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Original Article

Assessing the quality of tilapia fillets (*Oreochromis niloticus*) and the impact of frozen storage periods on their chemical composition

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ABSTRACT

This work aims to investigate the effect of two fish farms irrigation sources; Al-Batts Drain, (A) and El-Wadi Drain (B), Fayoum] on quality criteria of fresh Nile tilapia fillets and changes occurring in its proximate composition during frozen storage at -18˚C for 180 days. Quality indices (pH, TVB-N, TMA-N, TBA and Biogenic amines) and microbiological aspects (total bacterial count (TBC), total coliform count (TCBC) and yeasts and molds (Y&M) count) of fresh Tilapia fish fillets were determined. , The results showed that the values of pH were 6.18 and 5.95, TVB 15.4 and 12.72 mg/100g, TMA-N 0.78 and 0.60 mg/100gm, TBA 0.77 and 0.51 mg/kg while total Biogenic amines values were 38.01 and 24.71 mg-kg for samples obtained from Farm A and Farm B fresh samples, respectively.. The low counts of TB, TCB and Y&M indicated that to the safety of these samples. The content of moisture, protein, and lipid decreased during frozen storage periods while ash increased in frozen samples to record 5.52 and 5.43 % for samples A and B, respectively.

Keywords: Frozen storage, Tilapia fillets, chemical composition, quality.

1. INTRODUCTION

Fish is an excellent source of protein and other elements for the maintenance of human health (Andrew, 2001). Fishery products are recognized as a valuable source of nutrients; high-quality proteins, unsaturated lipids, vitamins, and minerals. Nutritionists and dieticians have identified fish as a source of polyunsaturated fatty acids that are beneficial for health (Venugopal, 2005).

With regard to preservation methods; freezing is the process of lowering the temperature to below the freezing point.The temperature allows the majority of the water to solidify into ice. The freezing point of tissue fluid is determined by the chemicals dissolved within. Also, it involves the removal of latent heat during the phase transition of water from

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liquid to solid, as well as the loss of sensible heat, (Gokoglu and Yerlikaya, 2015).

The rate of deterioration during frozen storage of fish varies with species and depends on the concentrations of substrates and metabolites in the tissue, microbial contamination and conditions of storage after catching (Pacheco-Aguilar, *et al*., 2000). The shelf life reflects susceptibility of the fish to deterioration. The quality of fish can be estimated by sensory tests, microbial and chemical methods (Ozogul, *et al.,* 2006; Raatikainen *et al.,* 2005).

This study aims to determine the effects of fish farms irrigation source on some quality attributes and chemical composition of tilapia fillets as affected by frozen storage at -18˚C for 6 months.

2. MATERIALS AND METHODS

2.1. Fish samples

Monosex Nile tilapia fish (*Oreochromis niloticus*) samples were collected from two fish farms in earthen ponds around Lake Qarun in El- Faiyum Province. The Qarun fish farm (farm A) located at the eastern shore of Lake Qarun while (farm B) is located at the western zone, (and irrigated with El-Batts and El-Wadi drains, respectively.

Approximately 15kg of fresh tilapia fish were obtained from a and B farms, transported in an ice box to the Fish Processing Technology Laboratory at the National Institute of Oceanography and Fisheries (NIOF) in Shakshouk, Egypt. The average weight and length of tilapia samples recorded 400±50g and length of 29.00±1.5cm for farm A and 500±60g and 31±2cm for farm B, respectively.

2.2. *Frozen tilapia fish fillets*

Manually tilapia fillets were investigated by frozen storage at -18˚C for 180 days and the samples were withdrawn at intervals of 2 months

2.3. Analytical methods

2.3.1. Chemical composition.

The proximate composition (moisture, crude protein, lipid and ash content) of fresh fish meat was determined according to AOAC (2012).

The carbohydrate content was calculated as follows:

Carbohydrate content = 100% - (% protein + % fat + % ash + % moisture).

2.3.2. Physico-chemical attributes

The pH value was determined according to AOAC (2012). Total volatile basic nitrogen (TVB-N) was determined by the Micro- distillation method proposed by (Pearson, 1991).

Thiobarbituric acid reactive substances (TBARS) were spectrophotometrically determined as described by Siu and Draper (1978).

