*Assiut Vet. Med. J. Vol 39 No. 77, April 1998*

Dept. of Food Hygiene.
Animal Health Research Institute

# SHELF LIFE OF TILAPIA NILOTICA STORED IN ICE

(With 3 Tables and 3 Figures)

By

***HODA A.E. AWAD***

(Received at 9/3/1998)

## فترة الصلاحية للبلطى النيلى المحفوظ فى الثلج

***هدى عبد الغنى عوض***

تم حفظ اسماك البلطى النيلى فى الثلج باستخدام معدلات ١: ١ , ١ : ٢ , ١ : ٣ ثلج الى اسماك وتم تعيين فترة الصلاحية للمجموعات الثلاثة بالتقييم الحسى والكيميائى والبكتيرى وصلت الاسماك الى وقت الرفض فى اليوم ١٨ , ١٨ , ١٥ معدلات ثلج الى اسماك ١: ١ , ١: ٢ , ١: ٣ على التوالى فى حين كان الأس الايدروجينى ٦,٣ , ٦,٤ , ٦,٤٥ والنيتروجين الكلى المتصاعد ٢٤,٤ , ٢٥,٢ , ٢٦,٤ مليجرام لكل ١٠٠ جرام بالنسبة للمجموعات الثلاثة على التوالى . تعدى العد البكتيرى عند وقت الرفض الحدود المقبولة لكل البكتريا المعدودة وشملت العد البكتيرى للميكروبات الهوائية والبكتيريا المحبة لدرجات الحرارة المنخفضة والبكتيريا المعوية والبكتريا الاهوائية . تمت التوصية باستخدام معدل ثلج : اسماك ١ :٢ لحفظ اسماك البلطى .

## SUUMARY

Tilapia Nilotica fish were stored in ice using 1:1 , 1:2 and 1:3 ice-fish ratios. shelf life was determined to the three fish groups by sensory , chemical and bacterial evaluation . Fish reached the rejection time at day 18 , 18 and 15 for 1:1 , 1:2 and 1:3 ice-fish ratios respectively where pH values were 6.3 , 6.4 and 6.45 , TVBN were 24.4 , 25.2 and 26.4 mg/100g for the three ice-fish ratios groups respectively . The bacterial counts exceeded the acceptability limits for all flora studied (total bacterial count , psychrotrophic , enterobacteriaceae and anaerobic bacteria) at rejection time . The use of ice-fish ratio 1:2 for keeping stored Tilapia was recommended.

***Key words:*** *Tilapia Nilotica - Ice store - Shelf life*

## INTRODUCTION

Fresh fish has always been a consumer's primary choice in sea food because it is easier to judge by eye the freshness of whole fish than filleted or processed ones. Icing fish immediately after being caught seems to be the more simple, cheaper and common method used world-wide to keep fish fresh during marketing. Although a detailed organoleptic inspection is usually sufficient to determine the freshness of iced fish , laboratory examinations are indispensable and must rapidly provide data for the assessment of quality.

pH value, trimethylamine (TMA) and total volatile basic nitrogen (TVBN) are widely used to estimate the degree of decomposition of fish and it's efficiency assay has been confirmed by several fish scientists and technologists (Sumner and Magno-Orejana, 1985, Bennour et al., 1991 and Reddy et al.,1995).

Fish decomposition is mainly due to bacterial growth which results in the production of various substances , some of which are not normally found in alive muscle tissue (Mendes and Lajolo, 1975).

Although much informations are available on the spoilage mechanism and the number and types of microorganisms associated with marine fish and shellfish, very few data have been published on the microbial flora of fish reared in fresh water, (Acuff et al., 1984).

Disney (1971) was the first who alerted fish scientists to the fact that fish from tropical waters might have longer storage life in ice than fish taken from cold waters. Later, Lima do Santos (1981) and Poulter et al. (1981) presented storage data for a number of studies carried out by FAO and Tropical Products Institute staff which indicated that while cold / temperate species can be kept an average of 14 days in ice , tropical species can be kept 21 days.

