**The Journal of Animal & Plant Sciences, 22(3): 2012, Page: 614-618**
**ISSN: 1018-7081**

# CHEMICAL AND SENSORY QUALITY CHANGES IN WILD AND FARMED FISH FLESH (*LABEO ROHITA)* AT FROZEN STORAGE (-18°C)

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## ABSTRACT

A study was conducted to evaluate the effect of frozen storage (-18 ˚C) on the chemical and sensory quality of wild and farmed fish flesh (*Labeo rohita*). Ten fish with an average weight of about 700-1000 g were collected each from *Head Balloki* (wild) and University of Veterinary & Animal Sciences, Pattoki Fish Farm. Fish fillets were prepared and studied for chemical composition and sensory attributes at 1st, 15th and 30th day of frozen storage. The design of the experiment was completely randomized and the significance was assessed through two way (site & study duration) ANOVA technique. Farmed fish was found significantly higher ($P \leq 0.05$) in dry matter (92.52%) than wild fish (90.51%). Ash contents were found (7.34%) in wild fish and (7.04%) in farmed fish. Ash contents were significantly higher on the first day followed by 15th day and 30th day. The crude fat contents of fish on 30th day were significantly higher than 1st and 15th days. Crude protein contents of wild fish was (80.29%) and (79.93%) in farmed fish. A non-significant difference ($P \geq 0.05$) among farmed and wild fish was observed. The storage intervals significantly affect protein contents on 15th and 30th day. In case of sensory attributes, colour, flavor, tenderness and overall quality of farmed fish was observed significantly higher compared to wild fish. Storage intervals also significantly affect the sensory attributes such as colour, flavor, juiciness, tenderness, oiliness and overall quality. These attributes were found significantly higher up to 15th days than 30th day of storage which deteriorates the product sensory attributes and overall quality. In conclusion, it has been observed that wild fish was richer in fat contents than farm fish and the storage intervals significantly affect/deteriorate the product quality after keeping more than 15th days at -18 ˚C. However, the effects of frozen storage on chemical and sensory quality changes need further long term investigation.

**Key words:** Chemical composition, *Labeo rohita*, Sensory attributes, Wild and farmed fish flesh.

## INTRODUCTION

Fish production sector is very important not only as a main source of animal protein to ensure food security but also to improve the quality of food and increase protein supply in the food chain, in developing countries like Pakistan (Sheikh and Sheikh 2004; Bacha *et al.,* 2011). Quality of fish flesh has gained importance in the general public and aquaculture industry owing to its direct relationship to human health and nutrition (Nguyen *et al.* 2004). The consumer's acceptance of fish and fishery products depends on several attributes of food quality. The most important indicators of flesh quality with respect to consumer's acceptance are safety, fat contents, nutrition, microbial load, biochemical and physicochemical properties flavour, texture, colour, and the suitability for processing and preservation (Gill 1990) while, nutritional factors includes omega-3 fatty acids and mineral contents. Cultured fish is considered a good source of essential fatty acids and is good for human's consumption like the wild fish (Danabas 2011). However, sensory evaluation is considered the most important tool that determines freshness of a fish product. Some of the key factors that affect the chemical and sensory quality of both wild and farmed fish product are: interspecies variation, intraspecific factors, spawning period, season, nutrition, post-harvest handling, environmental hazards, soil and water pollution, agriculture and domestic wastes, culture practices and storage intervals (Haard 1992; Kinsella 1988; Nielsen *et al.,* 2002). Different methods are used to maintain flesh quality. Freezing and frozen storage at -18 °C are considered to be most important methods to keep fish flesh quality good for longer time (Rasmussen 2001). Through these processes many damaging pathways of certain microbes are inhibited but undesirable reactions associated with lipid oxidation and protein denaturation have shown to occur, leading to detrimental changes in nutritional and sensory properties (Sikorski and Kolakowska 1994; Erickson 1997; Thongkaew *et al.,* 2005). Limited work has been done on the chemical and sensory evaluation of frozen storage (-18 °C) of raw fish flesh (*Labeo rohita*). The present study was therefore planned to compare the nutritional and sensory quality of wild and farmed *Labeo rohita* fish flesh at different storage intervals.

## MATERIALS AND METHODS

**Experimental sites and design:** The study was conducted at the Department of Fisheries & Aquaculture, University of Veterinary and Animal Sciences (UVAS), Ravi Campus, Pattoki. The experimental fish was Indian major carp (*Labeo rohita*) with an average weight of 700 g to 1000 g. The fish samples were collected from two different study sites. Wild fish samples from Head Baloki, River Ravi, District Kasur, Punjab while, Farmed fish samples from the Department of Fisheries and Aquaculture fish farm, UVAS, Ravi Campus, Pattoki. The design for the experiment was Completely Randomized with two factors (fish source and storage period).

