

## Quality assessment of *Tilapia nilotica* and *Mugil cephalus* fish from Egypt.

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### Abstract

A total of 160 random samples of *Tilapia nilotica* (TN) and *Mugil cephalus* (MC) fish collected from eight fish farms and natural water channels in Kafrelsheikh Governorate, Egypt during twelve months. All fish samples were evaluated microbiologically for aerobic plate count, psychrotrophic count, staphylococci count and mould count and for moisture, protein, fat and ash content. The microbiological examination of natural and farm TN and MC fish revealed that 12.5% and 27.5% of natural TN and MC fish respectively exceeded the Egyptian Standard (2005) for APC while 17.5% and 35% of Farm TN and MC respectively exceeded the Egyptian Standard (2005) for APC. The natural channels TN and MC fish samples showed average Psychrophilic counts of  $1.55 \times 10^4$  and  $1.71 \times 10^4$  CFU respectively while farm TN and MC fish showed higher average counts of  $2.69 \times 10^4$  and  $2.85 \times 10^4$  CFU respectively. 60% and 75% of natural channels TN and MC respectively contained staphylococci, of them 70.8% of TN and 66.7% of MC had coagulase positive *staphylococcus aureus*. 72.5% and 80% of farm TN and MC fish had *staphylococci*, of them 79.3% and 81.3% respectively contained coagulase positive *staphylococcus aureus*. Farm fish samples showed higher incidence and count for mold than natural fish samples. All examined fish samples showed moisture percent in the range between 71.2 and 74.1 and the protein value ranged from 17.9 and 20.05%. The *Tilapia nilotica* fish showed lower fat content than *Mugil cephalus* fish samples.

**Keywords:** *Tilapia nilotica*, *Mugil cephalus*, Natural channels fish, Farm fish, Microbial quality, Chemical quality.

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### Introduction

Fish are important healthy food, as it is a rich source of therapeutically important polyunsaturated fatty acids, easily digestible proteins, vitamins, and various other micro nutrients [1]. The quality of fish is a very difficult concept to explain due to different varieties of factors that must be considered as population, fish species, spawning period, nutrition, post-harvest handling, and storage [2].

Natural and farmed fish are varied in their nutrients contents, sensorial, microbiological and chemical properties [3]. In the course of everyday work, almost everyone involved in the fish industry from the fisherman, fish farmer to the retailers come across sensory assessment of fish. Consumers in shops, eating places and homes also use sensory assessment when forming judgements about fish quality. Sensory assessment is, therefore, a widespread and important activity [4].

Microbiological assessment of fish by using Aerobic bacterial count, incidence of Psychrophilic bacteria, *Staphylococcus aureus*, *Enterobacteriaceae* and Moulds evaluates the quality and shelf life of fish [5].

Proximate composition of fish involves the determination of moisture, lipid, protein and ash content. The proximate composition of fish is affected by a diversity of factors such as: size, sexual maturation, temperature, salinity, exercise, ration, time and feeding frequency, starvation, type and amount of dietary ingredients [4].

Therefore, the present study was planned to assess the quality

of both natural and farmed *Tilapia nilotica* and *Mugil cephalus* through determination of organoleptic, microbiological and compositional characters.

### Materials and Methods

A total of 160 random samples of *Tilapia nilotica* and *Mugil cephalus* were collected from eight fish farms and natural water channels in Kafr El-Sheikh Governorate, Egypt. The collected samples were packed in a sterile polyethylene bags, sealed and cooled in an insulated box contained crushed ice, then immediately transferred to the laboratory for further examination. The fish samples were subjected to organoleptic, microbiological and chemical examinations.

#### Microbiological examinations

All fish samples were prepared, examined and identified microbiologically according APHA (2001).for:-

- Aerobic plat count,
- Psychrotrophic count,
- Staphylococci count,
- Coagulase positive staphylococci
- Mold count.

#### Chemical examination

- Determination of moisture content of fish samples by drying method (AOAC, 2000).

- Determination of protein content of fish sample by Kjeldahl's method (AOAC, 2000).
- Determination of fat content in fish samples using Soxhlet's method. (AOAC, 2000).
- Determination of ash content of the fish samples by ashing (AOAC, 2000).