Trimethylamine (TMA-N) was determined according to AOAC (2012).

2.3.3. Bacteriological examination

Total bacterial count (TBC)

Total bacterial count was using nutrient agar medium (incubated at 30°C, for 3 days) as described by the standard procedures of (AOAC, 2012).

Yeasts and molds count

Yeasts and molds count were enumerated on malt agar as mentioned by Refai (1979).

2.4. Statistical analysis

The results obtained were statistically analyzed to determine the means and standard deviation (Mean ± SD and the least significant difference (LSD) was assessed at $P \leq 0.05$ using SPSS 10.0 for windows (SPSS, 1998)**.**

3. RESULTS AND DISCUSSION

3.1. Quality parameters of raw tilapia fish

Data in Table (1) illustrated the biochemical quality criteria of tilapia fish obtained from farms A and B. The values of pH, TVB-N (mg/100gm), TMA-N (mg/100gm) and TBA (mg MA/kg) were 6.18 ± 0.09, 15.04 ± 0.20 mg/100g, 0.78 ± 0.10 mg/100g and 0.77 ± 0.22 mg/kg for samples from farm A, while these values were 5.95 ± 0.18, 12.72 ± 0.41 mg/100g, 0.60 ± 0.07 mg/100g and 0.51 ± 0.11 mg MA/kg for farm B, respectively. These results are on harmony with Mohamed (1991) who found that the TVB-N of tilapia was 17.5 mg/100gm also El-Sherif *et al.* (2011) found that the TVB-N and TBA of tilapia fish were 14.31 mg/100g and 0.55 mg MA/kg respectively. From these results it could be noticed that the TVB-N, TBA and pH values in the

two farms samples are less than the spoilage values or unaccepted values and in the range of fish freshness values, so the tilapia fish samples used in this work were in fresh state. although there are significant differences ($P \leq 0.05$) were noticed between two fish samples A and B.

Table (1): Quality of raw tilapia fish fillets obtained from farms (1 and 2) (w.w.).

Criterions	Farm A	Farm B	L.S.D at 5%
pH value	6.18 ± 0.09	5.95 ± 0.18	0.077
TVB-N (mg\100 g)	15.04 ± 0.20	12.72 ± 0.41	1.215
TMA-N (mg\100 g)	0.78 ± 0.10	0.60 ± 0.07	0.009
TBA (mg MDA \ kg)	0.77 ± 0.22	0.51 ± 0.11	0.076

Data are calculated as mean ± (SD) Standard deviation; (n=3). Farm 1: Irrigated by El-Batts drain. Farm 2: Irrigated by El-Wadi drain.TVB-N: Total volatile basic nitrogen. TMA-N: Trimethyl amine nitrogen. TBA: Thiobarbituric acid. w.w.: On wet weight basis. L.S.D 5%: Least significant difference at $P \leq 0.05$

3.1.2 .Biogenic amines of raw tilapia fish

The determination of biogenic amines in food has both safety and quality issues. The contents of biogenic amines (spermine, putrescine, cadaverine, histamine, tyramine) in fresh tilapia fish are shown in Table (2). It can be seen that tilapia fish from farm A contains a relatively higher concentrations of histamine (13.55) mg/kg, followed by cadaverine (9.80) mg/kg, tyramine (8.62) mg/kg, putrescine (4.60) mg/kg and spermine (1.50) mg/kg. While the concentrations of mullet fish from farm B were cadaverine (10.40) mg/kg followed by histamine (9.06) mg/kg, tyramine (8.80) mg/kg putrescine (4.22) mg/kg and spermine (1.23) mg/kg. From results, the concentrations of BAs in fresh tilapia fish from farm (A) were higher than samples of from farm (B). The total biogenic amines values of fresh tilapia fish samples from farm (A) 38.07 mg/kg were significantly (P>0.05) higher than total BAs of samples from farm (B) 24.71 mg/kg.

Also, according to the mentioned results, our data showed that all detected biogenic amines in the investigated raw fish samples were much lower than the toxic levels of 500 ppm, a value at which one would expect illness and that the FDA would use in legal proceedings (EEC, 1991; FDA, 1998), Also, histamine and another detected amines values in investigated fresh tilapia fish samples were very below the allowable limit, where the maximum permissible limit of histamine set by Commission Regulation (EU, 200 mg/kg) and AFSC (Australian Food Standard Code, 200 mg/kg.)

