



Production and quality evaluation of hot smoked grass carp (*Ctenopharyngodon idella*) fillets stored at 4±1°C

Sabri M. A. Shehata¹, Abdelrahman S.A. Talab², Mohammed H. M. Ghanem¹
and Mahmoud M. M. Abbas^{1*}

1- Marine Biology Branch, Zoology Department, Faculty of Science, Al-Azhar University, Cairo, Egypt.

2- Fish Processing and Technology Laboratory, Fisheries Division, National Institute of Oceanography and Fisheries (NIOF), Cairo, Egypt.

* Crossponding Auher: Mahmoud_Mahrous42@yahoo.com, 00201064303459.

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ABSTRACT

The present study assessed the effect of hot smoke at 50-90°C for 5-6 h using hard sawdust of beech wood and two salt levels (10% and 16%) on keeping quality of grass carp, *Ctenopharyngodon idella*, fillets stored at 4±1°C. Chemical composition, physicochemical aspects, minerals and sensory analysis were determined.

Results showed that, the mean values of moisture, proteins, lipids, carbohydrates, ash, calorific value, pH, TVBN and TBA were 78.11±0.69, 16.55±0.84, 2.31±0.01, 1.16±0.01, 1.87±0.01, 91.63±1.49, 6.55±0.01, 4.43±0.05 and 0.43±0.01, respectively for raw grass carp; while it was recorded 48.22±0.23, 23.38±0.18, 13.88±0.11, 8.14±0.01, 6.38±0.09, 251.05±1.33, 6.15±0.05, 12.42±0.03 and 2.54±0.05, respectively for hot smoked grass carp fillets with 10% salt concentrations and 48.01±0.23, 23.01±0.18, 14.66±0.17, 5.41±0.03, 8.50±0.03, 247.27±2.22, 5.52±0.03, 8.88±0.02, 2.04±0.07, for the hot smoked grass carp fillets with 16% salt concentrations, respectively. Mean values of the tested minerals and heavy metals (mg/100g, on dry weight basis) of raw; hot smoked fillets with 10% and 16% salt concentrations were as follows: Ca (170±0.27, 233±1.11, 236±1.21); K (197±0.26, 349±3.01, 448±4.55), P (187±0.12, 343±3.33, 375±4.88), Na (93.80±0.35, 103±12.76, 115±12.77), Cd (0.07±0.001, 0.023±0.001, 0.020±0.001); Cu (1.33±0.01, 2.46±0.01, 3.46±0.04); Fe (25.15±0.47, 60.87±0.21, 69.23±1.31); Mn (0.98±0.01, 0.78±0.001, 0.76±0.02); Ni (0.64±0.003, 0.77±0.001, 0.60±0.001) and Zn (9.92±0.51, 24.38±0.04, 18.80±0.05), respectively. Statistical analyses showed that, moisture, pH value, TVBN and TBA were significantly increased with the increasing storage time, while, proteins, lipids and ash were significantly decreased. Physicochemical aspects and sensory scores showed that, 16% salted hot smoked fish was better than 10% with prolong the shelf life of hot smoked grass carp to 40 days of cold storage.

INTRODUCTION

Fish smoking is the oldest known preservation methods for centuries. It extends the shelf-life of fish and gives it the special color and flavor as a result of

dehydration, antimicrobial and antioxidant of the smoke compounds and it is also changes the texture of product (Huong, 2013).

Smoked fish are divided according to processing temperature cold-smoked (at 30- 40°C for 30-60 minutes, the internal temperature of the fish usually does not exceed 35°C) and hot-smoked (greater than 90°C, the internal temperature of fish typically exceeds 60°C), while as hot-smoking is the method employed in traditional fish smoking in many developing countries (MOFA, 1999 and UNDP, 2002).

Grass carp (*Ctenopharyngodon idella*) is one of the most important commercial freshwater species. The global aquaculture production of this fish was 5,537,794 tons in 2014, and it ranked first among principal aquaculture species (FAO, 2016). Previous studies concluded that salting, smoking, polyphenols and chitosan coating were effective in extending the shelf-life of grass carp (Salama & Ibrahim, 2012; Sun *et al.*, 2017; Wang *et al.*, 2014; Yu *et al.*, 2017 and Huang *et al.*, 2018). However, few studies have investigated the effect of different salt concentrations on the quality of hot smoked grass carp fillets. Therefore, the study aimed to examine the effect of hot smoking using two different salt concentrations (10% and 16%) on the keeping quality of grass carp, *C. idella*, fillets during cold storage as assessed by determination of chemical composition, physiochemical aspects, minerals, heavy metals and sensory analysis.

