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INVESTIGATING ON THE EFFECT OF FREEZING IN DIFFERENT TIME PERIODS ON THE CHEMICAL AND QUALITATIVE CHANGES OF FISH (GIANT TREVALLY)

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ABSTRACT

Changes in proximate composition of the Giant trevally were carried out for 0 days, 7 days, 14 days, 21 days, 28 days and 35 days at a freezing temperature. The moisture, ash, protein and fat contents were measured using standard methods. Based on obtained results, moisture content was decreased during different periods of freezing and its amount in fresh fish before freezing was (74.72%) that were decreased to 73.5%, 71.74%, 70.4%, 69.06% and 67.72%, respectively for 7, 14, 21, 28 and 35 days of freezing. The fat content in the fresh fish before freezing was (8.13%) that were decreased to 7.02% and 5.93%, and 5.33%, and 4.73%, and 4.13%, respectively, at 7, 14, 21, 28, and 35 days of freezing, respectively. The amount of protein in the fresh fish before freezing was (20.02%) that were decreased to 18.23% and 16.99%, and 15.75%, 14.51% and 13.27%, at 7, 14, 21, 28 and 35 days of freezing, respectively. Ash content in fresh fish before freezing was (1.21%) that decreased to 1%, 0.82% and 0.70%, and 0.58% and 0.46%, during 7, 14, 21, 28 and 35 days of freezing, respectively. it can be concluded that the best quality of frozen fish was obtained between 14 to 7 days of freezing.

Keywords: freezing; fish; Giant trevally; proximate nutrients; different time periods

INTRODUCTION

Freezing fish is an important method of fish processing. However, when seafood is frozen, and they are kept in frozen condition, they lose quality **(Haard, 1992)**. Losing the quality of frozen fish is mainly due to changes in the integrity of the muscles, proteins and fats **(Cappeln et al., 1999)**. Cell decomposition during freezing can cause lipid acidic hydrolysis and release of free fatty acids. Changes in fish muscle, proteins, lipids, and tissue properties have been studied for decades due to their economic importance **(Gandotra et al., 2012; Solanki et al., 2011)**. **Aberoumand and Jooyandeh (2010)** reported that for the different types of packaging storage at the appropriate temperature of freezing and characteristics of freezing of fish various species cause to great effects on the quality of the fish. They showed fish if need to freeze for a short time to maintain the taste and taste, it causes that protein and fat keep the optimum level. Freezing has been known as the best way to maintain food for long time. Freezing methods can affect the quality of fish, although there is a discrepancy in this issue. Hence, some authors observed that frozen fish over three months cannot be different compared to fresh fish species in colour, flavour and various parameters. However, other studies have shown that fishing for long periods of time may cause undesirable structural changes in muscle **(Nielsen and Jessen, 2007; Makri, 2009; Boodhoo et al., 2009)**. Protein denaturation is responsible for changing the properties of muscle, which ultimately causing changes in the characteristics of the tissue. In this sense, it has been reported that myosin protein accumulation cause to hardens and reduces the storage capacity of water (WHC) in frozen fish **(Ramirez et al., 2000; Ayala et al., 2005)**. The result is production of hard, dry, and low-quality fish. Additionally, the muscle tissue is more sensible to degradation, which, after freezing, causes rapid damage. These effects are maximized when the chain changes occur during the freezing period, such as air temperature, freezing speed. Some studies have confirmed that the increase in temperature through freezing during storage cause unpleasant changes in muscle of the fish, which causes more changes in the nature of the fish **(Zhou and Li-Chan, 2009)**. Frozen storage is an important method for processing of fish. However, when seafood is frozen and stored in frozen state they necessarily lose quality. Loss in quality of frozen stored fish is mainly due to changes in muscle integrity, proteins and lipids **(Marwa, 2015)**. Aim of this research was to study on influence freezing in time difference periods on quality and changes of proximate nutrients and energy values in fish Giant trevally.

Scientific hypothesis

Freezing has an effect on the nutrient composition (fat, protein, ash, moisture) and nutritional values (energetic value) of fish.

