JOURNAL OF THE
ARABIAN AQUACULTURE SOCIETY
Vol. 9 No 1 Arabian Aquaculture Conference May 2014

Comparative Study on Spoilage Markers and Chemical Composition of Farmed and Wild *Oreochromis niloticus*

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ABSTRACT

Comparative study was carried out for evaluation of spoilage markers and nutrient composition of wild and farmed *Oreochromis niloticus* to guide consumers during selection between wild and farmed fish at markets. A total of one hundred samples of fresh water *Oreochromis. Niloticus* of the same length and body weight were collected from Tolombat-7 which represent farmed samples and Desuk-fish market at Kafr El-Sheikh Governorate which represent Wild fish (50-fish from each source) The obtained results indicated that the freshness and chemical compositional parameters of wild fish were significantly differed than that of farmed fish as the levels of pH, Total Volatile Nitrogen (TVN) and histamine in the examined samples of wild fish were higher than those of farmed ones. On contrast, the thiobarbituric acid (TBA) values of farmed fish were higher than that in wild fish. The chemical analysis of such examined samples showed that the highest percentages of moisture, fat and ash were recorded in the examined samples of farmed fish; however, the wild *O. niloticus* contained the highest content of protein. On the other hand, the significance of estimation of these chemical parameters for evaluation of fish quality was discussed.

Keywords: Nile Tilapia - Spoilage Markers - Chemical Composition

INTRODUCTION

Aquaculture is the main source of fish production in Egypt, it contributes about 61% of the total production (G.A.F.R.d, 2006). One of the main targets of the Egyptian government is to compensate the shortage in meat production by increasing fish production.

Tilapia have many attributes that make them an ideal candidate for promoting aquaculture and provide sustainable development in Egypt these include: fast growth, tolerance to a wide range of environmental conditions, resistance to stress and diseases, ability to reproduce in captivity, feeding on low trophic levels and good sensorial proprieties of flesh (Boari et al., 2008 and Dergal et al., 2013).

Farmed fish is offered with nutrient rich foods couple with the natural productivity in the pond unlike the wild fish that has to depend completely on natural food production for its sustenance. These

differences have direct effects on body composition, health status as well as growth of fish. The feeding habits and type of food availability is a true reflector of fish body composition **(Ashraf et al, 2011).**

The term"quality" refers to the aesthetic appearance and freshness or degree of spoilage which the fish has undergone. It may also involve safety aspects such as being free from harmful bacteria, parasites or chemicals. It is important to remember that "quality" implies different things to different people and is a term which must be defined in association with an individual product type. For example, it is often thought that the best quality is found in fish which are consumed within the first few hours post mortem. However, very fresh fish which are in rigor mortis are difficult to fillet and skin and are often unsuitable for smoking. Thus, for the processor, slightly older fish which have passed through the rigor process are more desirable. Environmental conditions may affect the growth and multiplication of various kinds of micro-organisms, particularly in fish which may be contaminated with such organisms through the aquatic environment **(Yousef et al., 1985 and FAO, 2012).**

The majority of data from literature which compare quality of wild and farmed fish deals with chemical composition, nutritional value and other physical-chemical parameters **(Alasalvar *et al.*, 2002; Grigorakis *et al.*, 2003 and Grigorakis, 2007).**

The fish flesh, which is the main edible part, is generally sterile immediately after catching, however, it may become contaminated with different micro-organisms during subsequent handling as these micro-organisms can penetrate from skin and gut to the flesh **(Brock et al., 1984 and Etzel et al., 1998).** Generally fish may be subjected to contamination from various sources either during their presence in aquatic environment or after being harvested for marketing **(Heba et al., 2013)**

Hudson and Roberts (1984) provided some evidence that meat of alkaline pH become bacteriologically spoiled more rapidly than meats of acidic pH. The ultimate pH of fish flesh after death is related to amount of glycogen available at death. The more glycogen present, the lower the PH. The less in the muscular activity before death lead to higher the level of glycogen, the lower the ultimate pH. However, the pH of fish flesh has an important influence on its keeping quality not only because of its effect on rigor mortis but also because of its influence on growth of bacteria. The lower pH of the fish flesh leading to lowering in bacterial decomposition. Moreover the pH of flesh is of great importance in food technology, where it is the important factor controlling texture of cooked flesh (**Frazier and Westhoff, 1988, Hall, 1992 and Scott et al., 2005).**