The aim of this study is to determine the shelf life of Tilapia Nilotica during ice storage as well as the suitable ice-fish ratio which can be used to get longer shelf life.

## MATERIAL and METHODS

Tilapia Nilotica used in this study were obtained from fishermen in Nile River at Monieb, Giza Governorate. Fish were transported in a cooler containing crushed ice to the laboratory where 6 fishes were used to make the first sample (day 0), the others were divided to three groups and stored in

woody boxes with alternating layers of fish and ice . 1:1, 1:2 and 1:3 ice-fish ratios were used (w/w). Water was drained regularly from orifices made in the bottom of the storing boxes and ice was replenished when necessary . The storage of Tilapia fish groups under ice lasted 24 days, samples were periodically taken (every three days) for sensory, chemical and bacteriological examinations . The experiment was repeated for three times.

**Sensory evaluation**

Fish were evaluated by three members of fish Hygiene Research unit, Department of food hygiene research. The following organoleptic tests attribute appearance, odour, texture and taste were examined to determine the rejection time at which fish no longer appropriate for consumption using a rating scale from 5 to 1. The scale is based on the Torry scale as originally described by Shewan et al. (1953). The fish were judged unfit for consumption when the mean value for sensory score was below 3.

**Chemical analyses**

A 10 grams portion of fish flesh was homogenized in 50 ml of distilled water, and its pH was measured. (Anon 1977). Total volatile bases (TVB) content was determined by the micro diffusion method of Conway (Conway, 1947). Histamine level was determined colorimetricaly using the technique recommended by Hardy and Smith (1976).

**Bacterial analysis**

Fish-flesh (10-grams) were homogenized with 90 ml of sterile peptone water (0.1%) diluent then serial dilutions were made in the same diluent. The aerobic plate count (APC) and the psychrotrophic flora count (PFC) were obtained on plate count agar (PCA) medium incubated for 3 days at 30°C and at 4°C, respectively as recommended by A.O.A.C. (1990) . Anaerobic bacterial count on reinforced clostridial medium (RCM) was applied using the method described by Gudkov and Sharp (1966). Most probable number (MPN) of coliforms using multiple tube fermentation technique in MacConkey broth tubes was carried out according to A.P.H.A. (1992). Total enterobacteriaceae count using pouring technique on violet red bile glucose agar was applied as recommended by ICMSF (1980).

## RESULTS

The obtained results are illustrated in Tables (1,2 &3 and Figures 1,2 & 3).

## DISCUSSION

The sensory evaluation of the examined samples (Fig. 1 and Table 1) indicated that shelf life of iced Tilapia Nilotica was affected by the ice-fish

ratio used , samples with 1:1, 1:2 and 1:3 ice-fish ratios reached the rejection times at 18, 18 and 15 days of storage respectively. Thus samples stayed accepted for consumption when more ice was used. Nearly the same results were obtained by Poulter et al. (1981) and Maia et al. (1983) concerning warm fresh water fish, while Gallardo et al. (1983), Klausen and Lund (1986) and Bennour et al. (1991) recorded shorter shelf-life for cold water fish. The most widely-accepted theory for longer storage life of tropical fish species has been propounded by Shewan (1977); colder water are thought to have higher numbers of psychrotrophs which in turn, coat the fish and shorten the shelf life compared with tropical species.

The present study recorded the same shelf life (18 days) for different treated ice-fish ratio samples, 1:1 and 1:2. The fact that fish out of contact with ice had a longer shelf life and better acceptability than fish in contact with ice recorded by Subrata and Khasim, (1985) could explain the similarity of the two shelf lives instead of using two different ice-fish ratios .