## Results

The Microbiological examination of Aerobic count (cfu/g) of the examined fish samples :( n=40) is explained through Tables 1-8

**Aerobic plate counts (APC):** Results in Table 1 showed that the APC of the examined NT fish samples ranged from  $1.40 \times 10^4$  to  $4.49 \times 10^6$  with an average of  $1.71 \times 10^5 \pm 2.14 \times 10^4$  cfu/g. While NM fish samples showed counts from  $1.35 \times 10^4$  to  $6.15 \times 10^6$  with an average of  $3.14 \times 10^5 \pm 3.39 \times 10^4$  cfu/g. On the other hand the examined FT fish samples had count ranged from  $1.20 \times 10^4$  to  $8.17 \times 10^6$  with an average of  $3.73 \times 10^5 \pm 2.88 \times 10^4$  cfu/g. While FM fish samples showed counts ranged from  $1.25 \times 10^4$  to  $8.11 \times 10^6$  with an average of  $5.11 \times 10^5 \pm 3.04 \times 10^4$  cfu/g.

**Table 1. Aerobic count (cfu/g) of the examined fish samples :( n=40).**

Fish type	No. of positive samples		Minimum	Maximum	Mean $\pm$ S.E.M
	N	%			
Natural channels* TN	40	100	$1.40 \times 10^4$	$4.49 \times 10^6$	$1.71 \times 10^5 \pm 2.14 \times 10^4$ c
Farm** TN	40	100	$1.35 \times 10^4$	$6.15 \times 10^6$	$3.14 \times 10^5 \pm 3.39 \times 10^4$ b
Natural channels MC	40	100	$1.20 \times 10^4$	$8.17 \times 10^6$	$3.73 \times 10^5 \pm 2.88 \times 10^4$ b
Farm MC	40	100	$1.25 \times 10^4$	$8.11 \times 10^6$	$5.11 \times 10^5 \pm 3.04 \times 10^4$ a

Within the same column of different letters are significantly different at (P < 0.01).  
S.E.M = Standard error of mean.  
\* Fish caught from running water channels  
\*\* Fish caught from fish farms

**Table 2. Psychrotrophic count (cfu/g) of the examined fish samples (n=40).**

Fish type	No. of positive samples		Minimum	Maximum	Mean $\pm$ S.E.M
	N	%			
Natural channels* TN	36	90	$7.50 \times 10^3$	$5.41 \times 10^5$	$1.55 \times 10^4 \pm 1.31 \times 10^3$ b
Farm** TN	39	97.5	$1.25 \times 10^3$	$5.65 \times 10^5$	$2.69 \times 10^4 \pm 1.69 \times 10^3$ a
Natural channels MC	39	97.5	$6.55 \times 10^3$	$4.11 \times 10^5$	$1.71 \times 10^4 \pm 2.30 \times 10^3$ b
Farm MC	38	95	$7.50 \times 10^3$	$6.10 \times 10^5$	$2.85 \times 10^4 \pm 2.17 \times 10^3$ a

Means within the same column of different letters are significantly different at (P < 0.01).  
S.E.M: Standard Error of Mean.  
\*Fish caught from running water channels  
\*\*Fish caught from fish farms

**Table 3. Staphylococci count (cfu/g) of the examined fish samples-(n=40).**

Fish type	No. of positive samples		Minimum	Maximum	Mean $\pm$ S.E.M
	N	%			
Natural channels* TN	24	60	$0.73 \times 10^2$	$6.50 \times 10^3$	$1.41 \times 10^3 \pm 1.25 \times 10^2$ c
Farm** TN	29	72.5	$0.94 \times 10^2$	$7.82 \times 10^3$	$2.11 \times 10^3 \pm 1.28 \times 10^2$ b
Natural channels MC	30	75	$0.75 \times 10^2$	$4.63 \times 10^3$	$1.44 \times 10^3 \pm 1.87 \times 10^2$ c
Farm MC	32	80	$0.54 \times 10^2$	$8.14 \times 10^3$	$2.72 \times 10^3 \pm 1.38 \times 10^2$ a

Within the same column of different letters are significantly different at (P < 0.01).  
\* Fish caught from running water channels.  
\*\* Fish caught from fish farms.

**Table 4. Coagulase positive Staphylococci in the examined samples (n=115).**

Fish types	Natural TN		Farmed TN		Natural MC		Farmed MC	
	No.	%*	No.	%	No.	%	No.	%
Coagulase positive	17/24	70.83	23/29	79.31	20/30	66.67	26/32	81.25
Coagulase negative	7/24	29.17	6/29	20.69	10/30	33.33	6/32	18.75

\*The number of positive staphylococci samples for each fish type.