MATERIALS AND METHODS

Fish samples:

40 kg of fresh grass carp (mean weight of 1291.39±12.23 g and mean length of 41.37±4.04 cm) were bought from El-Obour City fish market. They were carefully washed with potable water, packed in ice boxes and transported to Fish Processing and Technology Laboratory, National Institute of Oceanography and Fisheries, El-Kanater El-Khiria City, Egypt within 2 h. In the laboratory, fish samples were re-washed thoroughly with potable water, scaled, beheaded, gutted, filleted and re-washed immediately and drained.

Brining:

Commercial salt was used in the preparation of brine. The fish were divided into two groups; the first group was brined in 10% NaCl solution for 2 h at room temperature, while the second one was brined in 16% NaCl solution for the same period and the same temperature. The weight of fish and brine were equal for both methods of brining.

Desalting and drying:

The desalting process was carried out by immersing the brined fish fillets in water for 10 min. then they were subjected to partial sun-drying temperatures fluctuated between 21°C and 28°C for two hours.

Smoking:

Fish samples were subjected for hot smoking using the hard sawdust of beech wood in a laboratory smokehouse at Shakshouk Research Station, El-Fayoum Governorate. Metal boarded plate was used above the smoke source by 75 cm to filtrate of smoke. Fish fillets were hooked above the smoke source by about 150 cm. Hot smoking process was continued for 5-6 h at 50-90°C. The smoking time, temperature and ambient conditions were monitored using a thermometer during the smoking operation. After smoking, samples were allowed to cool at ambient temperature and packaged in air tight polythene bags and kept in perforated plastic containers and stored at ±4°C till the onset of spoilage by panel test. Chemical

composition, physicochemical aspects, minerals, heavy metals and sensory analysis were carried out immediately after smoking and every ten days of storage.

Analyses:

Moisture, protein, lipids and ash were determined according to the methods described by AOAC, (2012). The pH value was done by the method of Goulas *et al.* (2005) using pH meter (HANNA, pH213). Total volatile bases nitrogen (TVBN) was done according to Mwansyemela (1973). Thiobarbituric acid (TBA) value was determined by the distillation method outlined by Tarladgis, *et al.*, (1960). Magnesium (Mg), calcium (Ca), sodium (Na), potassium (K), phosphor (P), copper (Cu), iron (Fe), manganese (Mn) and zinc (Zn) contents were analyzed using an inductively coupled plasma optical emission spectrophotometer (ICP-OES) (Model 4300 DV, Perkin Elmer, Shelton, CT, USA) according to AOAC (1999). Organoleptic evaluation was performed according to the method suggested by Twig *et al.*, (1976). Results were expressed as mean \pm SD. using SPSS 20, statistical software. Data were subjected to analysis of variance (ANOVA).

RESULTS AND DISCUSSION

Chemical composition

Chemical composition (on wet weight basis) of raw and hot smoked grass carp fillets are shown in Table (1). Data showed that, mean values of moisture, proteins, lipids, ash, carbohydrates and calorific value of raw fillets and hot smoked fillets treated with 10% and 16% salt concentrations were as follows: 78.11 \pm 0.69, 16.55 \pm 0.84, 2.31 \pm 0.01, 1.87 \pm 0.01, 1.16 \pm 0.01, 91.63 \pm 1.49; 48.22 \pm 0.23, 23.38 \pm 0.18, 13.88 \pm 0.11, 6.38 \pm 0.09, 8.14 \pm 0.01, 251.05 \pm 1.33 and 48.01 \pm 0.23, 23.38 \pm 0.18, 14.66 \pm 0.17, 8.50 \pm 0.03, 5.41 \pm 0.03, 247.27 \pm 2.22, respectively. Similar observations were agreed with Salama & Ibrahim, 2012 and Haq *et al.*, 2013.

Table 1: Chemical composition (on wet weight basis) of raw and hot smoked grass carp fillets.

Constitutes	Raw grass carp	Smoked grass carp	
		10% salt	16% salt
Moisture (%)	78.11 \pm 0.69	48.22 \pm 0.23	48.01 \pm 0.23
Protein (%)	16.55 \pm 0.84	23.38 \pm 0.18	23.38 \pm 0.18
Lipids (%)	2.31 \pm 0.01	13.88 \pm 0.11	14.66 \pm 0.17
Ash (%)	1.87 \pm 0.01	6.38 \pm 0.09	8.50 \pm 0.03
Carbohydrates (%)	1.16 \pm 0.01	8.14 \pm 0.01	5.41 \pm 0.03
Calorific value (kcal/100 g)	91.63 \pm 1.49	251.05 \pm 1.33	247.27 \pm 2.22

Physicochemical quality criteria

The mean values of physicochemical aspects of raw and hot smoked grass carp fillets treated with 10% and 16% salt concentrations were as follows: pH value (6.55 \pm 0.01, 6.15 \pm 0.05, 5.52 \pm 0.03); TVBN (4.43 \pm 0.05, 12.42 \pm 0.03, 8.88 \pm 0.02 mg/100g) and TBA (0.43 \pm 0.01, 2.54 \pm 0.05, 2.04 \pm 0.07 mg MDA/kg), on wet weight basis, respectively (Table 2). Similar observations were detected by Morzel & van de Vis (2003) and Xiao *et al.* (2000).