The average values of pH at 0 day were 5.8, 5.85 and 5.8 for ice-fish ratios 1:1, 1:2 and 1:3 respectively (Fig 2 and Table 2), the pH increased at the rejection time to 6.3, 6.4 and 6.5 respectively. The increase in pH between days 0 and day 24 were only 0.85 , 0.65 and 0.85 , the obtained result was observed by other authors . Reppond and Collins , (1983), EL-Marrakchi et al. (1990) and Bennour et al. (1991) .

Concerning TVBN , average values were 17.3 mg/100g for the three ice-fish ratios groups at day 0, then increased to 24.4, 25.2 and 26.4 mg/100g for 1:1, 1:2 and 1:3 ice-fish ratio respectively at the rejection time as determined by sensory evaluation (day 18 - day 18 - day 15) as shown in (Fig 2). The recorded values did not exceed 30 g/100g proposed by Connell, (1975) as a limit of acceptability for fish of cold and temperate waters. At day 24, the mean values of TVB was 25.8, 26.9 and 28 mg/100g and were lower than the proposed acceptable limit although the fish samples judged as spoiled. TVB content is not a sensitive index of freshness because of it's high variability and the test is usually reversed for fish near the limit of acceptance as mentioned by Howgate (1982).

The prouction of histamine in flesh of iced Tilapia were slow during the storage period and recorded <5 mg/100g of flesh as determined by the colorimetric method . The inhibitory effect of cold on histamine production was reported by several workers, Eitenmiller et al., 1982 and Gallardo et al.,1983) and it could explain the obtained results.

Total aerobic count averaged $1x10^3$ , $1.3x10^3$ and $1.2x10^3$ CFU/g at 0 day for ice-fish ratios 1:1, 1:2 and 1:3 respectively, (Fig 3 and table 3) after

3 days , there was very slight increase in total bacterial count which may be due to the disappearance of cold environment organisms that could not adapt cold environment as explained by Acuff et al. (1984). At the rejection times total bacterial count, psychrotrophic count, anaerobic count and enterobacteriaceae count exceeded the limits of acceptability recommended by ICMSF (1974). Thus, this may indicate the presence of good correlation between the sensory analysis and the bacterial counts and agreed with results obtained by (EL-marrakchi et al. (1990) and Bennour et al. (1991). Concerning anaerobic bacterial counts, they were $2.4x10^5$, $6.2x10^5$ and $3x10^6$ at the rejection times. The importance of anaerobic bacteria is that they are considered as a criterion for fish spoilage, Gram et al. ( 1987) .

## CONCLUSION

The preservative effect of ice on Tilapia nilotica can depend on ice-fish ratio used. There is 3 days increase in shelf-life when 1:1 and 1:2 ice fish ratios used than 1:3. Economically the ice-fish ratio 1:2 can be recommended because no significant differences were recorded by sensory, chemical and bacterial evaluations between 1:1 and 1:2 ice-fish ratios. We can conclude also that pH of fish during icing storage can't be depended on to evaluate its quality. Also TVB content is a valuable index in assessing the degree of Tilapia deterioration rather than evaluating different freshness degrees. Finally, sensory evaluation of Tilapia fish can reflect the bacterial load that exists.

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Table (1) :Organoleptic changes during ice storage of Tilapia nilotica