Table (2): Biogenic amines of raw tilapia fish fillets obtained from farms (A and B) (w.w.)

Biogenic amines (mg/kg)	Farm A	Farm B	L.S.D at 5%
Spermine	1.50 ± 0.30	1.23 ± 0.28	0.024
Putrescine	4.60 ± 0.08	4.22 ± 071	0.095
Cadaverine	9.80 ± 0.50	10.40 ± 0.62	1.007
Histamine	13.55 ± 0.28	9.06 ± 0.19	0.770
Tyramine	8.62 ± 0.07	8.80 ± 0.62	0.081
Total Bas	38.07	24.71	

Data are calculated as mean ± (SD) standard deviation; (n=3). Farm 1: Irrigated from El-Batts drain. Farm 2: Irrigated from El-Wadi drain. w.w.: On wet weight basis. L.S.D 5%: Least significant difference at $P \leq 0.05$

3.1.3. Microbial aspects of raw tilapia fish

The activity of microorganisms is the most important factor limiting the shelf life of fish and fish products. To assess the microbial quality and safety of fresh tilapia fish obtained from farms A and B; the samples were examined for the total bacterial count (TBC), total coliform count (TCBC) as well as yeasts and molds (Y&M) count and the results obtained are given in Table (2), the results indicated that TBC, TCBC and Y&M counts were 3.64, 2.71 and 2.15 $\log_{10}$cfu/g of fresh tilapia flesh

obtained from farms A, while the values were 3.52, 2.30 and 1.88 log_{10}cfu/g of obtained from farms B. The low number of TBC, TCBC and Y&M counts was indicator to the safety of fresh tilapia fish flesh obtained from two farms (A and B).

The TBC, TCBC and Y&M counts in this work are within the permissible limits which not exceeding than 10^6 cell/ g fresh flesh as reported by EOS (1990).

The same trend was found by Gennari *et al.* (1988, 1989) and Beltran *et al.* (1989) the bacterial counts of fresh sardine was 3.5×10^4cfu/g flesh. Also, EL-Sherif *et al.* (2011) found that the TBC of tilapia fish was 2.35 (log cfu / g).

It has been found in the present studies that the TBC within the permissible limit of 6 log cfu/g (ICMSF, 1986). Although there are significant differences ($P\leq 0.05$) were noticed between two fish samples A and B.

Table (3): Microbiological aspects of raw tilapia fish fillets obtained from farms A and B (Log_{10} cfu/g)

Microbiological aspects	Farm A	Farm B	L.S.D at 5%
TBC	3.64 ± 0.21	3.52 ± 0.15	0.021
TCBC	2.71 ± 0.08	2.30 ± 0.20	0.008
Y&M	2.15 ± 0.19	1.88 ± 0.09	0.105

Data are calculated as mean ± (SD) Standard deviation; (n=3). TBC: Total bacterial count. TCBC: Total coliform bacteria count. Y&M: Yeast and mould. cfu: colony forming unit. L.S.D 5%: Least significant difference at $P \leq 0.05$.

3.1.4. Effect of frozen storage on chemical composition of tilapia fish fillets

Moisture content

Data presented in Table (4) shows the effect of frozen storage at -18°C for 180 days of tilapia fish samples obtained from farms irrigated by Al-Batts Drain, A and El-Wadi Drain, B on the moisture content. It could be noticed that the moisture content of fresh tilapia decreased after frozen storage from 79.11 % to 76.65 % for samples and from 77.24 % to 75.00 % for samples B, respectively.

Table (4): Effect of frozen storage (-18°C for 180 days) on moisture content of tilapia fish fillets

Storage period (Days)	Moisture (%)		
	Farm A	Farm B	L.S.D at 5%
0	79.11 ± 0.29	77.24 ± 0.36	1.310
30	79.00 ± 0.88	77.05 ± 1.08	0.950
60	78.88 ± 2.04	76.60 ± 0.55	1.008
90	78.64 ± 1.00	76.28 ± 2.02	1.120
120	77.96 ± 0.68	76.00 ± 0.40	0.280
150	77.30 ± 0.09	75.35 ± 0.09	0.880
180	76.65 ±1.02	75.00 ± 1.12	0.098
***L.S.D at 5%**	0.080	0.261	