MATERIAL AND METHODOLOGY

Sample preparation

We were bought a fish with weight 843.5 g from Behbahan Fish Market, southern Iran and we transferred it to the Fisheries Laboratory of Khatam-Al-Anbia University of Technology. We washed out the fish and separated the fillet with weight 388 g and then chopped it and we stored it in a freezer. Fish fillets were extracted from the freezer after 0, 7, 14, 21, 28, 35 days, and analysed separately.

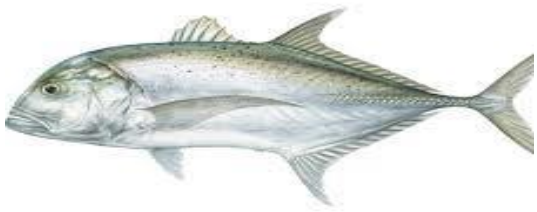

Figure 1 Giant trevally fish.

Ash analysis method

We took out a frozen fillet slice from the freezer and placed it in suitable place for melting. After thawing the fillets, fillets with weight 2 g by a digital scale with a precision of 0.1 (ek-5000 max: 5000-0.1, made in Japan), then they were individually placed in Chinese bushes and they were put in the furnace (made in Iran). The temperature of the furnace was set to 500 °C, which was not steady and was changed from 490 to 510 °C. When the furnace temperature reached to 414 °C, the furnace started to smoke out of the smoke. After the furnace temperature reached 500 °C, we started taking time and the sample kept in the furnace for two hr. After two h, we turn off the furnace and open the door by taking safety precautions and took out the bushes. If the sample was dark grey with dark spots, this indicated that the organic material of the sample was not completely converted into ash and we again placed the sample in a furnace for 1 h extra. The temperature was same the initial temperature of the furnace (500 °C). We started the timing after reaching a temperature of 500 °C. then, we turn off the furnace and separated sample from inside, so that the sample turned out to be bright grey, indicating the loss of all the organic matter in the Chinese bushes. Then we obtained the amount of ash **(AOAC 2005).**

Moisture analysis method

We were taking a large fish Giant trevally from the Behbahan market, Iran and we transferred it to the Fisheries Laboratory of Khatam-Alanbia University of Technology. We washed the fish and filtrated and stripped the fillet and kept it in freezer for freezing. We kept the fillet in the freezer for 0 day, 7 days, 14 days, 21 days, 28 days and 35 days, then we took it from the freezer for moisture analysing.

We brought out a frozen fillet piece for the test from the freezer and placed it in the suitable place for melting. After thawing the ice, we measured the fillets to 2 g with a digital scale of 0.1 precision (ek-5000 max scale: 5000-0. Made in Japan).

We put the measured samples to pre-weighed petri dishes and then we put them in an oven (Model: Memmert of Germany) at 110 °C for 1.5 h. We started timing after reaching the temperature of the oven to 110 °C. then, the petri dishes took out from the oven and then the samples were placed in the dictator to stabilize the weight and temperature, then samples weighed separately, and then samples again were put into the oven for 15 min, to ensure that all water inside the sample has been evaporated, if this sample weighed after 15 minutes was equal to the weight after 1.5 hr., it means that all the water inside the sample has been evaporated, otherwise the samples again was placed in the oven for another 15 min. For measuring fat, from moisture **(AOAC 2005)**. We used from below formula:

$$\text{Percentage of moisture} = (94\text{-}80.1) \times \text{fat percentage}$$

Different of moisture maximum and moisture minimum in fatty and low-fat fishes are numbers in brackets which are constant numbers.

The ash, fat and moisture contents were deducted from 100 will be calculated the amount of protein.

Energy evaluation

The food energy was calculated from the values of the proximate determination assuming that protein, and fat yield 4, and 9 calories respectively per g **(Iwe and Onuh, 1992)**.

Chemical analysis

Proximate analysis for moisture, fat, protein, ash contents were determined according to **AOAC (2005)** while the carbohydrate content of samples was obtained in form of difference between 100 and the sum of moisture, protein, fat and ash values.

Statistic analysis

Average values per each sample were determined and analysed using descriptive statistics using SYSTAT Version 6.0. The data obtained were compared with standard values as reported in the literature. Results are expressed as mean of triplicate trials. Data were analysed by one-way analysis of variance on the means of values (p <0.05).

