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Quality Assessment Of Salted Grass Carp (*Ctenopharyngodonidella*) Fillets Stored At Ambient Temperature.

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ABSTRACT

The present work was carried out to investigate the effect of salting (at 15% and 20% concentrations) and adding of some natural antioxidants (black seed, grape seed, jojoba extracts and chitosan) on the quality and shelf-life of grass carp, ***C. idella,*** stored at ambient temperature for 28 days. Chemical composition, pH value, total volatile basic nitrogen (TVB-N), thiobarbituric acid values (TBA); nutritional essential elements (Ca, K, P, and Na) and heavy metals (Cd, Cu, Fe, Mn, Ni, and Zn) and sensory scores were determined. Results indicated that, salting methods have a considerable effect on the nutritional value of fish, and in variations of moisture, protein, lipid, and ash contents. Statistical analysis revealed that, a significant decrease in moisture, protein, lipids, pH, Ca, K, P, Cd, Cu, Fe, Mn, Ni, and Zn, while it showed a significant increase in ash, carbohydrates, caloric values, TVBN, TBA and Na concentrations. However, moisture, protein, lipids were significantly decreased during storage, while ash, pH, TVBN and TBA were significantly increased but not exceed the maximum permissible levels. Changes in chemical composition, physicochemical aspects and sensory scores during salting and storage of grass carp showed that salting of fish using natural antimicrobial and antioxidants compounds were better than control and they were in the following order: black seed> chitosan>grape seed> jojoba.
Keywords: *Ctenopharyngodonidella*, salting, black seed, grape seed, jojoba, chitosan.

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INTRODUCTION

Natural antioxidants compounds extracted from plant leaves, seeds, roots and seafood products are preferred to synthetic antioxidants for preserving the quality and extending the shelf-life of fish products. They are safer than synthetics, due to their antimicrobial and antioxidative properties (Tongnuanchan&Benjakul, 2014 and Huang Zhan*et al*., 2018).

Grass carp (*Ctenopharyngodonidella*) is one of the most important commercial freshwater-cultured species. The global aquaculture production of this fish was 5,537,794 tons in 2014. It ranked first among principal aquaculture species (FAO, 2016). Fresh fish are highly perishable after death because of protein degradation, lipid oxidation or decomposition are caused by microorganisms and endogenous enzymes under a high pH value, and a concentration of free amino acids. Therefor, taking some measures to delay the deterioration of fish quality and to extend the shelf-life of fish products are necessary (Cai*et al*., 2015 and Huang Zhan*et al*., 2018).

Several studies showed that, natural antioxidants can maintain postmortem quality and extend shelf-life of fish and meat products. However, few studies have investigated the effect of natural antioxidants on the quality of fresh and salted grass carp fillets (Cai*et al*., 2015; Ghabraie*et al*., 2016 and Huang Zhan*et al*., 2018). Salting, apple polyphenols, and chitosan coating were effective in extending the shelf-life of grass carp (Talab*et al*., 2011;Sun *et al*., 2017; Wang *et al*., 2014a; Yu *et al*., 2017 and Huang Zhan*et al*., 2018). Therefore, the aim of the present work was dsidedto carry outthe effect of black seed extract, grape seed extract, jojoba and chitosan on the quality of salted grass carp fillets stored at ambient temperature in terms of chemical composition, physicochemical, minerals, heavy metals and sensory score.

MATERIAL 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-ObourCity market. They were carefully washed with potable water then packed in ice boxes and transported to Fish Processing and Technology Laboratory, National Institute of Oceanography and Fisheries, El-Kanater El-Khiria City, Egypt. In the labolatory, fishes were re-washed thoroughly with potable water, scaled, beheaded, gutted, filleted, rewashed immediately and drained **(Figure, 1):**.

Fish salting:

The obtained fish fillets were divided randomly into five groups. The control was not treated with natural antioxidants. The treatment groups were immersed in 1% (v/v) natural antioxidants solution (black seed extract, grape seed extract, jojoba and chitosan) for 1h at room temperature (4 kg grass carp fillets in 1000 ml of antioxidant solution). Each treated fillets were divided into two groups (15% and 20% salt concentration) and then packed individually in air tight plastic bottle with some air and stored at room temperature. Chemical composition, physical, chemical, sensory aspects, minor and major elements were carried out every week until they were denoted as completely spoiled by sensory panel.

Analyses:

Moisture, protein, lipid and ash were determined according to the methods described by A.O.A.C. (2012).pH value was done by the method of Goulas*et al*. (2005) using pH meter (HANNA, pH213). Total volatile bases nitrogen (TVBN) was done as described by 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), phosphorus (P), copper (Cu), iron (Fe), manganese (Mn) and zinc (Zn) contents were analyzed by using an inductively coupled plasma optical emission spectrophotometer (ICP-OES) (Model 4300 DV, Perkin Elmer, Shelton, CT, USA) according to the method of A.O.A.C. (1999). Organoleptic evaluation was performed as equation described by Twig*et al*.(1976).

Statistical analysis:

Results were expressed as mean ± SD. Data were subjected to analysis of variance (ANOVA) using SPSS 20, Statistical Software.

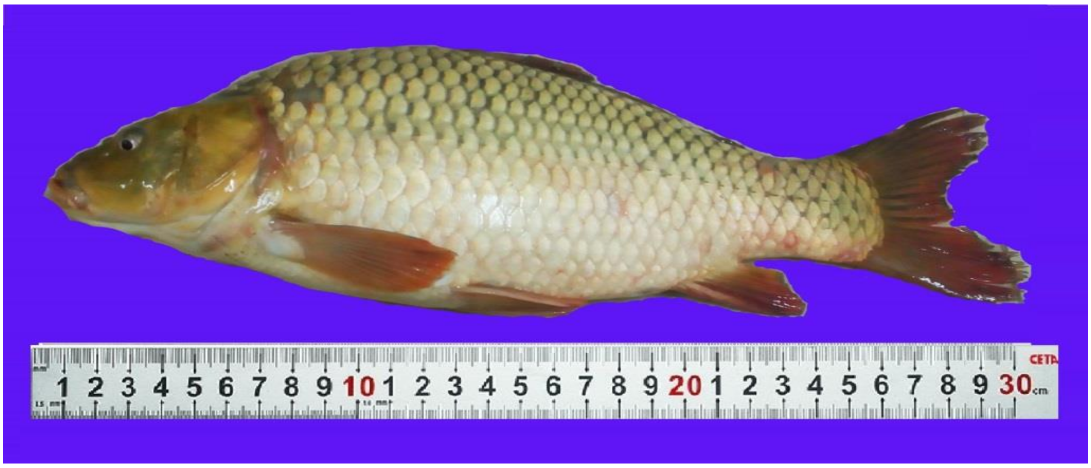

Fig 1: Lateral view of grass carp (*Ctenopharyngodonidella*) collected from El-Obour Market

RESULTS AND DISCUSSION

I- Chemical composition of raw and salted grass carp:

Table (1) and **Figure (2)** showed that, the mean (±SD) proximate composition of moisture, crude protein, crude fat, ash, carbohydrates and calories (g/100 g fish muscles on wet weight basis) were 78.11±0.69, 16.55±0.84, 2.31±0.01, 1.87±0.01, 1.16±0.01 and 91.63±1.49, respectively for the fresh grass carp. However, it recorded 74.56±0.09, 15.60±0.04, 1.99±0.04, 3.55±0.04,4.29±0.04 and 97.49±0.26, respectively for 15% salted grass carp and 73.78±0.09, 15.57±0.04, 2.02±0.04, 3.63±0.04, 5.01±0.04, 100.46±0.44, respectively for 20% salted one.