**Samples preparation:** The experimental fish samples collected from two different sites were brought to Labs in the Department of Fisheries & Aquaculture. The fish were gutted and washed properly with tap water. The fish fillets were prepared according to the methodology described by Khan *et al.* (2011). Equal sized fish fillets 2.5 x 3 x 7.5 cm with an average weight of 20-25 g were prepared from the middle part of the fish body after removing its head and caudal regions. The study design was completely randomized design with two factors (fish source and storage period).

**Sensory evaluation:** Sensory evaluation was performed by semi-trained panelists using 15-cm unstructured line scale methodology as described by Meilgaard *et al.* (2007). Ten (10) members panel of assessors was recruited from post-graduate students and faculty from Departments of Food & Nutrition and Fisheries & Aquaculture based on their frequent fish consumption pattern in daily life. The panelists were semi-trained about evaluation process, descriptors used for evaluation and use of unstructured line scale Performa for evaluation. Sensory descriptors were defined for the parameters of color, flavor, juiciness, tenderness, oiliness and overall acceptability as presented in Table 1. The evaluations were made on the same day after preparation of samples under white incandescent lights. The evaluations were done for freshly prepared samples before frozen storage followed by fortnightly evaluations up to 30 days of frozen storage (-18 °C). The fish samples were steam cooked in the oven at medium high temperature for 10 minutes without any spices. The samples were coded with three digit numbers and placed in plates to present the judges for sensory attributes (Table 1). The judges were asked to put a cross on 15-cm line for each parameter of all the samples. Drinking water was given to rinse the mouth between the evaluations of samples. The length from start of line to marked-cross was measured with scale and converted to numerical scores for statistical analysis.

**Table 1: Description of sensory attributes used for steamed fish flesh evaluation**

| Attributes | Description of Attributes |
|---|---|
| Colour | Intensity of "whitish"/"creamish" colour, typical of steamed fish flesh |
| Flavour | Intensity of perceived taste of typical steamed fish flesh. |
| Juiciness | Intensity of juiciness of steamed fish flesh while chewing |
| Tenderness | Intensity of "softness" perceived at the time of chewing |
| Oiliness | Intensity of oiliness that perceived taste of a typical steamed fish flesh |
| Overall quality | Overall impression of the steamed fish flesh based on above attributes |

**Chemical analysis:** The proximate analysis was done at initial stage, after 15 days and 30 days of frozen storage (-18°C) for dry matter, crude protein, crude lipid and ash following their respective protocols as given in AOAC (2006). Dry matter (DM) was determined by oven drying, ash contents by muffle furnace at 600 °C and crude protein (CP) by Kjeldhal analysis. Crude lipid was determined by following ether extraction method using Soxhlet apparatus.

**Statistical analysis:** The data thus obtained was analyzed using two way analysis of variance techniques (Steel *et al.*, 1997) with Cohort Co-Stat software version 6.303. The experimental site (wild or farm) was taken as 1st factor and frozen storage study intervals were taken as 2nd factor. DMR test was used to compare the means (Duncan, 1955). The level of significance was defined as $P=0.05$. The data is presented as mean ± standard deviation.

## RESULTS AND DISCUSSION

The results of proximate composition of experimental fish are presented in table 2. The mean value of farm fish was found to be higher in dry matter (92.52%) while, in wild fish it was found to be (90.51%) the lowest one. Statistical analysis revealed significant difference among farm and wild fish where farm fish was significantly higher in dry matter contents than wild fish. The time of frozen storage interval illustrated significant differences ($P < 0.05$) among different treatment days. Initial or day 1st was observed significantly higher followed by day 15th and day 30th, respectively (Table 2). Similarly, ash contents for wild fish were 7.34% and 7.04% in farm fish. Statistical analysis revealed non-significant difference ($P \geq 0.05$) among wild and farm fish. Time of storage intervals indicated that ash contents were significantly higher on the first day followed by 15th day and 30th day, respectively (Table 2). As for as crude