RESULTS AND DISCUSSION

Results obtained has been showed in Figure 1, Figure 2, Figure 3, Figure 5 and Table 1.

Figure 1 showed a decreasing pathway of moisture to 67.72% on day 35 (from 74.72% to 67.72%), which has a significant difference in all the steps mentioned (p <0.05). In the research conducted on the Caspian Sea fish (*Rutilus frisi kutum*), they found that the moisture content in this fish decreased from 75.9% to 72.3% after 12 months of storage in the refrigerator at 18 °C, that it agreed with our study (p <0.05).

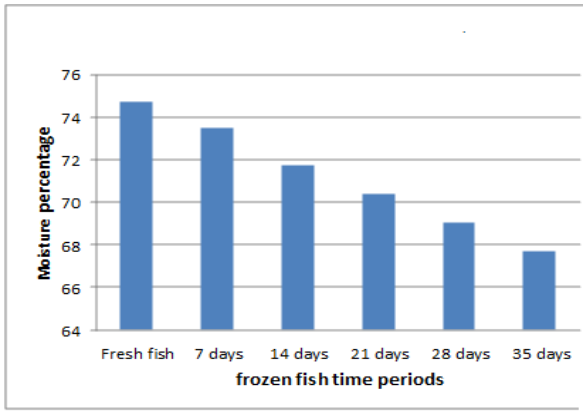

Figure 1 Moisture contents in the fish freezing different time periods.

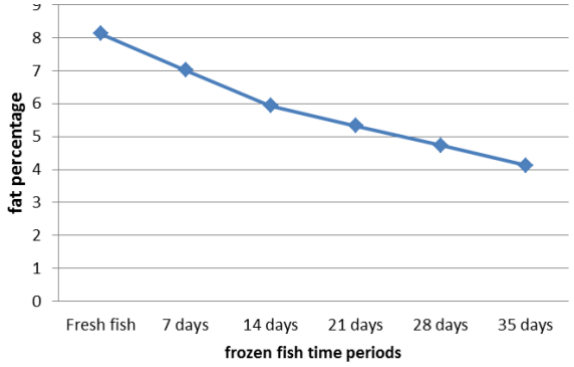

Figure 2 Fat contents in the fish freezing different time periods.

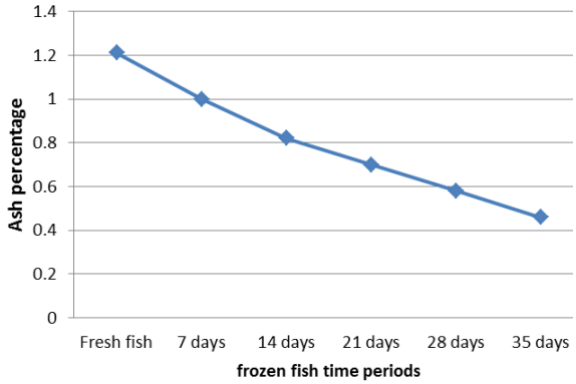

Figure 3 Ash contents in the fish freezing different time periods.

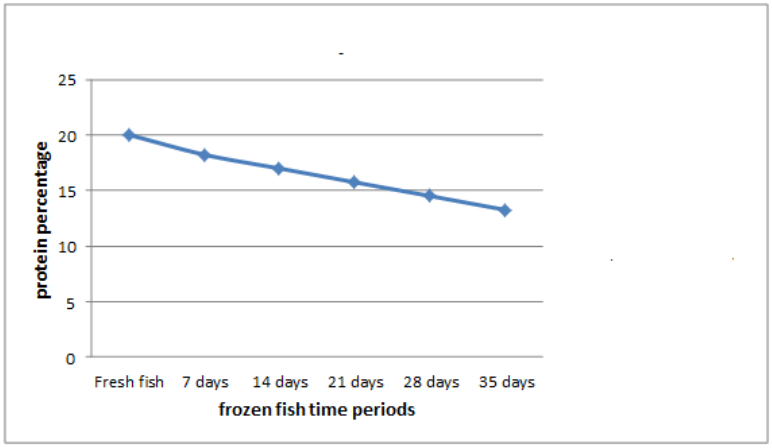

Figure 4 Protein contents in the fish freezing different time periods.