**Table 5. Mould count (cfu/g) of the examined fish samples-(n=160).**

Fish type	No. of positive samples		Minimum	Maximum	Mean $\pm$ S.E.M
	N	%			
Natural channels* TN	28	70	$4.70 \times 10$	$6.50 \times 10^3$	$2.05 \times 10^3 \pm 1.25 \times 10^2$ b
Farm** TN	33	82.5	$9.80 \times 10$	$9.82 \times 10^3$	$2.85 \times 10^3 \pm 1.28 \times 10^2$ a
Natural channels MC	25	62.5	$3.50 \times 10$	$4.85 \times 10^3$	$1.20 \times 10^3 \pm 1.87 \times 10^2$ c
Farm MC	27	67.5	$7.70 \times 10$	$6.14 \times 10^3$	$2.35 \times 10^3 \pm 1.38 \times 10^2$ b

Within the same column of different letters are significantly different at (P < 0.01).  
\*Fish caught from running water channels.  
\*\*Fish caught from fish farms.

**Table 6.** Moisture content of the examined fish samples :( n=40).

Fish types	Minimum	Maximum	Mean ± S.E.M
Natural channels* TN	72.2	76.2	74.14 ± 0.13 a
Farm** TN	70.9	75.4	72.91 ± 0.14 b
Natural channels MC	70.5	74.2	72.12 ± 0.14 c
Farm MC	69.5	73.3	71.20 ± 0.11 d

Within the same column of different letters are significantly different at (P < 0.01).

S.E.M: Standard Error of Mean.

\*Fish caughted from running water channels.

\*\*Fish caughted from fish farms.

**Table 7.** Protein content of examined fish samples: (n=40)

Fish type	Minimum	Maximum	Mean ± S.E.M
Natural channels* TN	16	21	18.51 ± 0.18 c
Farm** TN	16.2	19.3	17.91 ± 0.12 d
Natural channels MC	17.8	23.1	20.05 ± 0.20 a
Farm MC	16.3	22.8	18.9 ± 0.17 b

Within the same column of different letters are significantly different at (P < 0.01).

\*Fish caughted from running water channels.

\*\*Fish caughted from fish farms.

**Table 8.** Fat content of the examined fish samples: (n=40).

Fish type	Minimum	Maximum	Mean ± S.E.M
Natural channels* TN	1.5	3.8	2.20 ± 0.09 c
Farm** TN	1.8	4.1	2.98 ± 0.11 b
Natural channels MC	2.5	4.5	3.25 ± 0.11 b
Farm MC	3.2	5.8	4.9 ± 0.12 a

Means within the same column of different letters are significantly different at (P < 0.01).

\* Fish caughted from running water channels.

\*\* Fish caughted from fish farms.

**Table 9.** Ash content of the examined fish meat-(n=40).

Fish type	Minimum	Maximum	Mean ± S.E.M
Natural channels* TN	1.1	2.91	2.21 ± 0.10 A
Farm** TN	0.9	2.8	1.82 ± 0.6 B
Natural channels MC	1.3	3.1	2.15 ± 0.07 A
Farm MC	0.9	2.1	1.46 ± 0.09 C

Means within the same column of different letters are significantly different at (P < 0.01).

\* Fish caughted from running water channels.

\*\* Fish caughted from fish farms.

**Psychrotrophic counts (PC):** The results listed in Table 2 showed that the incidence percentage of psychrotrophic bacteria observed in natural channels TN, MC, and farm TN and MC fish were 90, 97.5, 97.5 and 95, respectively. The psychotropic count of the examined natural TN fish samples had an average of  $1.55 \times 10^4 + 1.31 \times 10^3$ , cfu/g while those of farm TN showed an average of  $1.69 \times 10^4 + 1.69 \times 10^3$  cfu/g. On the other hand natural channels MC and TN fish samples showed an average of  $2.1 \times 10^4 + 2.30 \times 10^3$  and  $2.85 \times 10^4 + 2.17 \times 10^3$  cfu/g, respectively.

**Staphylococci count:** *Staphylococci* in the examined fish samples were detected in 24, 29, 30 and 32 for natural channels TN and MC, and farm TN and MC with average percentages of 60%, 72.5, 75 and 80 %, respectively (Table 3). The *Staphylococci* showed average counts of  $1.41 \times 10^3 \pm 1.25 \times 10^2$ , cfu/g for natural channels TN while of  $2.11 \times 10^3 \pm 1.28 \times 10^2$  cfu/g for farm TN. Natural MC fish showed average count of  $1.44 \times 10^3 \pm 1.87 \times 10^2$  cfu/g and an average count of  $2.72 \times 10^3 \pm 1.38 \times 10^2$  cfu/g for farm MC fish samples.