The total volatile bases include ammonia, trimethylamine as well as small amounts of dimethylamine and methylamine. Ammonia is produced by bacteria as well as tissue enzymes. In shellfish, the increase in ammonia and TVN begins sooner than in fish. A significant increase of TVB in some reports indicated that Total Volatile basic nitrogen increased rapidly along with the time extension, indicating that the deterioration of fish and pork was an

acceleration process, and the deterioration speed of fish was faster than that of pork (**Yao et al., 2009 and Noseda et al., 2010**).

Fish lipids are characterized by their high content of polyunsaturated fatty acids (PUFA). However, these lipids are very susceptible to oxidation reactions (**Ozogul et al., 2011**). These reactions lead to the formation of primary products such as hydroperoxides, which are very unstable compounds quickly transformed into secondary products such as toxic aldehydes (**Rezaei and Hosseini, 2008**), measurable as thiobarbituric acid-reactive substances (TBARS) (**Yarnpakdee et al., 2012**).

As consumers awareness increased there is a need to access the quality, enhance safety and nutritional value in fish and in particular cultured fish in line with international requirements. Therefore, this work was performed to compare freshness and proximate compositions among the farmed and wild *Oreochromis niloticus* fish and provide information to guide consumers during selection between them under Egyptian conditions at Kafr El-Sheikh Governorate.

MATERIALS AND METHODS

1. Collection of samples

A total number of 100 samples of *O. niloticus* , 50 each from farmed and wild fish (same size of about 100 – 120 grams were cought with same manner at same time), were collected. The farmed fish were obtained from fish farms (Private farms) while the wild counterparts were obtained from fishermen at Desuk- Market at Kafr El-Sheikh Governorate. The samples were placed separately in clean sterile plastic bags and transferred in an insulted ice box to the laboratory under complete aseptic conditions without any delay. All collected samples were subjected to the following examinations .

2. Tests of spoilage markers

2.1. Determination of pH (Pearson, 1984)

In a blender, 10g of each sample were blended in 10 ml of distilled water. The homogenate was left at room temperature for 10 min. with continuous shaking. The pH value was determined by using an digitall pH meter (Bye model 6020, USA).

2.2. Determination of Total Volatile Nitrogen (TVN)

The technique applied for determination of total volatile nitrogen (TVN) was recommended by **Food and Agriculture Organization "FAO" (1980)** as follows:

$$\mathrm{TVN/l00g} = 26.88 \times (2 - \mathrm{T2})\ \mathrm{mg}$$

Where, T_2 = volume of NaOH consumed in the titration.

2.3. Determination of Thiobarbituric acid number (TBA)

The method adopted for estimation of TBA by Vyncke (1970) was applied.

$$\text{Concentration of malonaldehyde} = \frac{0.016 + 2.872\,\mathrm{X\ mg\ \%}}{10}$$

Where, X = the absorbance.

2.4. Determination of histamine

The estimated biogenic levels were histamine by using HPLC according to Moret and Conte (1996).

The concentration of histamine in the samples was recorded as mg/100 g according to the following formula:

$$\text{Amine concentration (mg/100 g)} = CV/W$$

Where,

C: Concentration of amine standard (mg / g)
V: Final dilution of sample extracts (ml)
W: Weight of the sample in the final extracts (g)

3. Determination of chemical composition of fish (AOAC, 2000)

3.1. Determination of moisture %

A dish was dried in an oven and cooled in the desiccator. Approximately 2 g of sample were weighed into the dish and dried in the oven at 102°C with the lid alongside for 2 hours. The dish was covered with the lid, and transferred to the desiccator and when the dish completely cooled, it was weighed, then heated in the oven half-an-hour and re- weighed. Repeat until successive weights do not differ.

$$\text{Moisture \%} = \frac{\text{Weight lost} \times 100}{\text{Weight of sample}}$$

3.2. Determination of protein %

It was applied by estimation of nitrogen content in the examined sample.