lipid is concerned the wild fish flesh contain significantly ($P < 0.05$) higher fat contents than farm fish. The results of fat contents at different storage intervals illustrated that lipid contents of fish on 30th day of storage were significantly ($P < 0.05$) lower than 1st and 15th days (Table 2). The mean values of crude protein indicated non-significant differences ($P \geq 0.05$) among farm and wild fish. However, the storage intervals significantly ($P < 0.05$) affect protein contents on 15th day and 30th day (Table 2). Results of our study are in accordance with the findings of Tokur *et al.* (2006); Sayar (2001); Biscalchin-grysheck *et al.* (2001); Lin *et al*. (1996) and Adu *et al.* (1983) who reported that crude protein, lipid, and crude ash contents of fish fingers decreased significantly as a result of washing and storage. In our study, a significantly lower lipid contents in farm fish was observed that might be due their smaller size compared to wild fish that were comparatively bigger in size. Frozen storage also significantly effects the lipid contents and a sharp decreased was observed in lipid percentage on 30th day of storage compared to day 1st and day 15th followed by ash contents. This decrease in lipid contents might be related due to fat oxidation. This fact of lipid oxidation during frozen storage is also explained by Alzagtat and Alli (2002); Careche and Tejeda (1994) and Siddaiah *et al.* (2001).

**Table 2: Proximate composition (% age) of farm and wild *Labeo rohita* fish flesh for 30 days of frozen storage.**

| Parameters/ Storage days | Farm Fish | Wild Fish (Head Baloki) | Mean |
|---|---|---|---|
| **Dry matter** | | | |
| 1st day | 92.84±2.47 | 98.86±0.38 | 95.85[a] |
| 15th day | 94.36±0.53 | 81.79±0.78 | 88.07[c] |
| 30th day | 90.38±0.81 | 90.89±0.35 | 90.64[b] |
| **Mean** | 92.52[a] | 90.51[b] | |
| **Ash** | | | |
| 1st day | 9.03±0.30 | 9.42±0.41 | 9.22[a] |
| 15th day | 7.00±0.58 | 6.5±0.60 | 6.76[b] |
| 30th day | 5.01±0.12 | 6.12±0.14 | 5.62[c] |
| **Mean** | 7.04[a] | 7.34[a] | |
| **Crude lipid** | | | |
| 1st day | 3.05±0.39 | 10.1±1.37 | 6.57 [a] |
| 15th day | 3.93±0.92 | 9.2±0.55 | 6.56 [a] |
| 30th day | 3.96±0.07 | 4.59±0.64 | 4.27 [b] |
| **Mean** | 3.65[b] | 7.97 [a] | |
| **Crude protein** | | | |
| 1st day | 80.59±0.71 | 79.53±0.87 | 80.06 [ab] |
| 15th day | 78.74±0.57 | 80.35±1.186 | 79.54[b] |
| 30th day | 80.44±1.08 | 81.00±0.115 | 80.73 [a] |
| **Mean** | 79.93 [a] | 80.29 [a] | |

*Values with different superscripts for each parameter in a row or column are significantly different ($P < 0.05$).

**Sensory evaluation:** The comparison of mean scores of sensory attributes of both farm and wild steamed fish are illustrated in Table 3. A significant variation was observed for sensory scores of colour, flavour, juiciness, tenderness, oiliness and overall quality at different freezing intervals. The mean values of colour for farm fish were found significantly higher ($P < 0.05$) than wild fish. The means of colour scores at different storage intervals illustrated significant differences ($P < 0.05$) among wild and farm fish (Table 3). The flavor scores of farm fish showed significantly higher ($P < 0.05$) mean values than wild fish. The storage intervals also revealed significant differences ($P < 0.05$) among 1st, 15th and 30th days (Table 3). There was non-significant differences ($P \geq 0.05$) observed between farm and wild fish for juiciness scores. Results of storage intervals illustrated that juiciness scores for 30th day was found significantly lower than 15th day and 1st day, respectively (Table 3). Tenderness revealed significant differences ($P < 0.05$) between farm and wild fish whereas, farm fish was found better in tenderness than wild fish. The storage intervals significantly ($P < 0.05$) affect the tenderness quality. Fish on 1st day get significantly higher scores followed by 15th day and lowest in 30th day (Table 3). The means for oiliness indicated non-significant difference differences ($P \geq 0.05$) among farm and wild fish. Similarly, storage intervals also did not affect the oiliness of steam fish (Table 3). The statistical analysis for overall quality revealed that farm fish was found significantly different ($P < 0.05$) with the highest mean score than wild fish. Storage intervals indicated that fish on 1st day get significantly higher ($P < 0.05$) score for overall quality followed by 15th day and 30th day, respectively (Table 3). The sensory attributes of fish during present study revealed that farmed fish gained significantly higher score for colour, flavour, tenderness and overall quality than wild fish. This difference in sensory attributes might be due to water quality, feed and environmental effect in natural aquatic environments. Continuous addition of domestic sewage and industrial pollutants from Lahore city and its vicinity in River Ravi has deteriorated water quality and affecting aquatic biodiversity as well. Allen and Hepher (1979) presented contrasting results that fish reared in ponds received well treated domestic wastes tasted good or even better than the fish reared in waste free ponds. It was determined that almost all sensory parameters gained significantly higher scores on 1st and 15th days compared to 30th days which gained lower scores of sensory evaluation. These data indicated that frozen storage of fish fillets at -18 °C for more than 15 days deteriorated the sensory parameters. Similar results have also been reported for sensory parameters of colour, odour, flavour, and general acceptability by Simeonidou *et al.* (1996) and Tokur (2006). They reported that values of sensory parameters decreased during the frozen storage period but they were still within acceptable limits. Numerous researchers have reported that protein solubility decreased during frozen storage due to denaturation and aggregation of myofibrillar proteins in