**The coagulase positive staphylococcus:** The aureus showed incidence of 70.83%, 79.31%, 66.67% and 81.25% for Natural

channels TN, Farm TN, Natural channels MC and Farm MC fish respectively (Table 4).

**Mould count:** Moulds were detected in natural TN fish samples with an average count of  $2.05 \times 10^3 \pm 1.25 \times 10^2$  cfu/g and with an average of  $2.85 \times 10^3 \pm 1.28 \times 10^2$  cfu/g for farmed MC fish samples. On the other hand natural MC fish samples showed an average of  $1.2 \times 10^3 \pm 1.87 \times 10^2$  cfu/g and with an average count of  $2.35 \times 10^3 \pm 1.38 \times 10^2$  cfu/g for farmed MC fish samples (Table 5).

### Chemical examination

The results obtained show that natural channels fish samples had higher moisture content than that of the farmed fish samples and the *Tilapia nilotica* fish samples had higher moisture content than that of *Mugil cephalu* illustrated in Table 6.

The protein content of examined fish showed high levels of protein in natural channels MC, 20.0% followed by farm MC, 18.9, while lower protein percentages 18.51 and 17.91 were observed in natural channels TN, and farm TN respectively explained clearly from Table 7.

Farm MC and natural channels MC had fat levels of  $4.9 \pm 0.12$

and  $3.25 \pm 0.11$  respectively while lower levels  $2.98 \pm 0.11$  and  $2.2 \pm 0.09$  were detected in farm TN and natural channels TN fish respectively (Table 8).

The levels of ash differ significantly among different examined fish. Higher contents  $2.21 \pm 0.10$  and  $2.15 \pm 0.07$  were obtained in natural channels TN and MC respectively while lower ash levels  $1.82 \pm 0.6$  and  $1.46 \pm 0.09$ , were observed in farm TN and MC fish samples respectively which is also shown in Table 9.

## Discussion

### Microbiological examination

The need for bacteriological examination of fish flesh is to determine conformance to the fish meat specification (i.e., bacteriological criteria) often used. Testing for conformance to such criteria provides only limited prediction to consumer against food poisoning and/or foodborne diseases. This often in fact the reason for carrying-out the tests to provide assurance of fish meat

Mass production of fish and its rapid distribution pose a particular risk due to wide spread food borne outbreak infections with enteropathogens [6].

The muscle tissues and body fluids of healthy living fish are usually free from bacteria, but while catching, handling, transportation and processing, contamination may occur which leads to introduction of pathogens into the meat. The sources of these pathogens may be from the gastro-intestinal tract or from surrounding environment [7].

Many factors affect the microbiological characters of different seafood types like species differences, environment, methods of catching, on board, handling, fishing vessels, sanitation, processing, preservatives and packaging [8].

These results indicated that the APC in farm type fish had significantly higher counts than in natural channels type fish. This may be attributed to that fish farmers commonly use organic fertilizers as a way of increasing the fertility of pond and production of natural food for fish and use agriculture run off water that both factors may contribute in increasing the bacterial load of fish as per Ampofo and Clerk [9]. While the higher bacterial count of *Mugil cephalus* species may be also attributed to its omnivorous bottom feeder feeding habit where the fish greases the pond bottom detritus, organic matter and sediments, which are usually of high bacterial count [10,11].

Regarding the microbial limit set by the Egyptian Standers of 106 cfu/g. 5 and 11 fish samples of natural channels TN and MC fish samples respectively had higher APC than that recommended limit by Egyptian Standards [12]. Also, 7 and 14 fish samples of farm TN and MC fish samples respectively had count higher than allowable by Egyptian Standers

There were significant differences between the psychrotrophic counts of natural channels and farm fish in both TN and MC species while there were a non-significant difference between TN and MC fish species (Table 2). This may be due to the difference in the climate and water temperature in running channels and stagnant of water of farms.

The obtained results show higher *staphylococcus* counts in the farm fish samples than observed in natural channels fish. The results also showed that MC fish spp. has a non-significant higher count of staphylococci count than TN fish spp., these results agree with those reported by Abdelhamid. These results can be explained as running water usually dilute the level of microbial contamination comparing with stagnant water in the farms. Coagulase positive *staphylococci* were detected in 70.83, 79.31, 66.67 and 81.25 of positive SC for natural channels TN, natural MC, farm TN and farm MC, respectively.

The higher incidences reported may be attributed to hand contamination of fish handlers during catching, sorting and selling which in turn contaminates fish and the water and ice used for their preparation for selling [13]. The variations between the obtained results and the previous studies may be due to variety of factors such as geographical distribution, the extent of applying the personal hygiene of fish handlers during sorting and selling, the degree of utensils contamination, the bacterial load of ice used for fish preservation and the time of sampling [14].