Table 2: Physical and chemical properties (on wet weight basis) of raw and hot smoked grass carp fillets.

Parameter	Raw grass carp	Smoked grass carp fillets	
		10% salt	16% salt
pH value	6.55 \pm 0.01	6.15 \pm 0.05	5.52 \pm 0.03
TVB-N (mg/100g)	4.43 \pm 0.05	12.42 \pm 0.03	8.88 \pm 0.02
TBA (mg MDA/kg)	0.43 \pm 0.01	2.54 \pm 0.05	2.04 \pm 0.07

Mineral contents:

The mean values of the tested minerals (mg/100g, on dry weight basis) of the raw; hot smoked grass carp fillets (with 10% and 16%) salt concentrations were as follows: Ca (170 ± 0.27 , 233 ± 1.11 , 236 ± 1.21); K: (197 ± 0.26 , 349 ± 3.01 , 448 ± 4.55), P: (187 ± 0.12 , 343 ± 3.33 , 375 ± 4.88) and Na: (93.8 ± 0.35 , 103 ± 12.76 , 115 ± 12.77), respectively (Table 3) Similar observations were recorded by Eyo (2001).

Table 3: Minerals concentrations (mg/100g, on dry weight basis) of raw and hot smoked grass carp fillets

Elements	Raw grass carp	Smoked grass carp	
		10% salt	16% salt
Ca	170 ± 0.27^a	233 ± 1.11^b	236 ± 2.21^c
K	197 ± 0.26^a	349 ± 3.01^b	448 ± 4.55^c
P	187 ± 0.12^a	343 ± 3.33^b	375 ± 4.88^c
Na	93.80 ± 0.35^a	103 ± 12.76^b	115 ± 12.77^c

Heavy metals levels:

The mean values of the tested heavy metals (mg/100g, on dry weight basis) of raw and hot smoked grass carp fillets treated with 10% and 16% salt concentrations were as follows: Cd (0.07 ± 0.001 , 0.023 ± 0.001 , 0.020 ± 0.001); Cu (1.33 ± 0.01 , 2.46 ± 0.01 , 3.46 ± 0.04); Fe (25.15 ± 0.47 , 60.87 ± 0.21 , 69.23 ± 1.31); Mn (0.98 ± 0.01 , 0.78 ± 0.03 , 0.76 ± 0.02); Ni (0.64 ± 0.003 , 0.773 ± 0.001 , 0.600 ± 0.001) and Zn (9.92 ± 0.51 , 24.383 ± 0.04 , 18.80 ± 0.05), respectively, (Table 4). Similar observations were recorded by Jayaprakash *et al.* (2015) and Leung *et al.* (2014).

Table 4: Heavy metals concentrations (mg/100g, on dry weight basis) of raw and hot smoked grass carp fillets

Metals	Raw grass carp	Smoked grass carp	
		10% salt	16% salt
Cd	0.07 ± 0.001^a	0.023 ± 0.001^b	0.020 ± 0.001^c
Cu	1.33 ± 0.01^a	2.46 ± 0.01^b	3.46 ± 0.04^c
Fe	25.15 ± 0.47^a	60.87 ± 0.21^b	69.23 ± 1.31^c
Mn	0.98 ± 0.01^a	0.78 ± 0.03^b	0.76 ± 0.02^b
Ni	0.64 ± 0.003^a	0.77 ± 0.001^b	0.60 ± 0.001^c
Zn	9.92 ± 0.51^a	24.38 ± 0.04^b	18.80 ± 0.05^c

Changes in chemical composition and physicochemical quality of hot smoked grass carp fillets stored at $4\pm1^\circ\text{C}$:**Moisture content:**

The mean values of moisture content of hot smoked grass carp fillets with 10% and 16% salt concentration stored at $4\pm1^\circ\text{C}$ were 48.22 ± 0.23 and 48.01 ± 0.23 at zero time of storage. They were 61.99 ± 0.55 and 59.45 ± 0.34 respectively, at the end of storage period (Figure 1). The obtained results disagree with Salama & Ibrahim (2012) whom recoded that, the moisture contents of smoked grass carp were decreased during storage at $2\pm1^\circ\text{C}$ for 30 days from 62.45 and 66.81 at zero time, to 60.50 and 64.71 at the end of cold storage. They attributed the decrease in moisture content to the exclusion of available water from the fish by the effect of different treatments salting, drying and smoking.