| Day | Appearence | | | Odour | | | Texture | | | Taste | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1st group | 2nd group | 3rd group | 1st group | 2nd group | 3rd group | 1st group | 2nd group | 3rd group | 1st group | 2nd group | 3rd group |
| 0 | 4 | 5 | 5 | 5 | 5 | 4.9 | 5 | 5 | 5 | 5 | 5 | 5 |
| 3 | 4.7 | 4.9 | 4.5 | 5 | 4.8 | 4.7 | 4.9 | 4.7 | 4.8 | 4.9 | 4.7 | 4.6 |
| 6 | 4.4 | 4.7 | 4.2 | 4.8 | 4.6 | 4.1 | 4.8 | 4.5 | 4.5 | 4.7 | 4.4 | 4.3 |
| 9 | 4 | 4.4 | 4.1 | 4.5 | 4.1 | 3.7 | 4.6 | 4.3 | 4.2 | 4.3 | 4 | 4.1 |
| 12 | 3.6 | 3.4 | 2.6 | 4.2 | 3.7 | 3.5 | 4.2 | 4.1 | 3.8 | 4.1 | 3.6 | 3.8 |
| 15 | 3.2 | 3.6 | 2.2 | 4 | 3.3 | 3 | 3.8 | 3.7 | 3.5 | 3.8 | 3.1 | 3.6 |
| 18 | 2.9 | 3.2 | 1.2 | 3.8 | 3 | 2.8 | 3.5 | 3.1 | 3.1 | 3.4 | 2.8 | 3.2 |
| 21 | 2.5 | 3 | 1 | 3.4 | 2.8 | 2.4 | 3.1 | 2.6 | 2.9 | 2.8 | 2.4 | 2.6 |
| 24 | 2.1 | 2.8 | 1 | 3.2 | 2.4 | 2 | 2.7 | 2.1 | 2.6 | 2.5 | 1.6 | 2.1 |



Table (2) : Changes in pH and TVBN during ice storage of Tilabia nilotica

| Day | pH | | | TVBN | | |
|---|---|---|---|---|---|---|
| | 1st group | 2nd group | 3rd group | 1st group | 2nd group | 3rd group |
| 0 | 5.8 | 5.85 | 5.8 | 17.3 | 17.3 | 17.3 |
| 3 | 5.85 | 5.95 | 6 | 18 | 18.5 | 19.2 |
| 6 | 5.9 | 6.1 | 6.15 | 19.7 | 20.6 | 21.8 |
| 9 | 5.95 | 6.1 | 6.3 | 20.3 | 23.2 | 23.1 |
| 12 | 6.1 | 6.2 | 6.4 | 22.2 | 24 | 24 |
| 15 | 6.25 | 6.35 | 6.45 | 23.6 | 24.6 | 25.8 |
| 18 | 6.3 | 6.4 | 6.5 | 24.4 | 25.2 | 26.4 |
| 21 | 6.45 | 6.45 | 6.55 | 25 | 26 | 27 |
| 24 | 6.65 | 6.5 | 6.65 | 25.8 | 26.9 | 28 |