Data are calculated as mean ± (SD) standard deviation; (n=3). Farm B: Irrigated by El-Batts drain. Farm B: Irrigated by El-Wadi drain. *L.S.D 5%: Least significant difference at $P \leq 0.05$

Protein content

The changes in protein content during frozen storage at -18°C for 180 days of tilapia fillets samples obtained from farms A and B are illustrated in Table (5). Protein contents of fresh tilapia fish was 16.50 and 18.30% for farms A and B respectively. The same trend was obtained by Ibrahim and El-Sherif (2016); they found that the protein content of three fish species, mullet, tilapia and silver carp were 18.35, 18.15 and 17.85% respectively. After 60 days of frozen storage the protein content decreased to 16.40% in farm A frozen sample, Also, it decreased to 18.06% in farm B frozen samples.

Arannilewa *et al.* (2005) reported that protein content of fresh Nile tilapia (*Sarotherodun galiaenus*) was 60.65% (dry wt.) and decrease to 57.7 and 43.7% after A and Bmonths of frozen storage, respectively. After 120 days of frozen storage, protein content slightly decreased to 16.02 and 17.44% for samples from farm A and B, respectively. At the end of frozen storage (180 days), protein content decreased to 15.25 and 16.50% for samples from farm A and B, respectively. The previous outcomes were consistent with previous studies by Badii and Howell, (2002); Siddique *et al.*, (2011); Jenkelunas, (2013).

Table (5): Effect of frozen storage (-18°C for 180 days) on protein content of tilapia fish fillets (ww)

Storage period (Days)	Protein (%)		
	Farm A	Farm B	L.S.D at 5%
0	16.50 ± 0.30	18.30 ± 0.26	1.008
30	16.50 ± 1.10	18.22 ± 0.33	1.100
60	16.40 ± 0.82	18.06 ± 0.57	0.840
90	16.25 ± 0.09	17.72 ± 0.18	0.099
120	16.02 ± 1.05	17.44 ± 0.88	1.006
150	15.85 ± 0.85	16.96 ± 1.03	0.188
180	15.25 ± 1.00	16.50 ± 0.90	0.560
L.S.D at 5%	0.181	0.170	

Data are calculated as mean ± (SD) standard deviation; (n=3). Farm A: Irrigated by El-*Batts drain. Farm B: Irrigated by El-Wadi drain. w.w.: On wet weight basis. L.S.D 5%: Least significant difference at P ≤ 0.05*

Lipid content

Data presented in Table (6) show the effect of frozen storage at -18°C for 180 days on the lipid content of tilapia fish samples obtained from farms A and B. Lipid contents of fresh tilapia fish were 2.87 and 3.12% for samples A and B, respectively. According to Ackman (1989), fish can be grouped into four categories according to their fat content: lean fish (< 2 %), low fat (2 to 4 %), medium fat (4 to 8%), and high fat (> 8%). According to this classification the tilapia fish used in this work is considered lean fish (< 2% fat).

Our results agreed with Khidhir *et al.* (2013) who reported that the values of fat content of Rainbow trout and Tilapia muscles ranged between 1.05- 1.29 %, they also showed that the fat content means values were 1.66; 1.04; 2.00 and 1.523% for Myanmar, Flander, Hasoon and White fish, respectively.

After 60 days of frozen storage the lipid content decreased to 2.72 and 3.02% for samples A and B, respectively. After 120 days of frozen storage, the lipid content decreased to 2.28 and 2.62% for samples from farms A and B, respectively. At the end of frozen storage, the lipid content decreased to 1.80 and 2.17% for samples from farms A and B, respectively.

Table (6): Effect of frozen storage (-18°C for 180 days) on lipid content of tilapia fish fillets (ww).