Table 1: Chemical composition (on wet weight basis) of fresh and salted fillets of grass carp

Chemical composition	Fresh grass carp	Salted grass carp 15%	Salted grass carp 20%
Moisture (%)	78.11±0.69	74.56±0.09	73.78±0.09
Proteins (%)	16.55±0.84	15.60±0.04	15.57±0.04
Lipids (%)	2.31±0.01	1.99±0.04	2.02±0.04
Ash (%)	1.87±0.01	3.55±0.04	3.63±0.04
Carbohydrates (%)	1.16±0.01	4.29±0.04	5.01±0.04
Caloric values (kcal/100 g)	91.63±1.49	97.49±0.26	100.46±0.44

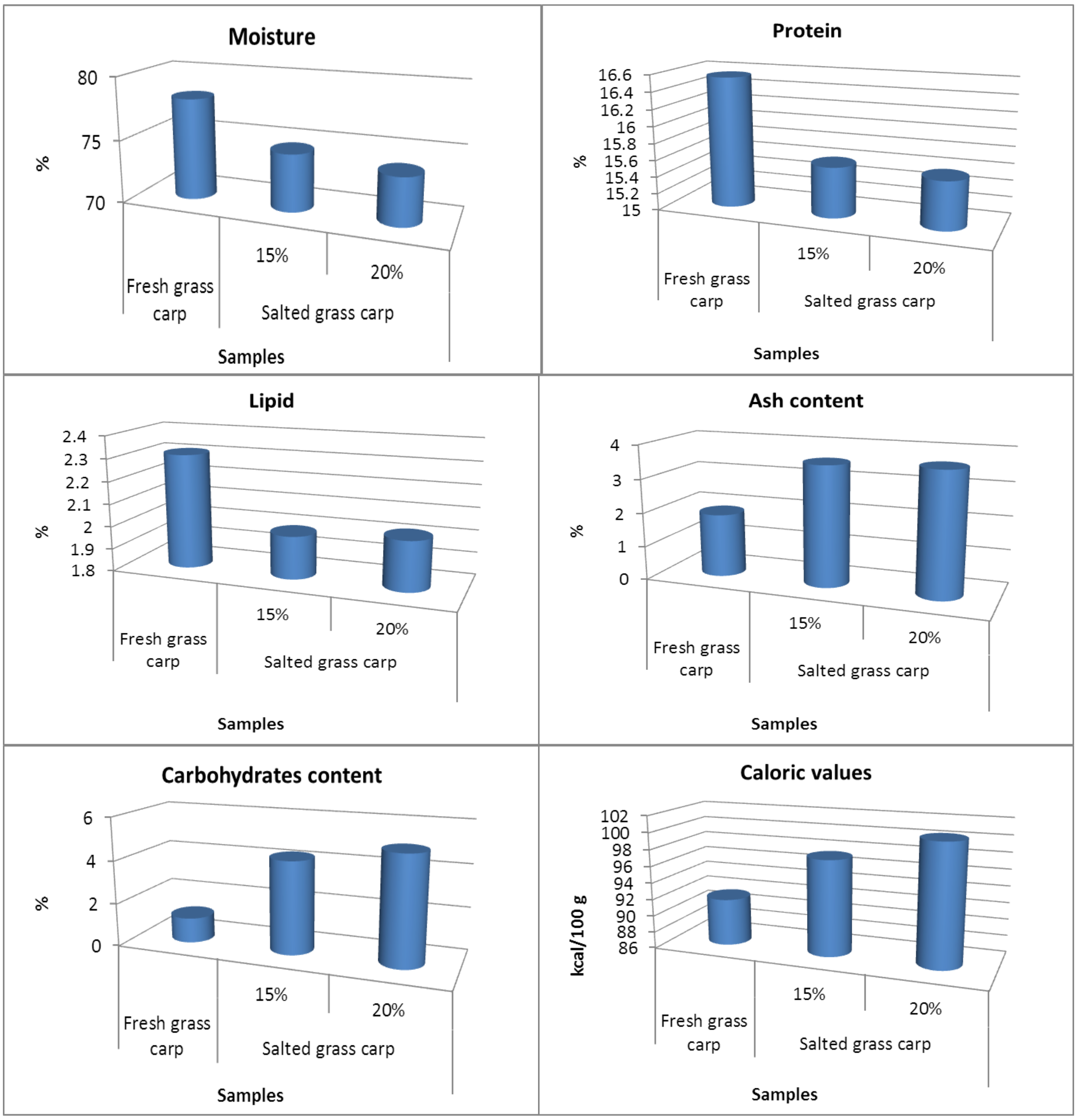

Fig 2: Chemical composition (on wet weight basis) of fresh and salted fillets of grass carp.

The obtained results agree with those reported by Yu*et al*., 2017 who reported that, the mean (±SD) proximate composition of moisture, ash, crude protein and crude fat (g/100 g fish muscle on wet weight basis) in the fresh grass carp were 78.98±0.61, 1.15±0.09, 18.03±0.35, and 2.12±0.21, respectively. Ormanci and Colakoglu (2015) contributed the major changes in protein content in salted fish to the increase of NaCl concentration, which increases protein degradation. The decrease in moisture, protein and lipids content after salting process may be due to the mass transfer occurs basically between salt and water during salting process: the fish muscles takes up salt and loses water. However, the increase in nutritional components, such as ash, carbohydrates and caloriesmay be due to the loss of water in fish muscles during salting process (Clucas & Ward, 1996; Bras & Costa, 2010; Chaijan, 2011;Oliveira*et al*., 2012 andBakhiet & Khogalie, 2012).

II- Physicochemical aspects of fresh and salted grass carp:

Table (2) and **Figure (3)** showed that, pH values were higher in fresh grass carp (6.55±0.01) than salted grass carp which varied from 6.49±0.01 in 20% salted grass carpto , 6.52±0.06 in 15% salted one. However, TVBN values were lower in fresh grass carp (8.43±0.05 mg/100g ww) than salted grass carp which fluctuated between 9.94±0.07 mg/100g ww in 20% salted grass carp and 11.02±0.01 mg/100g ww in 15% salted one. Moreover, TBA values were recorded the lowest value in fresh grass carp (0.43±0.01mg MDA/Kg ww) and increased to 3.50±0.05 mg MDA/Kg ww in 20% salted grass carp then recorded the highest one

(3.79±0.08 mg MDA/Kg ww) in 15% salted one. Result revealed that, salt process led to higher increase in TVBN and TBA values and slightly decreased in pH value.

Table 2: Physicochemical aspects (on wet weight basis) of fresh and salted fillets of grass carp.