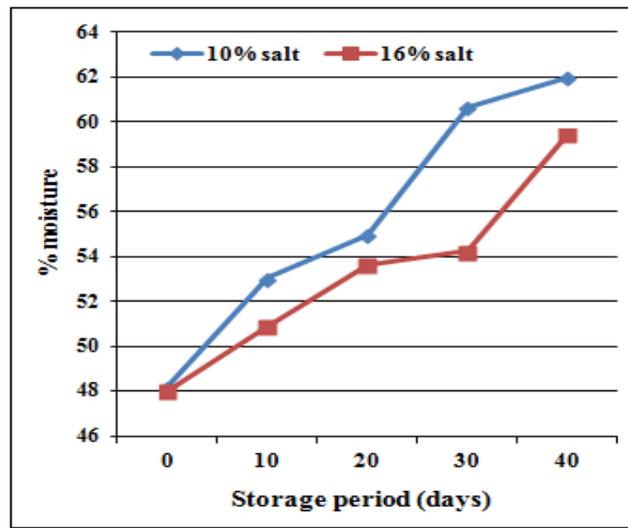


Fig. 1: Changes in moisture content (%) of hot smoked grass carp fillets stored at $4\pm 1^\circ\text{C}$

Crude protein content:

The values of crude protein content of hot smoked grass carp fillets with 10% and 16% salt concentration stored at $4\pm 1^\circ\text{C}$ were, 23.38 ± 0.18 , 23.38 ± 0.18 at zero time of storage; while they were 21.29 ± 0.12 , 21.69 ± 0.11 respectively, at the end of storage period (Figure 2). Present study were in agreement with Salama & Ibrahim (2012) whom concluded that, the crude protein contents of smoked grass carp were decreased during storage at $2\pm 1^\circ\text{C}$ for 30 days from 69.30 ± 0.07 and 70.01 ± 0.06 at zero time, to 67.78 ± 0.06 and 67.90 ± 0.06 at the end of cold storage. They attributed the decrease in crude protein content during cold storage of smoked grass carp to the decomposition and degradation of nitrogen substances which may be due to the activity of microorganisms and proteolytic enzymes.

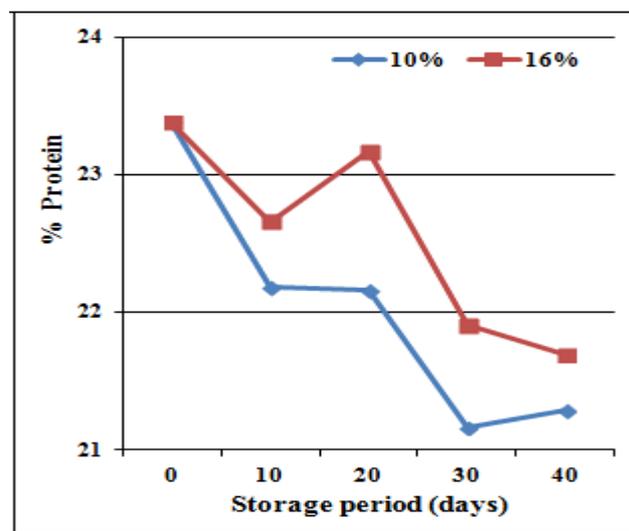


Fig. 2: Changes in protein content of hot smoked grass carp fillets stored at $4\pm 1^\circ\text{C}$

Lipid content:

The mean values of lipid content of hot smoked grass carp fillets treated with 10% and 16% salt concentrations stored at $4\pm 1^\circ\text{C}$ were 13.88 ± 0.11 and 14.66 ± 0.17 respectively at zero time of storage; while they were 10.62 ± 0.14 and 10.94 ± 0.17

respectively, at the end of storage period (Figure 3). These results coincide with those given by Salama & Ibrahim (2012) whom reported that, the lipid contents of smoked grass carp were decreased during storage at $2\pm 1^\circ\text{C}$ for 30 days from 19.46 ± 0.05 and 20.31 ± 0.06 at zero time, to 18.68 ± 0.06 and 19.23 ± 0.06 at the end of cold storage. They attributed the decrease in lipid content during cold storage of smoked grass carp to the activity of microorganisms and lipolytic enzymes which lead to breakdown of fatty acids.