Table (3) : Bacterial counts changes during ice storage of Tilapia nilotica

| Day | APC | | | Psychrotrophic count | | | Enterobacteriacae count | | | Anaerobic count | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1st group | 2nd group | 3rd group | 1st group | 2nd group | 3rd group | 1st group | 2nd group | 3rd group | 1st group | 2nd group | 3rd group |
| 0 | $10^3$ | $1.3x10^3$ | $1.2x10^3$ | $3.2x10^3$ | $3.1x10^3$ | $3.6x10^3$ | $5x10^3$ | $4.8x10^3$ | $4.8x10^3$ | $<10^2$ | $<10^2$ | $<10^2$ |
| 3 | $2.2x10^3$ | $3.1x10^3$ | $4.6x10^3$ | $4.6x10^3$ | $5x10^3$ | $4.1x10^4$ | $6.2x10^3$ | $1x10^4$ | $3x10^4$ | $6x10^2$ | $<10^2$ | $2x10^3$ |
| 6 | $7.1x10^4$ | $4x10^4$ | $6x10^5$ | $6x10^4$ | $1.2x10^4$ | $4.8x10^4$ | $1.1x10^4$ | $2x10^4$ | $7.1x10^4$ | $3.4x10^3$ | $2x10^2$ | $4.7x10^3$ |
| 9 | $3.2x10^5$ | $6.2x10^5$ | $7.2x10^5$ | $8x10^4$ | $3.7x10^4$ | $5.2x10^5$ | $2.8x10^4$ | $4.6x10^4$ | $9.3x10^4$ | $7.4x10^3$ | $2.2x10^3$ | $3x10^4$ |
| 12 | $4.3x10^5$ | $8x10^5$ | $2x10^6$ | $2.1x10^5$ | $2x10^5$ | $3x10^6$ | $4.2x10^4$ | $8x10^4$ | $5.1x10^5$ | $3x10^4$ | $1.7x10^4$ | $1.6x10^5$ |
| 15 | $7.3x10^5$ | $2x10^6$ | $4.3x10^7$ | $4.8x10^5$ | $4x10^5$ | $3.7x10^6$ | $8x10^4$ | $2.2x10^5$ | $9.6x10^5$ | $1.1x10^5$ | $3x10^5$ | $3x10^6$ |
| 18 | $2x10^6$ | $3.2x10^7$ | $3x10^8$ | $2x10^6$ | $8.2x10^5$ | $1.2x10^7$ | $9.1x10^4$ | $3.9x10^5$ | $4.6x10^6$ | $2.4x10^5$ | $6.2x10^6$ | $8.2x10^6$ |
| 21 | $4x10^7$ | $5x10^8$ | $7x10^9$ | $3x10^6$ | $1.3x10^6$ | $2.8x10^7$ | $3x10^5$ | $6x10^5$ | $7.9x10^6$ | $7x10^6$ | $8.1x10^6$ | $9.2x10^6$ |
| 24 | $8x10^7$ | $9.6x10^8$ | $9x10^9$ | $9x10^6$ | $2x10^6$ | $4.6x10^7$ | $6x10^5$ | $9x10^5$ | $9x10^6$ | $10^6$ | $9x10^5$ | $3x10^7$ |

Abbreviations :