Physicochemical aspects	Fresh grass carp	Salted grass carp 15%	Salted grass carp 20%
pH value	6.55±0.01	6.52±0.06	6.49±0.01
TVBN (mg/100 g)	8.43±0.05	11.02±0.01	9.94±0.07
TBA (mg MDA/kg)	0.43±0.01	3.79±0.08	3.50±0.05

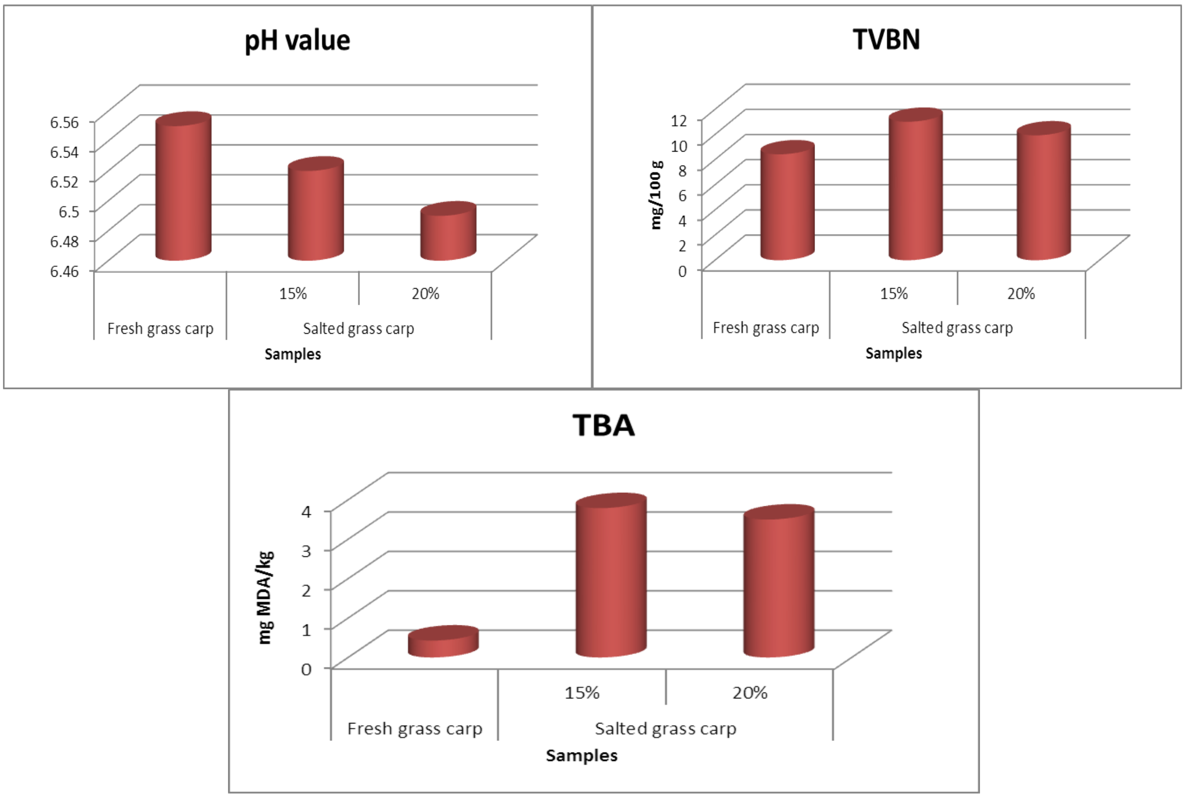

Fig 3: Physicochemical aspects (on wet weight basis) of fresh and salted fillets of grass carp.

III- Mineral composition of fresh and salted grass carp:

Mineral composition (mg/100g on dry weight basis) of fresh grass carp, 15% and 20% of salted grass carp were as follows: 170±0.27, 31±1.74 and 35±1.95, respectively for calcium (Ca) content;197±0.26, 100±1.54 and 195±1.88, respectively for potassium (K) content;187±0.12, 78±1.35 and 125±1.78, respectively for phosphorus (P) content;93.8±0.35, 111±1.97 and 120±1.49, respectively for sodium (Na) content **(Table, 3 and Figure 4).**Results showed that, salting process caused a significant decrease ($p \leq 0.05$) in (Ca, K and P) elements, while it caused a significant increase ($p \leq 0.05$) in Na content and ; this may be due to the sodium chloride added in processing procedure. Results agree with those reported by Mohammed (2010) who found that sodium content of raw and salted *Alestesdentex* were 142 and 612 mg/100g respectively.

Table 3: Nutritional essential elements(mg/100 g on dry weight basis)of fresh and salted fillets of grass carp.

Elements	**Grass carp samples**		
	Fresh samples	**Salted samples**	
		15%	20%
Ca (mg/100g)	170±0.27 [a]	31±1.74[b]	35±1.95[b]

K (mg/100g)	197±0.26 [a]	100±1.54 [b]	195±1.88 [c]
P (mg/100g)	187±0.12 [a]	78±1.35 [b]	125±1.78 [c]
Na (mg/100g)	93.80±0.35 [a]	111±1.97 [b]	120±1.49 [c]

Values are expressed as mean±SD. ANOVA followed by LSD's multiple range tests. Values in rows with different alphabetic characters are statistically significant at P <0.05.

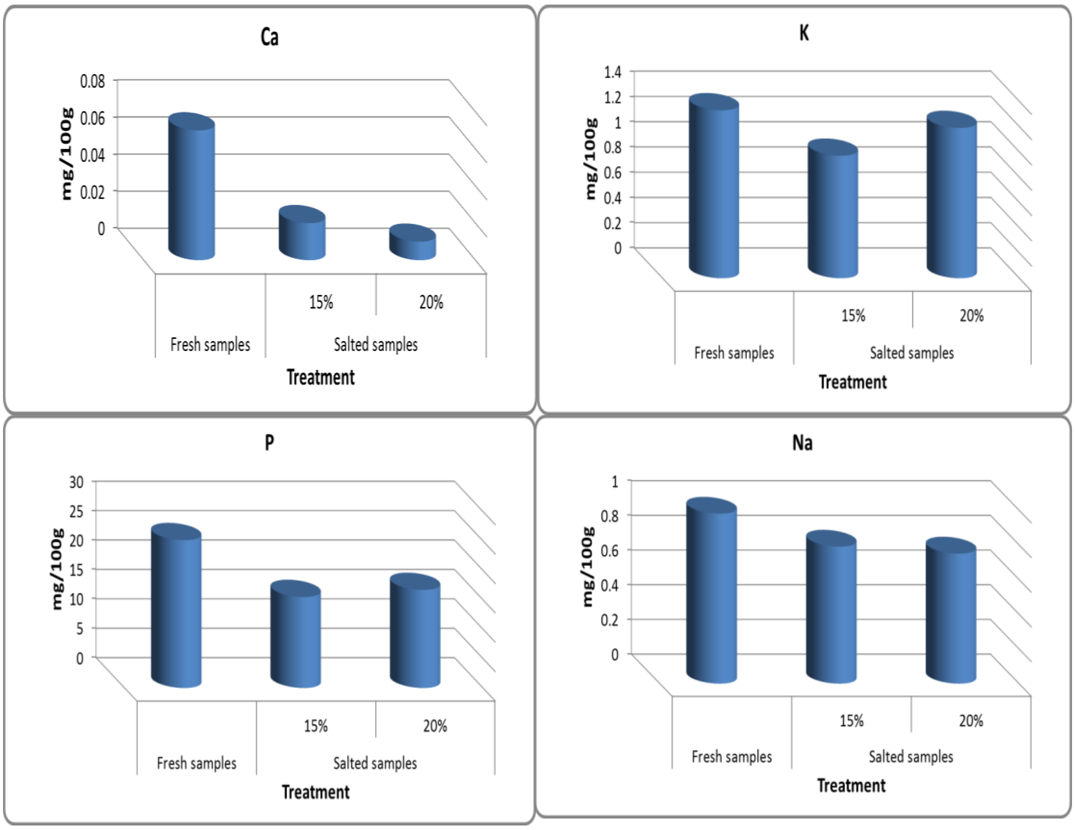

Fig 4: Nutritional essential elements(mg/100 g on dry weight basis)of fresh and salted fillets of grass carp