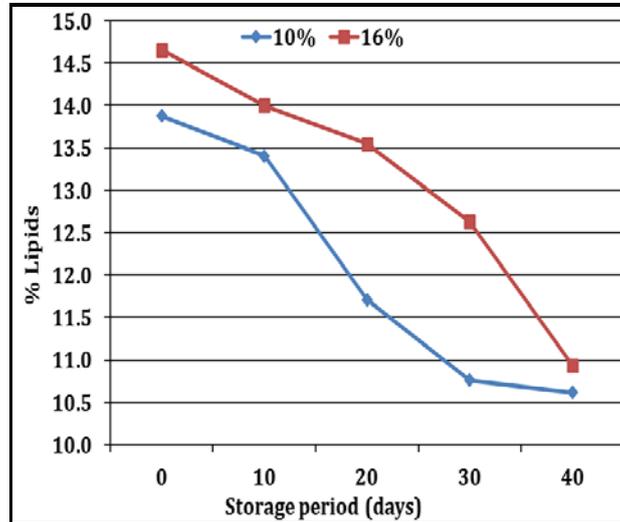


Fig. 3: Changes in lipid content of hot smoked grass carp fillets stored at $4\pm 1^\circ\text{C}$

Ash content:

The average values of ash content of hot smoked grass carp fillets treated with 10% and 16% salt concentrations and stored at $4\pm 1^\circ\text{C}$ at zero time were 6.38 ± 0.09 , 8.50 ± 0.03 , while they were 4.98 ± 0.03 , 7.79 ± 0.08 respectively, at the end of storage period (Figure 4). The present results disagree with those given by Salama & Ibrahim (2012) whom found that, ash contents of smoked grass carp were increased during storage at $2\pm 1^\circ\text{C}$ for 30 days from 11.20 ± 0.04 and 9.95 ± 0.04 at zero time, to 13.40 ± 0.05 and 12.80 ± 0.05 at the end of cold storage. They attributed the increase in ash content during cold storage of smoked fish to the addition of salt.

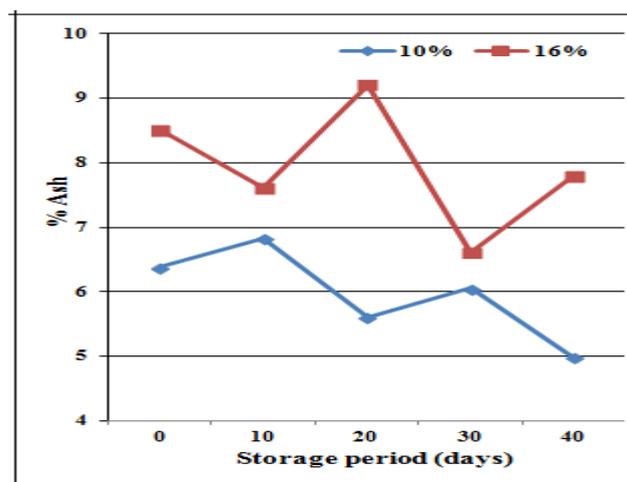


Fig. 4: Changes in ash content of hot smoked grass carp fillets stored at $4\pm 1^\circ\text{C}$

pH value:

pH values of hot smoked grass carp fillets treated with 10% and 16% salt concentrations and stored at $4\pm 1^\circ\text{C}$ at zero time were 6.15 ± 0.05 and 5.52 ± 0.03 . They were 6.38 ± 0.07 and 6.33 ± 0.02 respectively, at the end of storage period (Figure 5). These results disagree with those given by Salama & Ibrahim (2012) whom found that, pH value of smoked grass carp were decreased during storage at $2\pm 1^\circ\text{C}$ for 30 days from 6.6 ± 0.03 , 6.2 ± 0.04 , and 6.0 ± 0.05 at zero time, to 5.8 ± 0.03 , 5.4 ± 0.04 , and 5.1 ± 0.05 at the end of cold storage. They attributed the decline in pH value to the protein denaturation and fat autolysis which lead to the liberated amino acids, free fatty acids and lactic acid which may be produced in different amounts during the storage period. On the other hand, the decrease in pH may be attributed to the production of volatile basic components, such as ammonia, trimethylamine etc. by fish spoiling bacteria. Similar observation were detected by many authors including Bibek (1992); Reddy *et al.* (1997); Khallaf *et al.* (1997); Hyytia *et al.* (1999); Nykanen *et al.* (2000) and Ruiz-Capillas & Moral, (2001).