Crude protein = nitrogen × 6.25

3.3. Determination of fat %

A weighed sample was dried at 60 °C for 72 hours. The dried sample was exactly weighed and wrapped carefully in a filter paper. Such prepared sample was used in determination of fat % by weighing the sample after drying several times to record the loss of weight and calculate fat %.

3.4. Determination of ash percentage:

The ash percentage was determined according the following equation:

Ash % = difference between crucible with ash and empty crucible.

4. Statistical analysis

Statistical analysis of the obtained data was made using (t-test) for detecting the significance differences of the freshness and chemical composition parameters among wild and farmed O. niloticus according to (SAS, 2004).

RESULTS

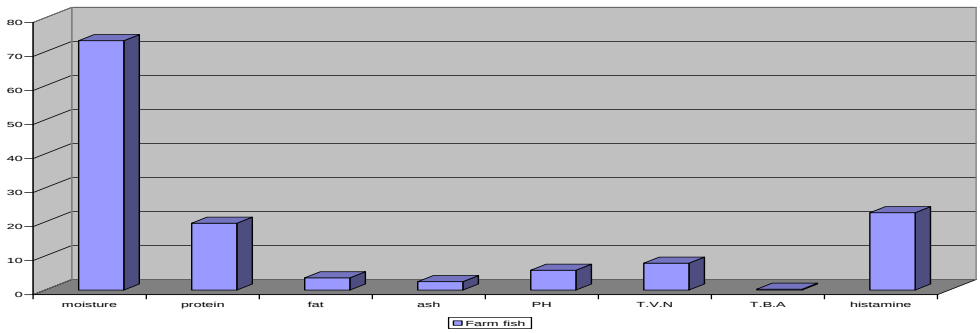
1. Spoilage markers parameters among farmed and wild fish

Results presented in Table (1) and Fig. (1) showed the spoilage markers parameters in farmed *O. niloticus* where pH values ranged from 5.67 to 6.02 with a mean value of **5.84±0.02**; the TVN ranged from 3.71 to 12.07mg/100g with a mean value of **7.92±0.49**; TBA value ranged from 0.12 to 0.47mg/kg with a mean value of **0.26±0.01** and the level of histamine ranged from 3.6 to 57.1 mg/100g with a mean value of **22.7±3.03**.

While, Table (2) and Fig. (2) revealed that the minimum value of pH was 5.77and 6.15 as a maximum with a mean value of **5.92±0.23,** TVN ranged from 6.16 as a minimum to 17.51 as a maximum with a mean value of **10.39±0.05,** while the mean value of T.B.A was **0.22±0.02** and minimum ranged from 0.09 to 0.36 mg/kg and the histamine level ranged from 5.1 to 79.2 with a mean level of **27.89±4.04** spoilage markers parameters in wild *O. niloticus.*

Table (1): ***Statistical analytical results of spoilage markers and chemical composition of farmed Oreochromis niloticus fish (n= 50).***

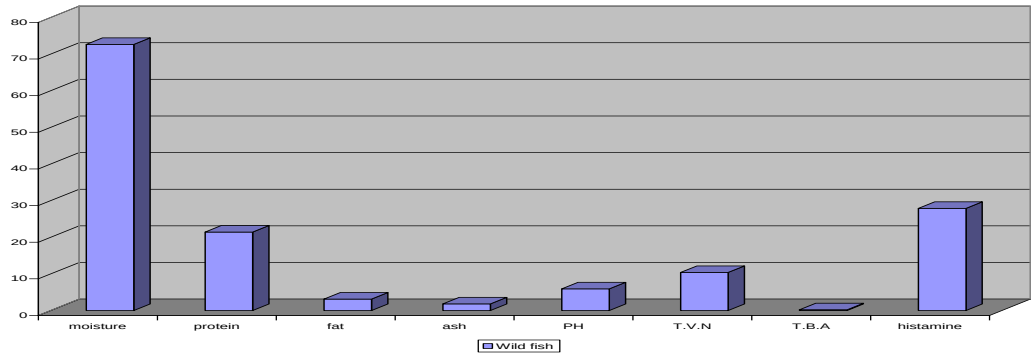
Parameters	Min.	Max.	Max.	Mean ± S
pH	**5.67**	**6.02**		**5.84±0.02**
TVN	**3.71**	**12.07**		**7.92±0.49**
TBA	**0.12**	**0.47**		**0.26±0.01**
Histamine	**3.6**	**57.10**		**22.7±3.03**
Moisture	**71.4**	**75.20**		**73.29±0.22**
Protein	**17.8**	**21.90**		**19.66±0.23**
Fat	**2.7**	**5.60**		**3.61±0.16**
Ash	**1.50**	**4.30**		**2.48±0.14**