fish mince (Benjakul *et al.,* 2005; Careche *et al.,* 1998; Huidobro *et al.,* 1998; Leelapongwattana *et al.,* 2005; Suvanich *et al.,* 2000). Freezing and frozen storage are important methods for the preservation of fish products. However, undesirable reactions associated with lipids and proteins occurred that leads to detrimental changes in nutritional and sensory properties (Sikorski and Kolakowska 1994; Erickson 1997).

In conclusion, wild fish was observed richer in fat contents than farmed fish and the storage intervals significantly deteriorated the product quality after keeping more than 15$^{th}$ days at -18 °C. However, the effects of frozen storage on chemical and sensory quality changes need further long term investigation.

**Table 3: Sensory evaluation scores of farm and wild *Labeo rohita* fish flesh for 30 days of frozen storage.**

| Parameters/ Storage days | Farm Fish | Wild Fish (Head Baloki) | Mean |
|---|---|---|---|
| **Colour** | | | |
| 1$^{st}$ day | 10.61±2.80 | 9.02±2.95 | 9.81$^{a}$ |
| 15$^{th}$ day | 10.52±10.52 | 7.63±3.52 | 9.07$^{ab}$ |
| 30$^{th}$ day | 7.815±7.82 | 8.21±2.29 | 8.01$^{b}$ |
| **Mean** | 9.65$^{a}$ | 8.28$^{b}$ | |
| **Flavour** | | | |
| 1$^{st}$ day | 10.85±2.22 | 9.15±3.35 | 9.99$^{a}$ |
| 15$^{th}$ day | 10.98±2.65 | 9.61±2.56 | 10.29$^{a}$ |
| 30$^{th}$ day | 8.41±2.72 | 7.49±2.47 | 7.95$^{b}$ |
| **Mean** | 10.08$^{a}$ | 8.75$^{b}$ | |
| **Juiciness** | | | |
| 1$^{st}$ day | 9.13±1.99 | 8.52±3.21 | 8.83$^{a}$ |
| 15$^{th}$ day | 9.22±2.29 | 10.54±2.01 | 9.88$^{a}$ |
| 30$^{th}$ day | 7.72±2.70 | 7.17±2.82 | 7.44$^{b}$ |
| **Mean** | 8.74$^{a}$ | 8.68$^{a}$ | |
| **Tenderness** | | | |
| 1$^{st}$ day | 10.32±1.78 | 8.17±2.85 | 9.25$^{a}$ |
| 15$^{th}$ day | 8.97±1.99 | 8.87±2.05 | 8.92$^{a}$ |
| 30$^{th}$ day | 7.79±2.63 | 7.38±2.68 | 7.59$^{b}$ |
| **Mean** | 9.03$^{a}$ | 8.14$^{b}$ | |
| **Oiliness** | | | |
| 1$^{st}$ day | 8.56±3.59 | 7.30±2.73 | 7.93$^{a}$ |
| 15$^{th}$ day | 7.41±3.09 | 8.61±3.41 | 8.01$^{a}$ |
| 30$^{th}$ day | 7.42±2.31 | 6.96±2.20 | 7.19$^{a}$ |
| **Mean** | 7.80$^{a}$ | 7.62$^{a}$ | |
| **Overall quality** | | | |
| 1$^{st}$ day | 11.08±1.98 | 8.98±3.13 | 10.03$^{a}$ |
| 15$^{th}$ day | 10.98±1.81 | 8.53±2.52 | 9.75$^{a}$ |
| 30$^{th}$ day | 7.86±2.34 | 7.72±1.77 | 7.79$^{b}$ |
| **Mean** | 9.97$^{a}$ | 8.41$^{b}$ | |

*Scores with different superscripts for each parameter in a row or column are significantly different ($P < 0.05$).

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