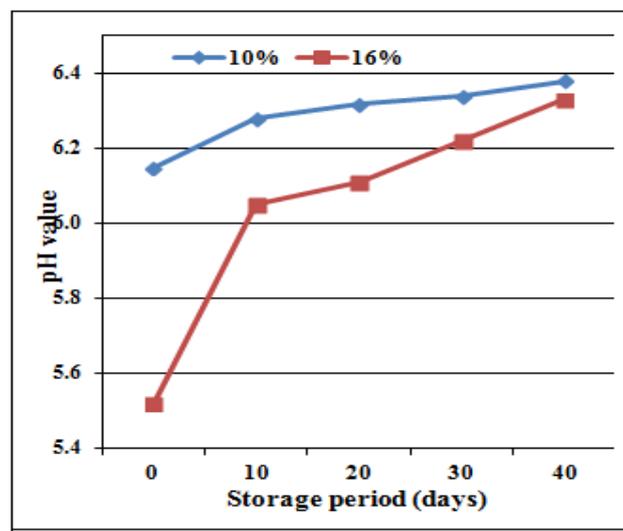


Fig. 5: Changes in pH value of hot smoked grass carp fillets stored at $4\pm 1^\circ\text{C}$

Total volatile basic nitrogen (TVBN) content:

The mean values of total volatile basic nitrogen (TVBN) of hot smoked fillets treated with 10% and 16% salt concentrations and stored at $4\pm 1^\circ\text{C}$ were 12.42 ± 0.03 and 8.88 ± 0.02 , respectively at zero time of storage. They were 28.68 ± 0.03 and 22.39 ± 0.05 respectively, at the end of storage period (Figure 6). These results were in accordance with those given by Plahar *et al.* (1999) and Salama & Ibrahim (2012) whom stated that, TVBN contents of smoked grass carp were increased during cold storage.

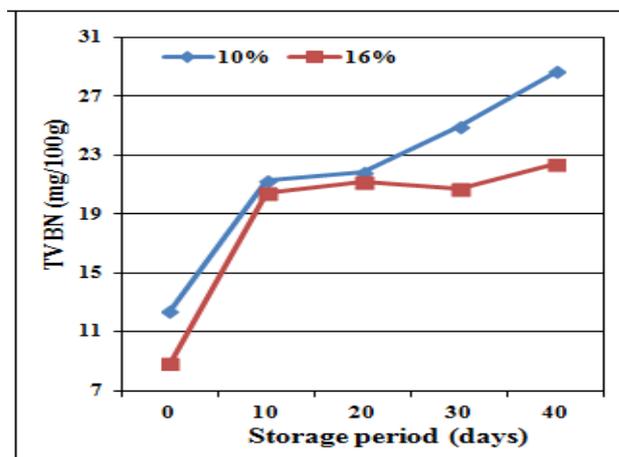


Fig. 6: Changes in total volatile basic nitrogen (mg/100g,) of hot smoked grass carp fillets stored at $4\pm 1^{\circ}\text{C}$

Thiobarbituric acid (TBA) value:

The mean values of thiobarbituric acid (TBA) value of hot smoked grass carp fillets treated with 10% and 16% salt concentrations and stored at $4\pm 1^{\circ}\text{C}$ were 2.54 ± 0.05 and 2.04 ± 0.07 , respectively at zero time of storage. They were 6.68 ± 0.07 and 5.70 ± 0.03 respectively, at the end of storage period (Figure 7). These results coincide with those given by Gomes *et al.* (2003) and Salama & Ibrahim (2012).

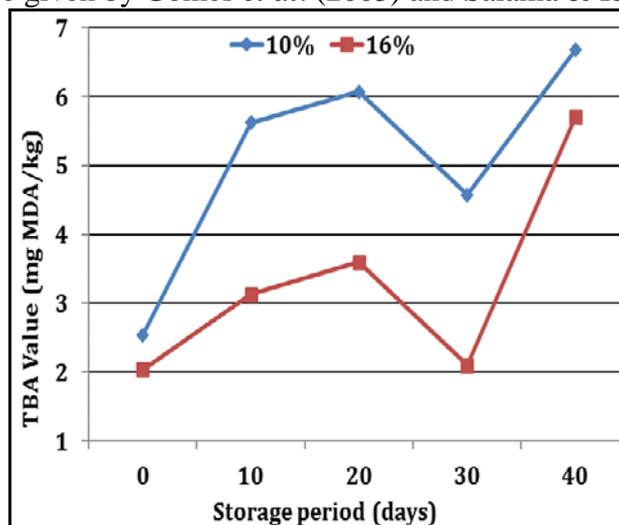


Fig. 7: Changes in thiobarbituric acid value (mg MDA/kg) of hot smoked grass carp fillets stored at $4\pm 1^{\circ}\text{C}$