IV- Heavy metals concentrations of fresh and salted grass carp:

Heavy metals concentrations of fresh grass carp, 15% and 20% salted grass carp were as follows: 0.07±0.001, 0.02±0.001 and 0.01±0.001, respectively for cadmium (Cd) content; 1.33±0.01, 0.97±0.001 and 1.19±0.09, respectively for copper (Cu) content;25.15±0.47, 15.48±1.03 and 16.68±1.01, respectively for iron (Fe) content;0.98±0.01, 0.79±0.001 and 0.75±0.001, respectively for manganese (Mn) content;0.64±0.003, 0.49±0.01 and 0.47±0.001, respectively for nickel (Ni) content; 9.92±0.51, 9.16±1.01 and 7.92±0.08, respectively for zinc (Zn) content (**Table, 4and Figure, 5)**.

Results revealed that, salting process caused higher reduction in the concentrations of all tested metals. Cd concentration in the analyzed fish samples (mg/100g) was below the maximum permissible value indicated by the European Community (EEC, 2001). The maximum Cd level permitted by the FAO (1983) is 0.5 mg/100g and 0.2 mg/100g by MAFF (1995). Similar observations were also reported by Sobhanardakani and Jafari (2014) whom reported that, cadmium concentration in the muscles of fresh grass carp was ranged from 0.004 to 0.012 mg/100g.Pirestani*et al.* (2009) recorded that, the levels of Mn, Fe, Zn and Cu of fresh common carp were 0.17 ± 0.01; 12.55 ± 0.21; 7.44 ± 0.30 and 2.58 ± 0.14 mg/kg dry weight. While, Yi and Zhang (2012) found that, the mean concentrations of copper, zinc and cadmium in *C. idella* fish caughted from the Yangtze River were 0.834±0.655; 2.8±3.17 and 0.0457±0.0449 mg/kg wet weight, respectively.

Table 4: Heavy metals concentrations (mg/100 g on dry weight basis)of fresh and salted fillets of grass carp.

Heavy metals	Grass carp samples		
	Fresh samples	Salted samples	
		15%	20%
Cd (mg/100g)	0.07 ± 0.001^{a}	0.02 ± 0.001^{a}	0.01±0.001b
Cu (mg/100g)	1.33 ± 0.01^{a}	0.97 ± 0.01^{b}	1.19 ± 0.01^{c}
Fe (mg/100g)	25.15 ± 0.47^{a}	15.48 ± 1.14^{b}	16.68 ± 1.44^{c}
Mn (mg/100g)	0.98 ± 0.01^{a}	0.79 ± 0.001^{b}	0.75 ± 0.001^{b}
Ni (mg/100g)	0.64 ± 0.003^{a}	0.49 ± 0.001^{b}	0.47 ± 0.001^{b}
Zn (mg/100g)	9.92 ± 0.51^{a}	9.16±0.87a	7.92 ± 0.98^{b}

Values are expressed as mean±SD. ANOVA followed by LSD's multiple range tests. Values in rows with different alphabetic characters are statistically significant at P <0.05.

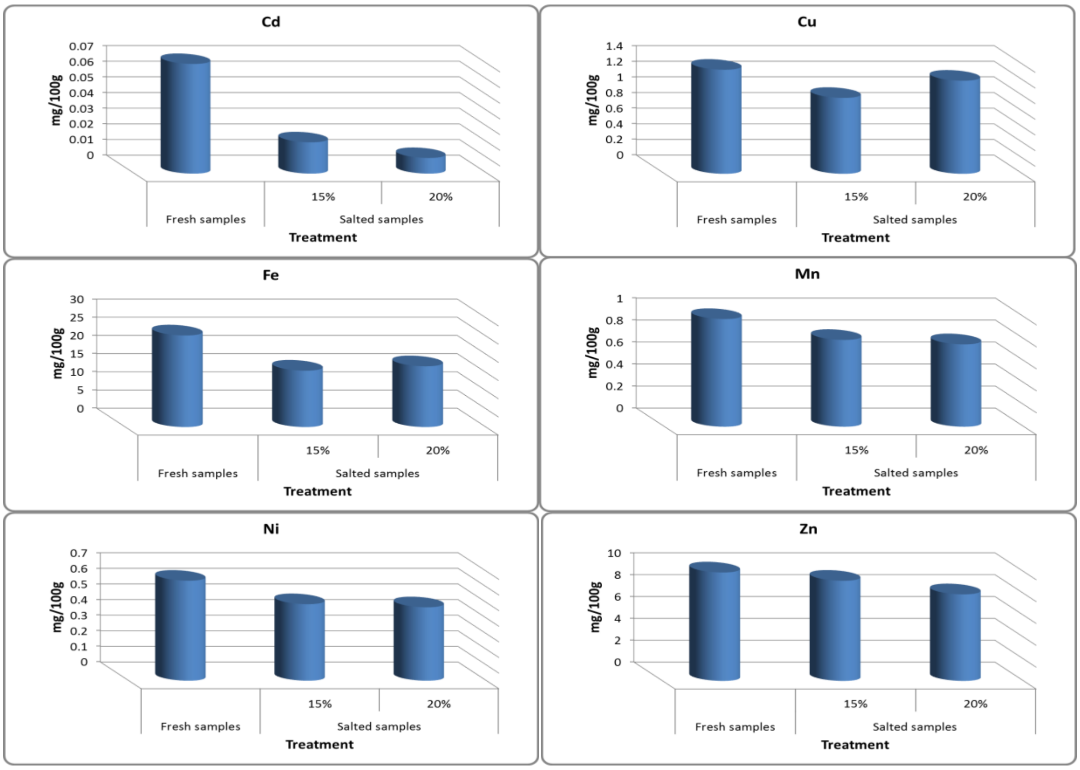

Fig 5: Heavy metals concentrations (mg/100 g on dry weight basis)of fresh and salted fillets of grass carp

A- Chemical composition changes of salted grass carp stored at ambient temperature:

1- Moisture content

Table (5) and Figure (6) showed that, moisture content in control, chitosan, grape seed, black seed and jojoba of 15% and 20% salted grass carp were 74.56, 75.46, 74.81, 75.35 and 74.78and 73.78, 74.76, 73.58, 74.72 and 74.50,respectively at zero time. It was recorded 68.99, 69.94, 69.91, 68.97 and 68.51and 67.64, 69.04, 69.27, 67.94 and 66.20, respectively, at the end of storage period. Moisture content was significantly decreased in all treatments, where moisture content of salted grass carp with addition of chitosan, grape seed, black seed and jojoba were higher than control. The results are in accordance with those reported by Badawy (1979); Hernandez-Herrero (1997) and Ahmed *et al.* (2010).The decrease in moisture content during storage may be due to the high osmotic pressure which leads to diffuses salt into the fish tissues. At the same time, however, water moves by osmosis from the fish at a high speed into the surrounding brine and the fish declines in weight (Voskresensky, 1965 and Alsaban *et al.*, 2014).