Fig(1): ***Mean values for chemical composition and spoilage markers of farm fish***

Table (2): ***Statistical analytical results of spoilage markers and chemical composition of wild Oreochromis niloticus fish (n= 50).***

Parameters	Min.	Max.	Max. Mean ± SE
pH	**5.77**	**6.15**	**5.92±0.23**
TVN	**6.16**	**17.51**	**10.39±0.05**
TBA	**0.09**	**0.36**	**0.22±0.016**
Histamine	**5.1**	**79.2**	**27.89±4.04**
Moisture	**70.6**	**74.3**	**72.6±0.20**
Protein	**19.4**	**23.6**	**21.4±0.25**
Fat	**2.3**	**4.8**	**3.14±0.123**
Ash	**1.1**	**3.2**	**1.81±0.117**



Fig(2): Mean values for chemical composition and spoilage markers of wild fish

2. Chemical composition among farm and wild fish

The results of chemical examination presented in Table (1) and Fig. (1) of farmed *O. niloticus* cleared that the moisture % ranged from 71.4 to 75.20 with a mean value of 73.29 ± 0.22, protein% ranged from 17.20 to 21.90 % with a mean value 19.66 ±0.23, fat % ranged from 2.7 to 5.60 with mean value 3.61± 0.16 and ash % ranged from 1.50 to 4.30 % with mean value of 2.48 ± 0.14.

From Table (2), Fig. (2), the results of chemical examination of wild *O. niloticus* cleared that, the moisture % ranged from 70.6 to 74.3 with a mean value of 72.6±0.20, protein percent ranged from 19.4 to 23.6 % with a mean value 21.4±0.246, fat % ranged from 2.3 to 4.8 with average value 3.14±0.123 and ash % ranged from 1.1 to 3.2 % with average value of 1.81±0.117.

DISCUSSION

Comparison between farmed and wild Oreochromis niloticus in spoilage markers

The spoilage markers parameters which were illustrated in Table (3) and Fig.(3) as pH value, TVN and Histamine levels were higher in wild *O. niloticus* than that of farmed *O. niloticus*, but, the TBA value was higher than that of wild fish

In addition, farmed specimens had a higher degree of muscle post-mortem degradation. pH is related to the post-mortem evolution of the flesh and is influenced by the species, feeding, station of the year, etc. **(Linden and Lorent, 1996).**

TVN is used as a criterion for the freshness of fish raw material **(Haaland and Njaa, 1987).** Its amount increases with time of storage in the unfrozen state. Levels not more than 20 mg TVN per 100 g fish mass are regarded by the industry as limits for a good quality fish meal for instance and its increasing of the market samples reflected their poor quality and unhygienic market cnnditions Azza and El-shahat (2011).

Histamine, for instance, is formed during the bacterial degradation of Histidine, which is an essential amino acid in fish nutrition. Contamination with histamine can cause food poisoning and allergic reactions **(Dr. Christian and Dr. Kai)**. Histamine is highly resistant to heat and it is not destroyed even if fish are cooked or canned **(Huss, 1994)**. A level less than 5mg/100g (50ppm) is safe for consumption. Maximum levels of histamine have set at 10-20mg/100g in many countries. Levels above 50mg/100g is a hazard action level, unsafe for consumption. T.B.A value is a widely used as fish quality indicator and for oxidative rancidity. The high content of PUFAs in fish increases the rate of oxidation, since the increased double bonds accelerates oxidation. Lipid oxidation is one of the main factors limiting the quality and acceptability of meats and other muscle foods). Rancidity appears in fish when TBA become greater than 1-2 mg malonaldehyde/kg **(Zaid et al., 2013).** ,

The current results come in accordance with those obtained by **Ammar (2001**) who reported that pH, TVN and histamine in wild fish higher than that of fresh fish, while, the TBA level in farmed fish higher than that of wild fish.