Sensory evaluation:

The initial values of sensory scores (color, flavor, taste, tenderness, juiciness, overall acceptability scores) of smoked grass carp treated with 10% and 16% salt concentration and stored at $4\pm 1^{\circ}\text{C}$ showed no negligible alternation after processing during zero time. However, 10% salted smoked grass carp showed very good scores (8.95) for color, pronounced scores (8.70) for flavor, very full scores (8.85) for taste, very tender scores (8.50) for tenderness, very juicy scores (8.25) for juiciness, very good scores (9.00) for overall acceptability immediately after processing during zero time. Moreover, the trial 16% salted smoked fish showed very good scores (8.90) for color, pronounced scores (8.65) for flavor, very full scores (8.75) for taste, very tender scores (8.30) for tenderness, very juicy scores (8.35) for juiciness, very good scores (8.50) for overall acceptability immediately after processing at zero time with the slightly increase in salted taste. In general, a noticeable difference could be observed between smoked grass carp groups (10% and 16%) in the case of taste characteristic after processing during zero time.

During the storage time, the overall acceptability scores of two groups (10% and 16%) samples decreased from 8.80 and 8.50 during 10th days of storage to reach its lowest score 3.25 and 4.55 during the end of storage (40th days), respectively which was below the acceptable limit of score (5); thus the two groups (10% and 16%) become rejected for consumers after 40th days of storage.

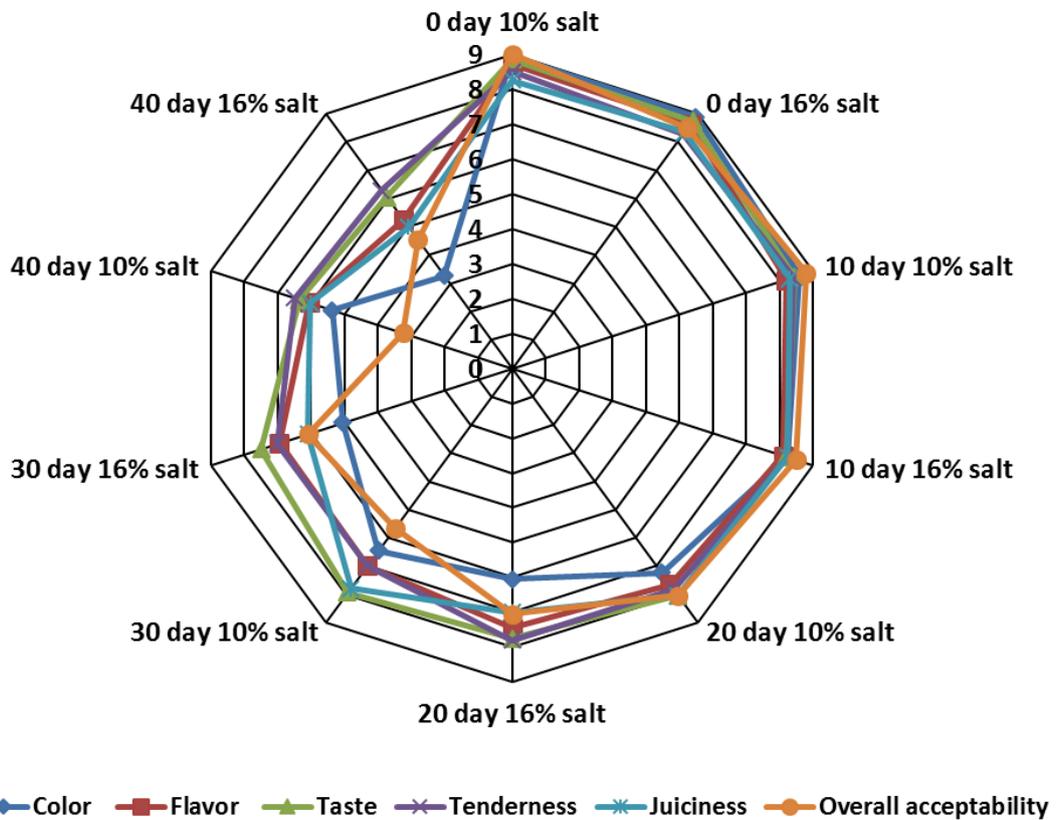


Fig. 8: Changes in sensory scores of hot smoked grass carp fillets stored at 4±1°C.