Table (5): Moisture content changes in the salted grass carp storage at ambient temperature.

Treatment	Salt	Storage periods (days)				
		0	7	14	21	28
Control	15%	74.56±0.38	72.44±0.65	71.23±0.65	70.20±0.81	68.99±0.33
	20%	73.78±0.81	71.50±0.44	69.90±0.76	69.23±0.66	67.64±0.23
Black seed	15%	75.46±0.22	74.39±0.34	74.20±0.66	71.14±0.77	69.94±0.23
	20%	74.76±0.34	73.88±0.56	72.91±0.54	70.01±0.09	69.04±0.43
Chitosan	15%	74.81±0.54	74.05±0.34	73.17±0.81	70.80±0.09	69.91±0.32
	20%	73.58±0.66	73.01±0.45	72.26±0.45	70.02±0.88	69.27±0.12
Grape seed	15%	75.35±0.34	75.01±0.56	72.01±0.43	71.97±0.67	68.97±0.83
	20%	74.72±0.22	74.01±0.54	71.72±0.33	70.23±0.56	67.94±0.16
Jojoba	15%	74.78±0.34	74.16±0.66	71.74±0.23	70.93±0.33	68.51±0.18
	20%	74.50±0.66	73.51±0.55	70.19±0.23	69.52±0.34	66.20±0.19

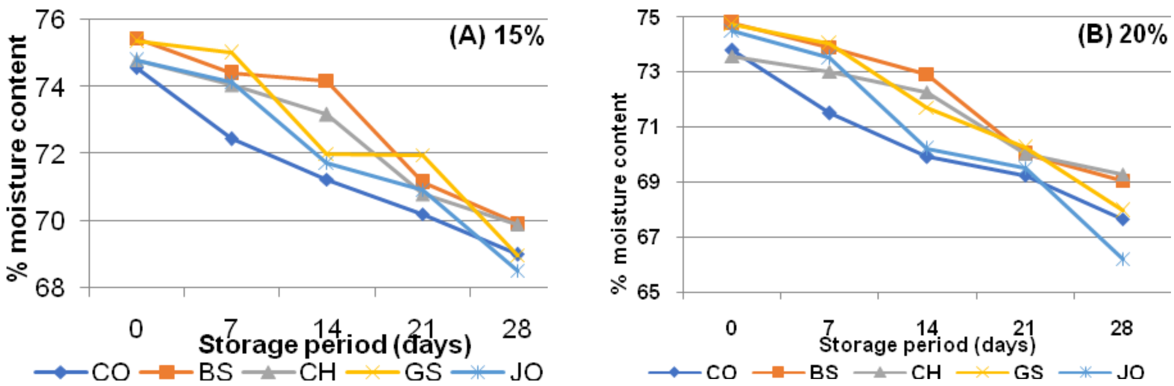

Fig 6: Changes in moisture content of salted grass carp storage at ambient temperature.

2- Protein content:

Protein content in control, black seed, chitosan, grape seed, and jojoba of 15% and 20% salted grass carp were 15.60, 15.67, 15.69, 15.64, 15.61 and 15.57, 15.65, 15.61, 15.67, 15.58, respectively at zero time. It was recorded 12.49, 13.28, 13.64, 13.47, 12.99 and 12.33, 13.26, 13.18, 12.84, 12.90, respectively, at the end of storage period. Results revealed that, protein content was decreased in all treatments after addition of chitosan, grape seed, black seed and jojoba, however, it was higher than control (**Table, 6 and Figure,7**). As a result of decreasing in protein content salt penetrates the tissue, it alters the colloidal properties of the proteins and changes the nature of the water/protein relationship (Zaitzev*et al*., 1969). This finding can be explained as a result of the denaturation of both sacoplasmic and myofibrillar proteins, due to the effect heavy salting on fish muscle. Results are in accordance with El-Sharnouby(1989); Ahmed *et al*. (2010) and Alsaban*et al*. (2014).

Table 6: Changes in crude protein (%, on wet weight basis) in the salted grass carp storage at ambient temperature

		Storage times				
		0 day	7 days	14 days	21 days	28 days
Control	15%	15.60±0.11	15.01±0.12	14.11±0.21	13.38±0.15	12.49±0.66
	20%	15.57±0.21	14.73±0.27	14.01±0.12	13.06±0.17	12.33±0.66
Black seed	15%	15.67±0.21	14.94±0.28	14.79±0.66	13.72±0.17	13.28±0.66
	20%	15.65±0.14	14.76±0.28	14.60±0.24	13.64±0.66	13.26±0.66
Chitosan	15%	15.69±0.17	14.69±0.29	14.16±0.20	13.77±0.17	13.64±0.66
	20%	15.61±0.13	14.41±0.20	14.01±0.28	13.59±0.15	13.18±0.66
Grape seed	15%	15.64±0.17	14.95±0.25	14.53±0.29	13.89±0.19	13.47±0.66
	20%	15.67±0.21	15.06±0.28	14.21±0.27	13.69±0.11	12.84±0.66
Jojoba	15%	15.61±0.09	14.07±0.21	13.60±0.27	13.46±0.10	12.99±0.66
	20%	15.58±0.10	13.86±0.12	13.44±0.26	13.32±0.13	12.90±0.66

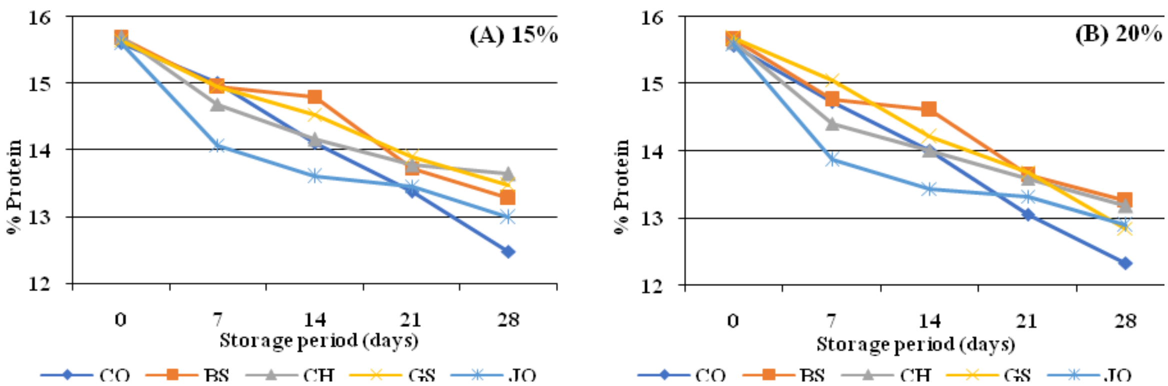

Fig 7: Changes in protein content of salted grass carp storage at ambient temperature

3- Lipid contents:

Lipid contents in control, black seed, chitosan, grape seed, and jojoba of 15% and 20% salted grass carp at zero time were 1.99, 1.76, 1.78, 1.78, 1.88 and 2.02, 1.91, 1.97, 1.95, 1.94, respectively. It was 1.22, 1.40, 1.28, 1.16, 1.26 and 1.45, 1.47, 1.39, 1.38, 1.54, respectively, at the end of storage period. Results revealed that, lipids content was decreased in 15 and 20% salted fish after addition of chitosan, grape seed, black seed and jojoba, however, it was increased than control (**Table, 7 and Figure 8**).

