2003). In this study frozen storage reduced both the percentage protein and fat content in all the species. Several workers have similarly observed that protein, ash, moisture and fat decreased with frozen storage (Omotosho, 1995; Kamal *et al.*, 1996; Arannilewa *et al.*, 2005). This reduction in percentage protein is explained by denaturation (Reay, 1993; Mills, 1975) while reduction in percentage fat is associated with oxidation of the fat (McGill *et al.*, 1974; Josephson, 1989). The most susceptible fish to protein loss during frozen storage was fish *sparidae* (13.02% - 12.74%) respectively, while the least susceptible to protein loss during freezing was *lizadussmieri* (10.13% - 10.06%). This study served to confirm the fact that frozen storage lead to a loss of nutrient quality in Iranian fishes and fatty fishes such as *platycephalidae* is more susceptible to nutrient loss during processing.

Generally, fish has been widely accepted as a good source of protein and other elements necessary for the maintenance of healthy body (FAO, 1985). Inadequate storage techniques would imply a substantial shortfall in fish availability thereby affecting the animal protein intake of the people in the tropics whose protein intake from fish ranges between 17.5-50% (FAO, 1985; Willman *et al.*, 1998). Freezing is a common practice in the meat, fish and other animal protein based industry, because it preserved the quality for an extended time and offers several advantages such as insignificant alterations in the product dimensions, and minimum deterioration in products color, flavor and texture (Obuz and Dikeman, 2003). However, there are some disadvantages associated with frozen storage (Kropf and Bowers, 1992) including freezer burn, product dehydration, rancidity, drip loss and product bleaching which can have an overall effect on the quality of the frozen foods. The proximate composition of samples that were stored in a freezer compartment of the refrigerator for different number of months prior analysis is presented in Table 1, 2, 3, and 4. The decrease in protein contents of fishes could be connected with denaturation of fish protein that is associated with frozen fish (Reay, 1933). The changes in fat content during frozen storage could be associated with the oxidation of fat (McGill *et al.*, 1974; Josephson, 1989) this confirm results obtained from our study. The result revealed that the ash and moisture content also decrease after the frozen storage.

Deterioration during frozen storage is inevitable, and in order to obtain satisfactory results, fish for freezing must be of good quality. The proteins changes in fish frozen under poor conditions can be recognised in the thawed fish. 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. Changes taking place in the lipids of the frozen fish will also slow down when the temperature is reduced. The oxidation of the fat leads to objectionable flavours and odours. This can be particularly serious in fish of high fat content and probably also accounts for most of the flavour changes in lean fish. The addition of chemicals to prevent oxidation has not been successful, except for some special types of products. 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. Thus fish in a block keep better than fish frozen individually, and the addition of an ice glaze is beneficial. Glazing is carried out after freezing by brushing or spraying chilled water onto the surface of the fish or by dipping in cold water.

Packaging materials, impermeable to moisture and oxygen can be effective, especially if vacuum packaging is employed. Some transfer of moisture from the product is unavoidable during freezing and frozen storage, which leads to dehydration of the fish. Good operating conditions are essential in order to keep dehydration to a minimum. It has been clearly established that fluctuating cold store temperatures are a major cause of dehydration. In practice the more severe cases of drying occur during frozen storage rather than during freezing. In extreme dehydration the frozen fish acquires a dry wrinkled look, tends to become pale or white in colour and the flesh become spongy. This characteristic appearance is called, inappropriately, 'freezer burn'. The weight loss is, of course, serious from an economic point of view and dehydration will accelerate the other important changes - protein denaturation, as well as oxidation. Glaze on the exposed surfaces of the fish before storage will however, evaporate over a period of time and drying of the fish itself will resume. Reglazing is therefore a common need. Paper wrappers can be used as a protection, but depending on the conditions some drying of the fish within the packing will still occur (MacGill *et al.*, 1974; Obuz *et al.*, 2003).

Conclusion

The main objective of this study was to observe the change of nutritional values specially protein, lipid and moisture in different fish species against the freezing time. The effect of freezing duration on the nutrient composition of the selected fish species, which were used in the experiment, was not same. The results showed that freezing is the best when preservation of the fish is of priority. Studies on the freeze denaturation of fish muscle proteins were reviewed with emphasis given to changes in their physico-chemical and biochemical properties during frozen storage. Finally we can conclude that we may consume the fish after freezing. But we should try to consume the fish in fresh condition as early as possible as quality remain better in earlier stage. Since fish is not normally consumed raw, freezing processing method is employed in preparation them for consumption which could have varying effect on their nutrients, texture and flavour. The fishes species were rich in protein but the protein content reduced with processing gave a better result when long-time preservation is of interest but the freezing was the better processing method when preservation of nutrient is the focus. Freezing processing made fish less susceptible to spoilage. Because all fishes species no available to form fresh in all seasons year,

this processing is a good preservation method for consumers in Iran.

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