APC : aerobic plate count

1st group : ice fish ratio 1:1

2nd group : ice fish ratio 1:2

3rd group : ice fish ratio 1:3

pH : Hydrogen ion concentration

TVBN : Total volatile basic nitrogen

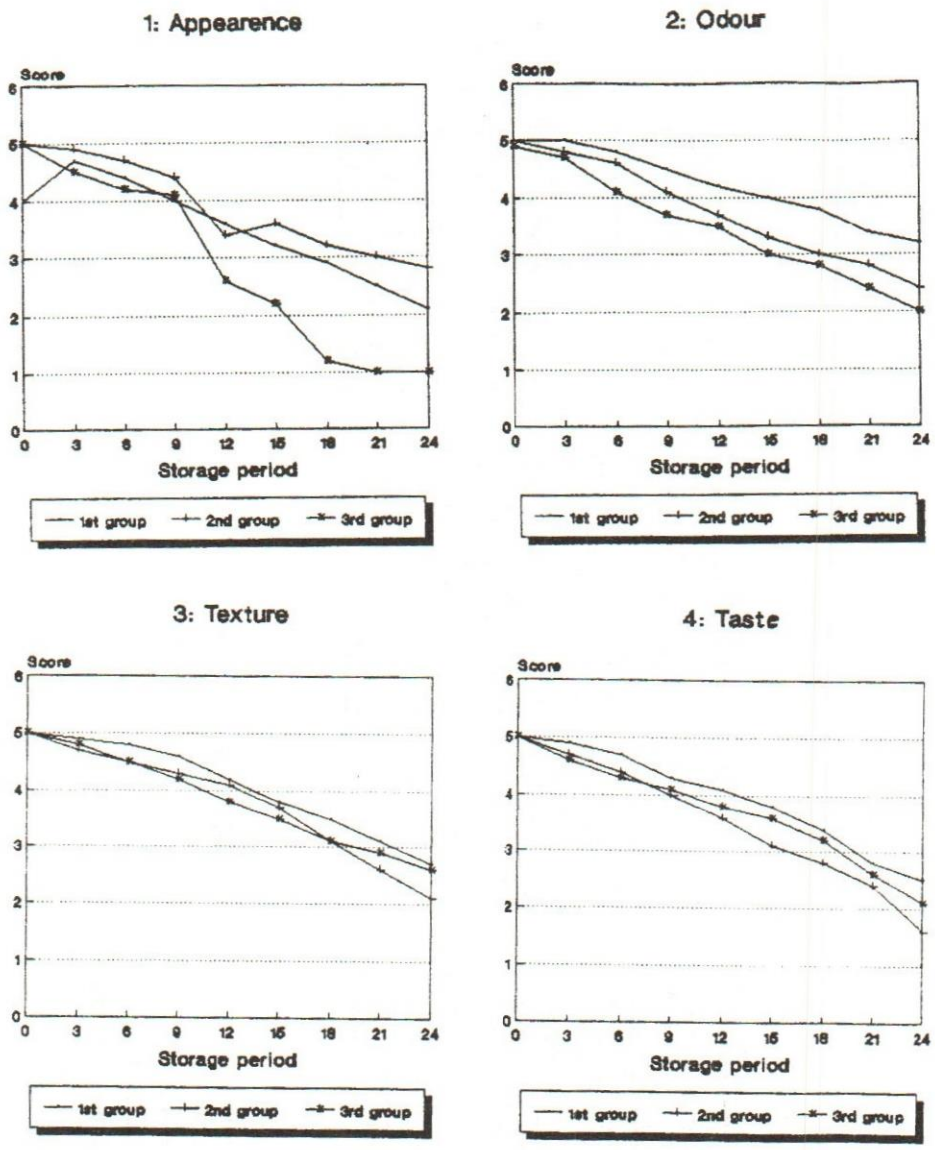


Fig ( 1 ) : Organoleptic changes in appearence , odour , texture and taste . Score scale : 5 (very good) , 4 (good) , 3 (moderate) , 2 (bad) and 1 (decomposed)

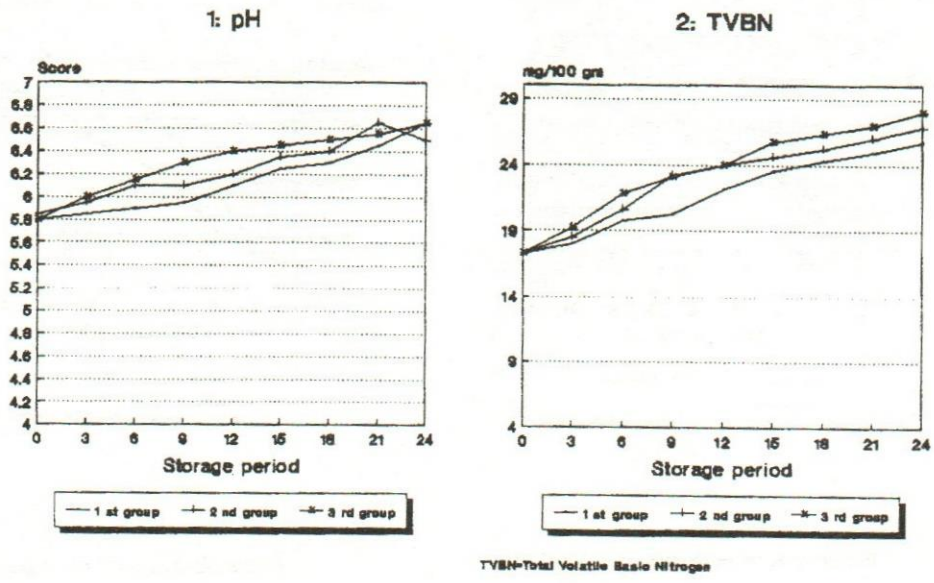


Fig (2) : Changes in pH and TVBN during ice storage of Tilapia Nilotica.