The decreasing in lipid content, may be attributed to their insolubility in water, which diffusion throughout the cell walls to the brine solution and the hydrolysis of triglycerides and phospholipids, which is catalyzed by lipases and phospholipases and release of free fatty acids that is soluble in water and leaching into the drip (Voskresensky, 1966; Aman and Shehata, 1978; Al-Habib& Al-aswad, 1985 and Alsaban*et al.*, 2014).

Table 7: Changes in crude fat (%, on wet weight basis) in the salted grass carp storage at ambient temperature.

Treatment		Storage times				
		0 day	7 days	14 days	21 days	28 days
Control	15%	1.99±0.02	1.60±0.04	1.35±0.04	1.27±0.06	1.22±0.07
	20%	2.02±0.02	1.82±0.04	1.80±0.03	1.49±0.01	1.45±0.02
Black seed	15%	1.76±0.03	1.47±0.09	1.37±0.04	1.24±0.01	1.40±0.03
	20%	1.91±0.04	1.63±0.07	1.66±0.05	1.67±0.02	1.47±0.04
Chitosan	15%	1.78±0.03	1.38±0.03	1.36±0.05	1.41±0.03	1.28±0.05
	20%	1.97±0.07	1.50±0.09	1.47±0.05	1.48±0.04	1.39±0.09
Grape seed	15%	1.78±0.08	1.37±0.06	1.30±0.05	1.19±0.09	1.16±0.05
	20%	1.95±0.09	1.77±0.09	1.62±0.09	1.54±0.03	1.38±0.04
Jojoba	15%	1.88±0.08	1.45±0.09	1.34±0.06	1.30±0.03	1.26±0.04
	20%	1.94±0.04	1.72±0.03	1.63±0.03	1.66±0.03	1.54±0.03

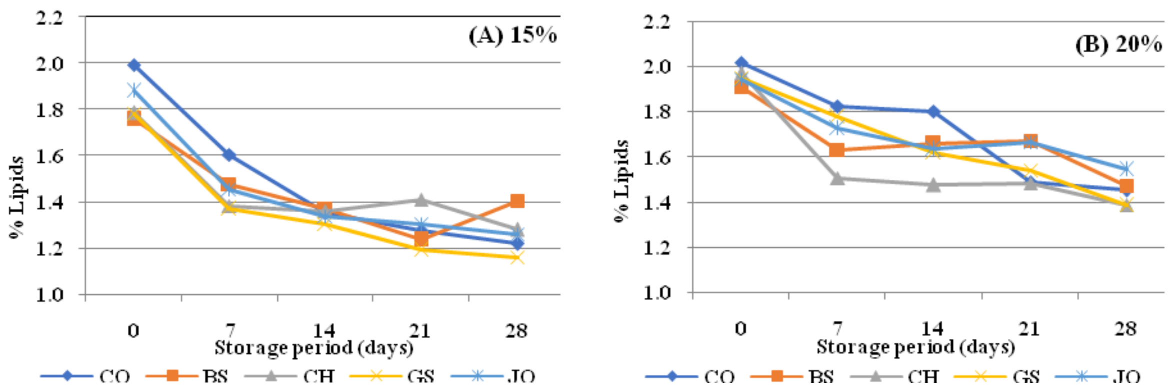

Fig 8: Changes in lipid contents of salted grass carp storage at ambient temperature.

4- Ash content:

Ash content in control, black seed, chitosan, grape seed, and jojoba of 15% and 20% salted grass carp were 3.55, 3.97, 3.52, 3.59, 3.98 and 3.63, 4.05, 4.18, 4.08, 4.23, respectively at zero time. It was recorded 6.22, 6.35, 6.23, 6.35, 6.40 and 6.43, 6.53, 6.75, 6.54, 6.84, respectively, at the end of storage period.

From the above findings, it can be concluded that, ash content was decreased in all treatments, where ash content of salted grass carp after addition of chitosan, grape seed, black seed and jojoba, however, it was higher than control (**Table, 8 and Figure 9**).The increasing in ash content during salting period may be due to effect of extracted lipid which helps to create a crusted surface on each dried fish (Mohammed, 2007) and effect of ground bones and scales in dried meat, also the presence of residues from salt during preparation of samples for analysis and this consequently lead to increase the ash content. Results were in agreement with (Hernandez-Herrero, 1997; Ahmed, *et al*., 2010 and Alsaban, *et al*., 2014). It is known that inorganic matter increases in salted fish and it depends on preservation period and salt rate. Moreover, inorganic matter and salt rates increase along the storage period in a stored anchovy that had been salt cured and were in storage for 29 weeks, and that this condition affects other components (Kolsarici & Candoğan, 1997 and Binici & Kaya, 2017).

Table 8: Changes in ash content (%, on wet weight basis) in the salted grass carp storage at ambient temperature

Treatment \ Storage times		Storage times				
		0 day	7 days	14 days	21 days	28 days
Control	15%	3.55±0.03	3.90±0.01	4.66±0.09	5.05±0.05	6.22±0.06
	20%	3.63±0.04	3.94±0.10	4.78±0.02	5.19±0.05	6.43±0.03
Black seed	15%	3.97±0.09	4.09±0.02	4.80±0.03	5.25±0.03	6.35±0.06
	20%	4.05±0.03	4.18±0.03	4.89±0.08	5.42±0.03	6.53±0.05
Chitosan	15%	3.52±0.08	3.90±0.05	4.64±0.04	5.09±0.05	6.23±0.06
	20%	4.18±0.02	4.24±0.05	5.07±0.05	5.52±0.03	6.75±0.05
Grape seed	15%	3.59±0.02	4.13±0.06	4.81±0.08	5.27±0.03	6.35±0.03
	20%	4.08±0.01	4.36±0.08	5.03±0.06	5.47±0.05	6.54±0.02
Jojoba	15%	3.98±0.07	4.18±0.09	4.86±0.03	5.32±0.03	6.40±0.05
	20%	4.23±0.02	4.33±0.03	5.06±0.05	5.71±0.01	6.84±0.03

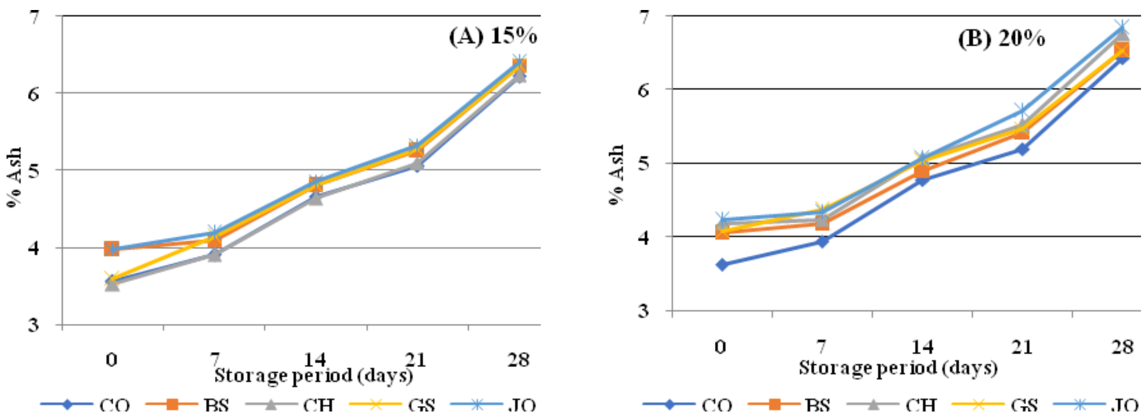

Fig 9: Changes in ash content of salted grass carp storage at ambient temperature.