CONCLUSIONS

From above findings, it can be concluded that, the hot smoking can be used for processing grass carp which led to the production of a high-quality delicatessen food item, which could be an alternative to cooked fresh fish. To the best of our knowledge this is one of the little studies of the shelf life of hot smoked grass carp. Based on the physicochemical analysis and sensory scores it can be illustrated that, 16% salted hot smoked grass carp was better than 10% with prolong the shelf life of hot smoked grass carp to 40 days of cold storage.

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ARABIC SUMMARY

إنتاج وتقييم جودة فيليه مبروك الحشائش المدخن على الساخن والمخزن على 4±1م°

صبري محمد علي شحاتة^١، عبد الرحمن سعيد عبداللطيف تغلب^٢، محمد حامد محمد غانم^١، محمود محروس محمد عباس^١

- ١- قسم علم الحيوان ، كلية العلوم ، جامعة الأزهر ، القاهرة ، مصر .
٢- معمل تكنولوجيا تصنيع الأسماك ، شعبة المصايد ، المعهد القومي لعلوم البحار والمصايد ، القاهرة ، مصر .

قيمت الدراسة الحالية تأثير التدخين الساخن على 50-90م° لمدة 5-6 ساعة بإستخدام نشارة خشب الزان مع مستويين من الملح 10% و 16% على حفظ جودة فيليه أسماك مبروك الحشائش المخزن على 4±1م°. تم دراسة التركيب الكيميائي والخصائص الفيزيائية والكيميائية والحسية والمعادن.

وأظهرت نتائج الدراسة أن متوسط قيم الرطوبة ، البروتين ، الدهن ، الرماد ، الكربوهيدرات ، القيمة الحرارية، الرقم الهيدروجيني، النيتروجين الكلي المتطاير، حامض الثيوباربتيريك في فيليه أسماك مبروك الحشائش الطازج (78.11±0.69 ، 16.55±0.84 ، 2.31±0.01 ، 1.87±0.01 ، 1.16±0.01 ، 91.63±1.49 ، 6.55±0.01 ، 4.43±0.05 ، 0.43±0.01) بينما سجلت في فيليه أسماك مبروك الحشائش المدخن على الساخن بإستخدام 10% ملح (48.22±0.23 ، 23.38±0.18 ، 13.88±0.11 ، 6.38±0.09 ، 8.14±0.01 ، 251.05±1.33 ، 6.15±0.05 ، 12.42±0.03 ، 2.54±0.05) وسجلت في فيليه أسماك مبروك الحشائش المدخن على الساخن بإستخدام 16% ملح (48.01±0.23 ، 23.38±0.18 ، 14.66±0.17 ، 8.50±0.03 ، 5.41±0.03 ، 247.27±2.22 ، 5.51±0.03 ، 8.88±0.02 ، 2.04±0.07) على التوالي.

ومن ناحية أخرى، فإن متوسط قيم المعادن والعناصر الثقيلة (ملجم/100جم وزن جاف) في فيليه أسماك مبروك الحشائش الطازج، فيليه أسماك مبروك الحشائش المدخن على الساخن بإستخدام 10% ملح، فيليه أسماك مبروك الحشائش المدخن على الساخن بإستخدام 16% ملح كانت كالتالي: الكالسيوم (233±1.11 ، 236±1.21) ، البوتاسيوم (197±0.26 ، 349±3.33 ، 448±4.88) ، الفوسفور (187±0.12 ، 343±3.33 ، 375±4.88) ، الصوديوم (93.80±0.35 ، 103.±12.76 ، 115±12.77) ، الكاديوم (0.07±0.001 ، 0.023±0.001 ، 0.020±0.001) ، النحاس (1.33±0.01 ، 2.46±0.09 ، 3.46±0.14) ، الحديد (25.15±0.47 ، 60.87±0.21 ، 69.23±1.31) ، المنجنيز (0.98±0.01 ، 0.78±0.03 ، 0.76±0.02) ، النيكل (0.64±0.003 ، 0.77±0.001 ، 0.60±0.002) ، والزنك (9.92±0.51 ، 24.38±0.04 ، 18.80±0.05) ، على التوالي.

علاوة على ذلك ، زادت قيم الرطوبة، وقيمة الأس الهيدروجيني، النيتروجين الكلي المتطاير، حامض الثيوباربتيريك بشكل كبير أثناء التخزين البارد، بينما انخفضت قيم البروتين والدهن والرماد بشكل ملحوظ. أوضح التحليل الفيزيائي والكيميائي والحسي أن فيليه مبروك الحشائش المدخن على الساخن بنسبة 16% ملح كان أفضل من 10% والذي أدى إلى إطالة فترة صلاحية فيليه مبروك الحشائش المدخن على الساخن إلى 40 يوماً من التخزين البارد.