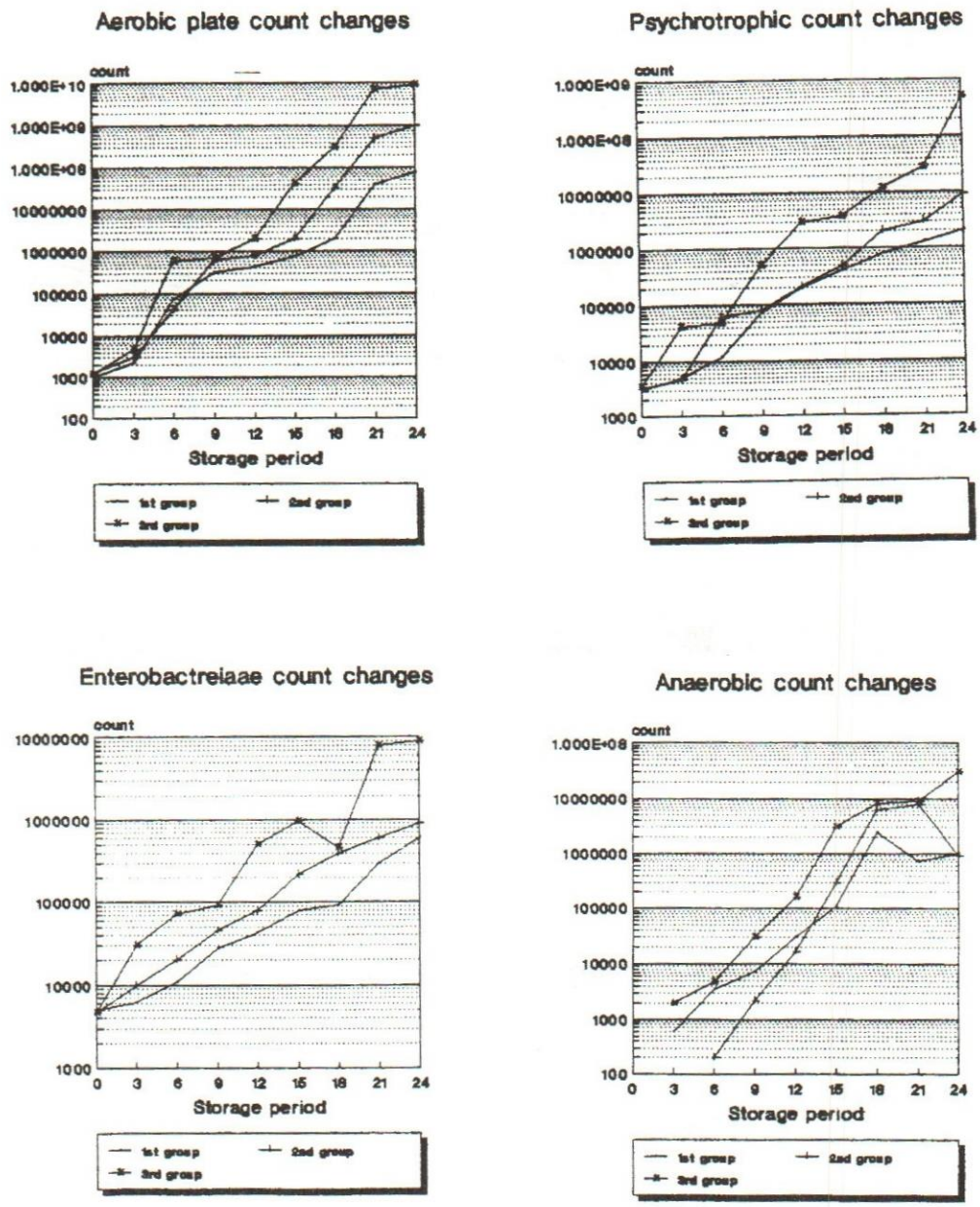


Fig (3) : Changes in APC, Psychrotrophic, Enterobacteriacae and Anaerobic counts during ice storage of Tilapia Nilotica