B- Physicochemical changes of salted grass carp stored at ambient temperature:

1- pH value:

pH value in control, chitosan, grape seed, black seed and jojoba of 15% and 20% salted grass carp were 6.52, 6.52, 6.53, 6.50, 6.53 and 6.49, 6.48, 6.49, 6.49, 6.48, respectively at zero time. It was recorded 7.21, 7.03, 7.00, 6.78, 6.76 and 7.12, 7.00, 6.90, 6.76, 6.74, respectively, at the end of storage period. Data showed that, pH values were decreased in 15 and 20% salt treatments after addition of chitosan, grape seed, black seed and jojoba, however, it was higher than control(**Table, 9 and Figure, 10)**.The decrease in pH values from 6.55 to 6.52 and 6.49 of 15% and 20% of salted fish may be due to the ionic strength of the solution inside of the cells. This results agree with those reported by Leroi & Joffraud (2000)and Goulas & Kontominas (2005).

Table 9: Changes in pH in the salted grass carp storage at ambient temperature.

Treatment \ Storage times		Storage times				
		0 day	7 days	14 days	21 days	28 days
Control	15%	6.52±0.05	6.77±0.01	6.89±0.04	7.00±0.05	7.21±0.04
	20%	6.49±0.01	6.68±0.05	6.86±0.09	6.99±0.01	7.12±0.04
Black seed	15%	6.52±0.04	6.60±0.01	6.67±0.05	6.85±0.04	7.03±0.05
	20%	6.48±0.05	6.59±0.01	6.62±0.04	6.81±0.05	7.00±0.04
Chitosan	15%	6.53±0.01	6.62±0.05	6.62±0.01	6.81±0.04	7.00±0.05
	20%	6.49±0.04	6.57±0.08	6.60±0.04	6.75±0.05	6.90±0.04
Grape seed	15%	6.50±0.05	6.60±0.01	6.70±0.05	6.74±0.04	6.78±0.01
	20%	6.49±0.01	6.58±0.04	6.64±0.01	6.70±0.05	6.76±0.04
Jojoba	15%	6.53±0.04	6.60±0.05	6.66±0.04	6.71±0.06	6.76±0.01
	20%	6.48±0.01	6.59±0.04	6.62±0.05	6.68±0.04	6.74±0.05

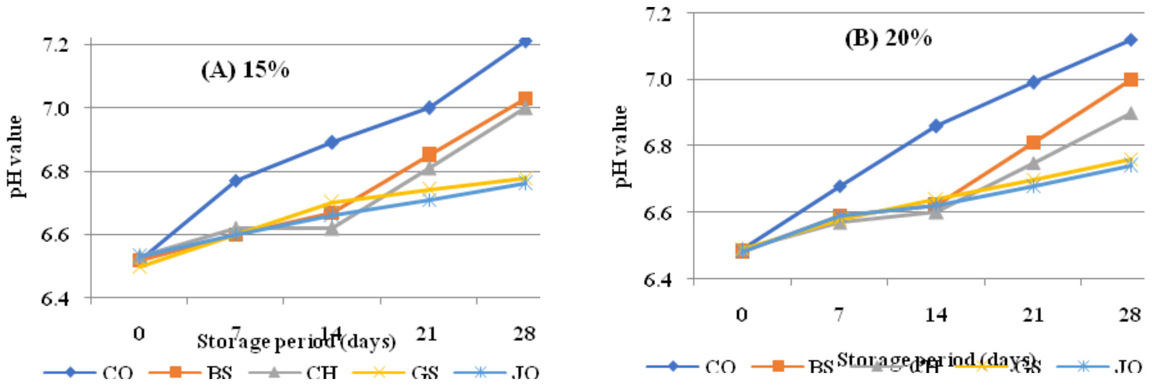

Figure 10: Changes in pH value of salted grass carp storage at ambient temperature.

2- Total volatile basic nitrogen (TVBN):

TVBN values in control, black seed, chitosan, grape seed, and jojoba of 15% and 20% salted grass carp were 15.02, 14.04, 14.90, 14.22 and 15.42 and 14.94, 13.64, 13.54, 13.62, 14.80, respectively at zero time. They were recorded 40.45, 23.45, 24.62, 29.14 and 33.59 and 39.40, 21.90, 23.60, 26.40 and 30.40, mg/100g on wet weight basis, respectively, at the end of storage period. Data showed that, TVBN values were increased in 15 and 20% salt treatments after addition of chitosan, grape seed, black seed and jojoba, however, it was lower than control**(Table, 10 and Figure,11).**

Table 10: Changes in total volatile base-nitrogen (TVB-N, mg/100g) in the salted grass carp storage at ambient temperature.

Treatment \ Storage times		Storage times				
		0 day	7 days	14 days	21 days	28 days
Control	15%	15.02±0.13	22.66±0.10	32.30±0.13	35.45±0.13	40.45±0.10
	20%	14.94±0.10	20.92±0.15	30.73±0.10	32.40±0.15	39.40±0.13
Black seed	15%	14.04±0.11	16.14±0.13	17.12±0.15	20.45±0.10	23.45±0.15

	20%	13.64±0.15	15.35±0.10	16.34±0.13	18.40±0.15	21.90±0.10
Chitosan	15%	14.90±0.10	16.59±0.15	19.87±0.10	21.12±0.11	24.62±0.13
	20%	13.54±0.10	16.27±0.13	18.69±0.15	20.10±0.13	23.60±0.10
Grape seed	15%	14.22±0.11	16.93±0.11	20.39±0.13	24.14±0.10	29.14±0.15
	20%	13.62±0.11	15.14±0.13	18.95±0.15	20.40±0.13	26.40±0.10
Jojoba	15%	15.42±0.15	18.43±0.10	21.45±0.13	26.59±0.10	33.59±0.15
	20%	14.80±0.10	17.72±0.13	20.74±0.10	25.40±0.11	30.40±0.13

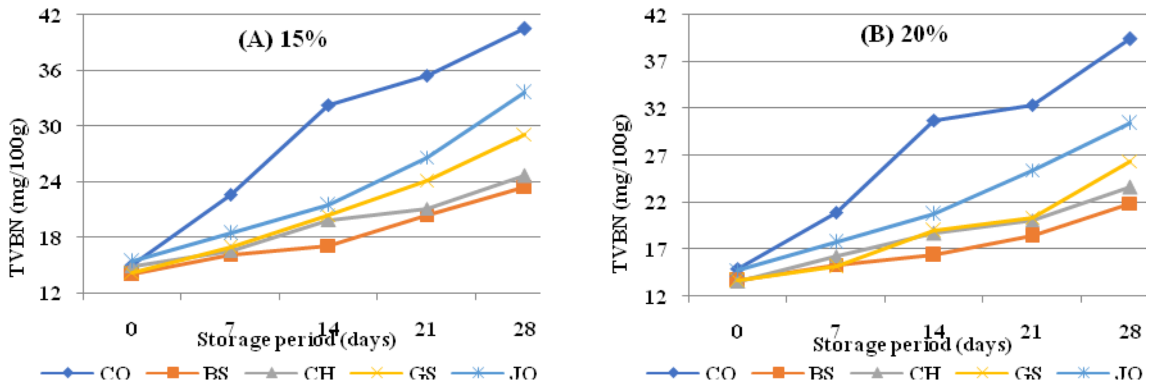

Fig 11: Changes in TVBN value of salted grass carp storage at ambient temperature.