According to the Egyptian standard for fresh fish, 8 samples of natural channels TN, 10 samples of natural channels MC, 12 samples of farm TN and 10 samples of farm MC exceeded the allowable limit of 103 cfu/g. (Tables, 3 and 4) which may constitute a potential health hazards for fish consumers as gastroenteritis outbreaks [13,15].

The results obtained indicate that the TN fish had higher mould count than MC fish species, and the fish live under farm conditions had higher mould count than that of fish live under natural channels conditions. This may be attributed to running water is in continuous refreshment than that in farms and the higher moisture content of *Tilapia* than *Mugil cephalus* fish may causes a higher contamination of *Tilapia nilotica* fish with mould than *Mugil cephalus* fish [16].

The presence of mould in fish samples was declared by Yanong who reported that the farm TN fish is commonly contaminated with mould and yeast than other types of fish which may fed on feed contaminated with moulds and yeasts [17]. Also, the presence of high number of fish in limited areas encourages the growth and multiplication of mould and bacteria.

### Chemical examination

**Moisture content:** The results obtained showed that natural channels fish samples had higher moisture content than that of the farm fish samples and the *Tilapia nilotica* fish samples had higher moisture content than that of *Mugil cephalus*. These results agree with those of Aussanasuwannakul et al. who reported that the natural channels fish contained higher moisture content than the farm fish due to the limited and controlled environmental conditions [18]. Moreover, Kristofferson et al. and, Attouchi and Sadok attributed it to the high dietary fat level in the feed and reduced activity of cultured fish as well as due to the unlimited access to feed in intensive farming system leads to increased muscle carbohydrates [19,20].

**Protein content:** Protein content for each fish species varies according to many factors. The percent of protein increases

with spawning season, maturation, and the high protein diet. The variation in protein source has influenced the organoleptic properties of fresh water fish by changing the color or altering the flavor [21].

The protein content of examined fish showed high levels of protein in natural channels MC, 20.0% followed by farm MC, 18.9, while lower protein percentages 18.51 and 17.91 were observed in natural channels TN, and farm TN, respectively (Table 7). Morris, 2001 and Francesco et al. attributed the difference in protein content between *Mugil cephalus* and *Tilapia nilotica* to the direct influence of fish species on the protein content of fish, as protein percent is not impacted by diet, but mainly is determined by the species type, genetic characteristics and size. Protein oxidation in fish meat is considered to impact negatively on the muscle texture, which consequently affects the organoleptic evaluation of the fish [22].

**Fat content:** Lipid content of fish flesh is directly related to the nutrition of the fish and the lipid content of natural channels fish, however, cannot be manipulated by the fisherman and will be mainly influenced by the prey type and availability, among other factors [3,23].

Farm MC and natural channels MC fish had fat levels of  $4.9 \pm 0.12$  and  $3.25 \pm 0.11$  respectively while lower levels  $2.98 \pm 0.11$  and  $2.2 \pm 0.09$  were detected in farm TN and natural channels TN fish respectively (Table 8). Such results agree with those reports that there is an increase in lipid concentration in muscles of farm brackish water fish as well as the whole body than natural channels fish by Kaushik et al. [24]. Similar results were reported by El-Ebiary and Zaki, Abdelhamid et al. [25,26].

High fat content in the fish may cause rapid deterioration and spoilage of fish meat that with poor microbiological quality and the level of the fat in ration of the fish should not higher than 8 % for obtaining good quality fish meat [27]. The remarkable higher percent of fat in the farm fish open the door for producing a high quality fish and fish products by adding omega-3 rich ingredients to fish feed which leads to increasing the percent of beneficial omega-3 fatty acids in farmed fish consequently helping to improve some cardiovascular disorders [28].

**Ash content:** The levels of ash differ significantly among different examined fish. Higher contents  $2.21 \pm 0.10$  and  $2.15 \pm 0.07$  were obtained in natural channels TN and MC fish respectively while lower ash levels  $1.82 \pm 0.6$  and  $1.46 \pm 0.09$ , were observed in farm TN and MC fish samples respectively (Table 9). These results may be attributed to that the farm fish may be fed on a diet of limited minerals, while the natural channels fish take a higher level of mineral from different natural conditions that causes increasing the level of ash. Lower mean percentage of ash values, 1.24 % for natural channels fish were reported by Sant'Ana et al. [29].

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