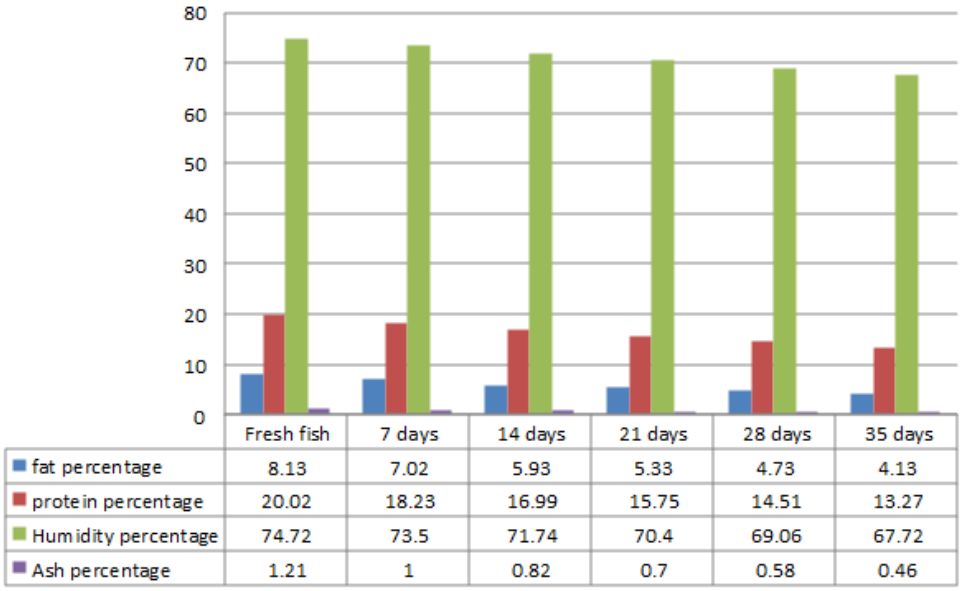

Figure 5 Comparison of proximate nutrient contents in the fish freezing different time periods.

Table 1 Proximate nutrients and energy values in fresh and frozen fish in different time periods.

	Fat	Protein	Ash	Moisture	Energy (KJ)	Energy (Kcal)
Fresh fish	8.13	20.02	1.21	74.72	660.45	157.25
7 days after freezing	7.02	18.23	1.00	73.50	571.62	136.10
14 days after freezing	5.93	16.99	0.82	71.74	509.59	121.33
21 days after freezing	5.33	15.75	0.70	70.40	479.30	114.12
28 days after freezing	4.73	14.51	0.58	69.06	434.74	103.51
35 days after freezing	4.13	13.27	0.46	67.72	390.18	92.90

In the two species of *Upeneuts molluccensis* and *Mullus suranuletus* moisture contents were reported to be 79.41% and 73.14% respectively after freezing **(Öksüz and Küver, 2011)**. Also, it was found in Atlantic Ocean Herring fish (*Clupea harengus*), Macrel fish (*Scomber scombrus*) 68.6 and 65% **(Olagunju et al., 2012)**. The highest water content is fillet, was about 80% in low fat and fat free fish and about 70% in fatty fish, so the amount of water in fish muscle was different (p <0.05).

According to the test carried out, Figure 2 showed that during the storage period of the fish fillet in the freezer, a decrease in fat was observed.

The main reasons for reducing fat during storage in freezer depends on freezing conditions (freezing of low and fast), and formation of ice crystals during the storage period of the samples, which, depending on the diameter of the particles, which may cause damage to the frozen fish tissue., the formation of the ice crystals not only causes tissue rupture in the samples, but also the removal of these crystals in a thawing time in the form of droplets of water from the tissue is separated, which together with the fat and other soluble materials, which causes to reduce the percentage of final fat in treatments.