Comparison between farmed and wild Oreochromis niloticus in chemical composition

The proximate chemical composition parameters presented in Table (4) and Fig (3) revealed that the mean value of moisture, fat and ash percentages of the farmed fish had a higher level than that of wild *O. niloticus* fish ,fat content is related with moisture .This results may be attributed to the farmed fish fed on a ration contain a high level of fat and ash and the farmed fish take a long period of culturing till marketing that causes increasing body weight of the fish than wild fish with increasing moisture and fat content of farmed fish than the wild fish.

Our results were nearly similar with those of **Muchiri and Nanua (2006)** who reported that nutritional composition of farmed Nile tilapia does not significantly vary from the wild catch fish except for the lipid content **Also Alasalvar et al. (2002)**

and **Orban et al. (2002).** They described that farmed fish show higher fat and lower moisture than wild specimens, , whereas protein remain unchanged, due to high dietary fat level in the feed and a reduced activity Farmed fish generally have a softer texture than wild fish and this could be attributed to factors like lipid content and amount of exercise **((Haard, 1992a).** The highest value recorded in protein contents of wild fish agreed with the findings of **Ashraf et al. (2011).**

The variations in the chemical composition of fish are closely related to the environment of rearing in ponds or nature and completely depend on feed intake. During periods of heavy feeding, at first the protein content of the muscle tissue will decrease very slightly and then the lipid content will show a marked and rapid increase. Fish will have starvation periods for natural and physiological reasons (**Sulieman and James (2011).** Farmed seafood have an advantage over wild caught fishery products since they are produced and harvested under controlled conditions, and for this reason the hazards associated with fish consumption might be reduced. Fish farming has registered a worldwide rapid expansion in the recent decades **(FAO, 1998).**

Table (3): ***Comparison of spoilage markers (Mean ± se) among farmed and wild Oreochromis niloticus fish (n= 50).***

Parameters	Farmed fish	Wild fish	T
pH	**5.84±0.018**	**5.92±0.229**sig**	**2.857 0.006**
TVN	**7.92±0.49**	**10.39±0.05**sig**	**3.35 0.0015**
TBA	**0.26±0.01**	**0.22±0.016 NS**	**1.6 0.11**
Histamine	**22.7±3.03**	**27.89±4.04 NS**	**1.01 0 .31**

**** = Significant at (P < 0.05) ** = Significant at (P < 0.01). *** = Significant at (P < 0.001). NS = Non- significant (P = 0.05).***

Table (4): ***Comparison of parameters of chemical composition (Mean ± se) among farmed and wild Oreochromis niloticus fish (n= 50).***

Parameters	Farmed fish	Wild fish	T
Moisture	**73.٢٩±0.٢١٦**	**72.6±0.2***	**2.3 0.02**
Protein	**19.٦٦±0.٢3**	**21.4±0.246 NS**	**5.33 2.59**
Fat	**3.٦1±0.16**	**3.14±0.123 NS**	**11.5 2.14**
Ash	**2.48±0.14**	**1.81±0.117*****	**3.72 0.0005**

**** = Significant at (P < 0.05) ** = Significant at (P < 0.01). *** = Significant at (P < 0.001). NS = Non- significant (P = 0.05).***