Storage period (Days)	Fat (%)		
	Farm A	Farm B	L.S.D at 5%
0	2.87 ± 0.21	3.12 ± 0.09	0.511
30	2.80 ± 0.08	3.10 ± 0.05	0.320
60	2.72 ± 0.00	3.02 ± 0.22	0.007
90	2.50 ± 0.22	2.87 ± 0.10	0.150
120	2.28 ± 0.11	2.62 ± 0.17	0.205
150	2.04 ± 0.21	2.40 ± 0.09	0.009
180	1.80 ± 0.05	2.17 ± 0.25	0.131
L.S.D at 5%	0.120	0.171	

Data are calculated as mean ± (SD) standard deviation; (n=3). Farm A: Irrigated by El-Batts drain. Farm B: Irrigated by El-Wadi drain. w.w.: On wet weight basis. L.S.D 5%: Least significant difference at *P ≤ 0.05*

Ash content

Table (7) shows the values of ash contents of fish samples A and B during frozen storage of tilapia at -18°C for 180 days. From the table, the ash content of fresh tilapia A and B farms were 1.46 and 1.25%, respectively. After 60 days the values of ash slightly increased in both samples from farms A and B which recorded 1.93 and 2.21%, respectively.

The same trend was found by Gandotra *et al.*, (2012) who reported that the ash content decreased during freezing of fish from 1.7% to 1.3%. Arannilewa *et al.*, (2005) observed that the ash content remained almost the same throughout the 60 days of frozen storage of tilapia.

Ash content increased after 120 days in frozen samples from the two farms A and B. the values were 3.53 and 3.61 % respectively. At the end of storage, the values of ash content increased in frozen samples to 5.52 and 5.43 % for samples A and B, respectively. Our results agree with Emire *et al.*, (2009) who reported that the ash content of tilapia, (*Oreochromis niloticus*) decreased during its frozen storage. The decrease in ash content was attributed to the drip loss during thawing process by (Beklevik *et al.*, 2005).

Table (7): Effect of frozen storage (-18°C for 180 days) on ash content of tilapia fish fillets obtained from farms A and B (ww)

Storage period (Days)	Ash (%)		
	Farm A	Farm B	L.S.D at 5%
0	1.46 ± 0.08	1.25 ± 0.10	0.280
30	1.64 ± 0.11	1.53 ± 0.08	0.004
60	1.93 ± 0.20	2.21 ± 0.22	0.106
90	2.46 ± 0.04	2.99 ± 0.06	0.230
120	3.53 ± 0.42	3.61 ± 0.15	0.003
150	4.39 ± 0.37	4.71 ± 0.19	0.006
180	5.52 ± 0.09	5.43 ± 0.11	0.001
L.S.D at 5%	0.055	0.208	

Data are calculated as mean ± (SD) standard deviation; (n=3). Farm A: Irrigated by El-Batts drain. Farm B: Irrigated by El-Wadi drain. w.w.: On wet weight basis. L.S.D 5%: Least significant difference at $P \leq 0.05$

Total carbohydrates contents

Table (8) shows the values of the carbohydrates content of fish samples A and B during frozen storage of tilapia at -18°C for 180 days. From these data the carbohydrates content of fresh tilapia from farms A and B were 0.06 and 0.09%, respectively. At the end of storage the values of the carbohydrates content increased in frozen samples to 0.78 and 0.90 % for samples from farms A and B, respectively.

Table (8): Effect of frozen storage (-18°C for 180 days) on carbohydrates content of tilapia fish fillets obtained from farms A and B (ww)

Storage period (Days)	Carbohydrates (%)		
	Farm A	Farm B	L.S.D at 5%
0	0.06 ± 0.07	0.09 ± 0.02	0.004
30	0.06 ± 0.01	0.10 ± 0.00	0.008
60	0.07 ± 0.00	0.11 ± 0.01	0.015
90	0.15 ± 0.03	0.14 ± 0.10	0.005
120	0.21 ± 0.11	0.30 ± 0.11	0.008
150	0.42 ± 0.02	0.68 ± 0.09	0.106
180	0.78 ± 0.12	0.90 ± 0.05	0.111
L.S.D at 5%	0.012	0.010	

Data are calculated as mean ± (SD) standard deviation; (n=3). Farm A: Irrigated by El-Batts drain. Farm B: Irrigated by El-Wadi drain. w.w.: On wet weight basis. L.S.D 5%: Least significant difference at $P \leq 0.05$

CONCLUSION

Based on the results obtained, quality indices proved that tilapia fish samples had high freshness. Besides, the chemical composition of tilapia fish fillets obtained from two farms irrigated by two different drains (A and B) were slightly decreased in moisture, protein and fat content while ash content increased slight during freezing storage at -18 for 180 days.

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