Fat oxidation was another factor in reducing fat during storage in freezer, which can reduce fat percentage at the end of the shelf life. The final reduction is the total fat in the measured samples because of the enzymes that are effective on the hydrolytic spoilage of the fat, especially the cold-resistant lipases and its conversion to free fatty acids. The result of an increase in temperature at the surface causes that the moisture at food surface quickly evaporates. The outer surface of product dried and crust is formed. Gradually, the internal moisture content of the product also becomes steam and a positive slope of the vapor pressure is created. The vapor penetrates through the vents and causes canals at the surface of cells and membranes. As the operation progresses, the oil is sticked to the surface of the product and penetrates the product through holes and channels created as a result of evaporation of water. In this mechanism, there is a linear relationship correlation between reducing moisture and absorbing oil during frying. For example, the food contains higher moisture also absorbs more oil. The fat content in *Orcynopsis unicolor*, *Euthynnus affinis* and *Liza dussmieri*, were different **(Aberoumand, 2012)**. In Harring and Macrel fat contents has been reported 11.14% and 12.33% respectively **(Olagunju et al., 2012)**.The amount of fat in fish body muscle varies according to environmental conditions of fish.

Due to long time storage of the samples in freezer, the ice crystals join together and become big and cause a rupture of the cell membrane, which results in the release of ell materials that contain minerals and nutrients in thawing time, so that causes reducing the minerals exist in ash. Figure 3 showed this subject.

According to Figure 3, the ash content of fresh fish (zero day) was 1.21% that decreased to 0.46% in 35 days. This reduction was due to the increase in exit of water during freezing. According to some studies, the amount of ash in

Shagh fish and Mackerels were 1.6% and 0.7% respectively **(Emadi, 2008)**. Ash contents in Cod fish was 1.2% and in Yellow Ribbon 1% **(Razavi Shirazi, 2007)**. Ash contents in the *Orcynopsis tricolor*, *Euthymults affinis*, and *Liza dussmieri* were 2%, 3.27% and 1.36% **(Aberoumand, 2012)**, Ash contents in *Clupea harengus*, *Scomberus scomber* reported 1.51% and 1.79% **(Olagunju et al., 2012)**. The reason of the difference in ash contents in the fish species were type of feeding, gender, age, habitat and the method of measurement.

According to the Figure 4, the percentage of protein decreased from 20.02% in fresh fish (zero day freezing) to 13.27% on 35 days.

The reason for decreasing the protein percentage in the sample during the storage period in freezer was release of amine compounds. If the freezing time increases, the amount of nitrogen released also will be increased and it is removed from the main components of the protein chain and leads to decrease protein contents during freezing. This decrease occurs at higher temperatures (above zero) and leads to a further reduction in protein content, and if the frozen temperature of product was less than -18 °C (i.e. 35 °C), this decrease occurs less **(Chiba et al., 1991)**. Loss quality during frozen storage is inevitable, and to obtain satisfactory results, fish for freezing must be of good quality. The freezing of fish influenced the proximate composition of their muscles also the quality of fish samples during storage revealed the decreasing of the taste with increasing duration of storage **(Marwa, 2015)**.

From the results of Table 1, it can be concluded that fillet energy value in treatment 7 days freezing period was the best compared to the other freezing periods. Table 2 showed that the amount of proximate nutrients in each freezing period related to the previous period were constant from the 21 days freezing period , which indicates the lack of effect of freezing on nutrients. However, in the 14 days freezing period related to the previous period, all nutritional compounds were decreased, which indicates the effect of freezing on proximate nutrients. Freezing from the 14 days period did not have any effect on the amount of protein since its amount was constant. The amount of energy decreased from the 14 days freezing period to that of the previous period and fresh fish.

CONCLUSION

The results of this research showed that the best quality of frozen fish found between 7 days and 14 days of freezing and the quality of fish was best in fresh item. The rate of loss quality was accelerated during frozen storage time. The protein denaturation, lipid hydrolysis and oxidation increase as the storage period increase. The freezing of fresh fish leads to decrease in protein %, lipid %, ash % and moisture % compared with fresh muscle fish. The increases of pH value for imported frozen. However, in the 14 days freezing period related to the previous period, all nutrient compounds were decreased, which indicates the effect of freezing on proximate nutrients. Freezing from the 14 days period did not have any effect on the amount of protein because its amount was constant. The amount of energy decreased from the 14 days freezing period to that of the previous period and fresh fish. Recommendation was eating fresh fish which is most benefit for human health.

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