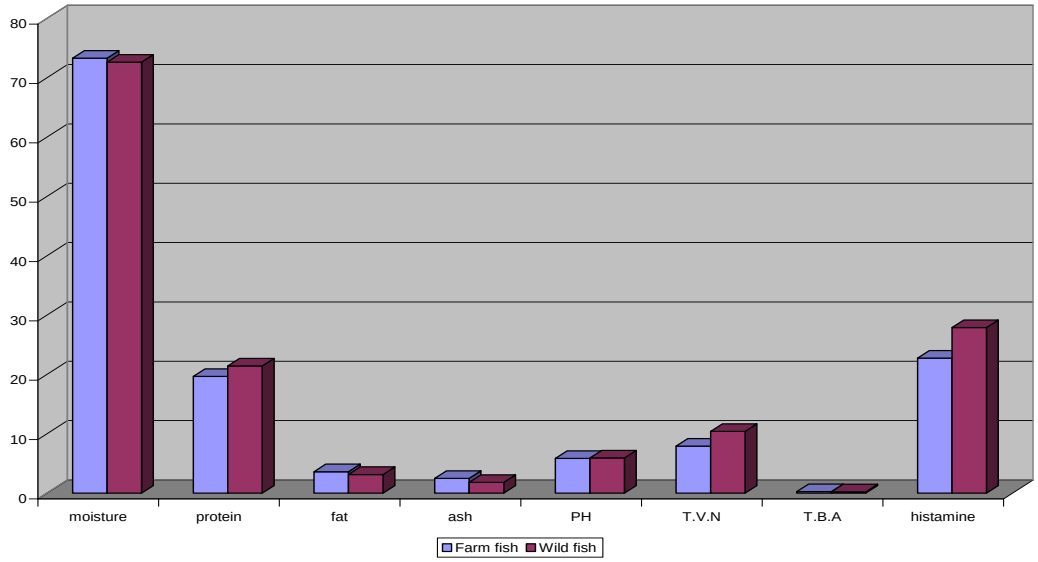


Fig (3): ***Comparison between results of farmed fish and wild fish for chemical composition and freshness.***

CONCLUSION

In conclusion to reduce spoilage markers

Starvation before harvesting is recommended, Prevent exhaustion, avoid contamination, Chilling immediately after harvesting and during marketing strict temperature control and storage at refrigeration is required

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دراسه مقارنه عن علامات التلف والتركيب الكيميائئ بين الخصائص الكيميائية لأسماك البلطى المستزرعة والبرية

جمال باز محمد باز هناء فتحى فرج سلامه سلوى هنداوى الفقى أميمه عبد الفتاح أحمد صالح

معهد بحوث صحة الحيوان فرع كفرالشيخ

معهد بحوث صحة الحيوان فرع دمنهور

قسم الرقابه الصحيه على الاغذيه

أجريت هذه الدراسة لدراسة خصائص الطزاجه و الخصائص الكيميائية لأسماك البلطى النيلى المستزرعة والبرية . حيث تم أجراء هذه الدراسة على عدد ١٠٠ سمكة (٥٠ سمكة) بلطى نيلى مجمعة من طلمبات – ٧ و ٥٠ سمكة بلطى نيلى تم تجميعها من سوق الاسماك بمدينة دسوق – بمحافظة كفر الشيخ و تم وضع العينات فى أكياس بلاستيكية معقمة وتم إرسالها مباشرة الى معمل قسم صحة الاغذية بكلية الطب البيطرى – بمشتهر – جامعة بنها ليتم تحليلها وقياس اختبارات النضارة و التى تشمل معدل الاس الهيدروجينى ، و مستوى اجمالى النيتروجينات الطيارة(TVN) ، حمض الثيوباربتيريك (TBA) ، و الهيستامين كما تم دراسة بعض الخصائص الكيميائة للحوم البلطى النيلى و هى مستوى الرطوبة ، البروتين و نسبة الدهون و نسبة الاملاح وقد اوضحت الدراسه أن مستوى الاس الهيدروجينى ، و النيتروجينات الطيارة و الهيستامين اعلى فى الاسماك البرية عنه فى الاسماك المستزرعة بينما مستوى حمض الثيوباربتيوريك فى البلطى المستزرع اعلى من الاسماك البرية مستوى الرطوبة و نسبة الدهون و نسبة الاملاح فى الاسماك المستزرعة اعلى من الاسماك البرية بينما كانت نسبة البروتين فى الاسماك البرية اعلى من الاسماك المستزرعة.

هذا وقد تم مناقشة الاهميه الصحيه لهذه المتغيرات وعلاقتها بالصحه العامه