3- Thiobarbituric acid value (TBA):

TBA values in control, black seed, chitosan, grape seed, and jojoba of 15% and 20% salted grass carp were 3.79, 3.36, 3.76, 3.44, 3.63 and 3.50, 3.24, 3.39, 3.38, 3.35, respectively at zero time. It was recorded 11.51, 10.37, 6.54, 7.57, 8.00 and 11.06, 9.94, 5.83, 6.55, 7.08, mg MDA/kg respectively, at the end of storage period.

From the above findings, it can be conculoded that, TBA values were increased in 15 and 20% salt treatments after addition of chitosan, grape seed, black seed and jojoba, however, it was higher than control **(Table, 11 and Figure,12).** The increase in TBA indicated the formation of secondary oxidation products such as aldehydes and other volatile compounds responsible for rancid flavour and off odors as well as colour and texture deterioration. The oxidative breakdown of lipids is also evidenced by the incidence of high TBA values in the respective samples Kolakowska (2002) and Jeyasanta *et al*. (2016).

Table 11: Changes of thiobarbituric acid (TBA, mg MDA /kg) in the grass carp, salted fillets storage at ambient temperature.

Treatment / Storage times		Storage times				
		0 day	7 days	14 days	21 days	28 days
Control	15%	1.79±0.05	3.91±0.09	4.53±0.05	7.69±0.07	9.36±0.06
	20%	1.70±0.06	3.27±0.05	3.98±0.06	7.27±0.05	8.91±0.07
Black seed	15%	1.86±0.09	1.86±0.07	2.26±0.09	2.76±0.07	2.87±0.06

	20%	1.74±0.05	1.76±0.06	1.52±0.05	2.18±0.09	2.44±0.05
Chitosan	15%	1.81±0.09	2.17±0.07	2.41±0.06	3.62±0.05	3.89±0.07
	20%	1.74±0.06	2.10±0.05	2.10±0.09	2.96±0.06	3.68±0.09
Grape seed	15%	1.94±0.07	2.93±0.06	2.96±0.05	4.52±0.07	5.42±0.09
	20%	1.88±0.05	2.65±0.09	2.58±0.09	3.82±0.05	4.40±0.09
Jojoba	15%	1.78±0.09	2.04±0.07	3.88±0.06	4.86±0.09	5.85±0.05
	20%	1.60±0.06	1.85±0.05	3.20±0.09	3.99±0.07	4.93±0.06

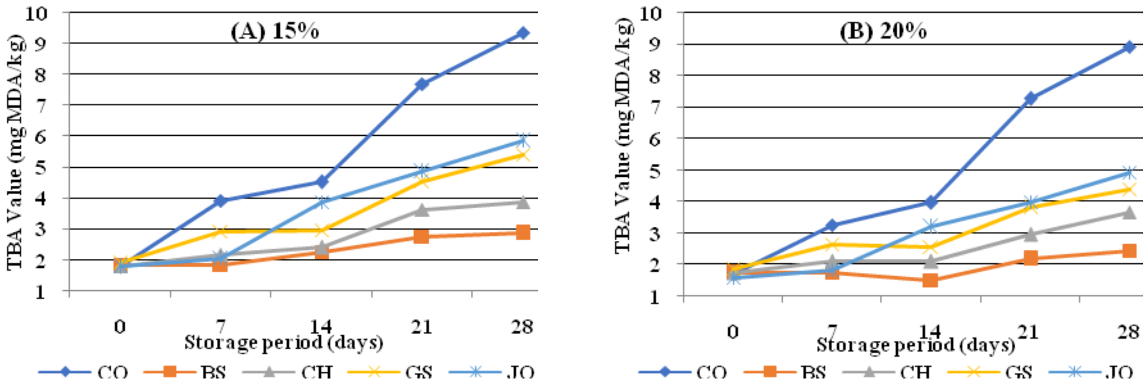

Fig 12: Changes in TBA value of salted grass carp storage at ambient temperature.

C- Sensory evaluation of salted grass carp stored at ambient temperature:

Sensory analysis of 15% and 20% salted grass carp stored at ambient temperature are illustrated at Figures (13 and 14). The overall acceptability scores decreased with the increasing storage period. Samples with 20% salt received higher scores than 15% salt concentration. This may be due to the increasing salt concentration had a progressive effect on increasing the sensory quality at ambient temperature.

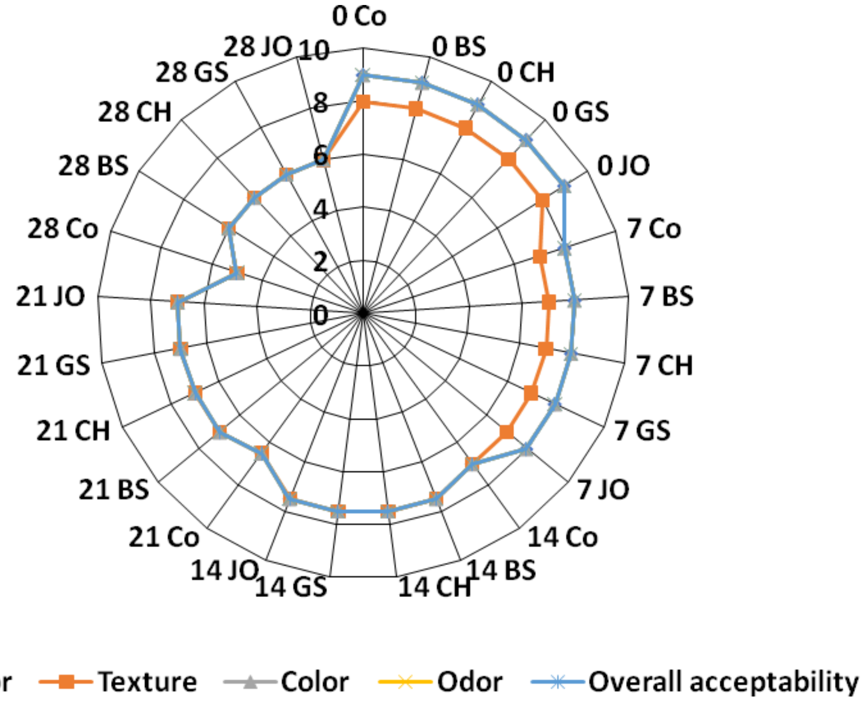

Fig 13: Sensory evaluation of 15% salted grass carp stored at ambient temperature

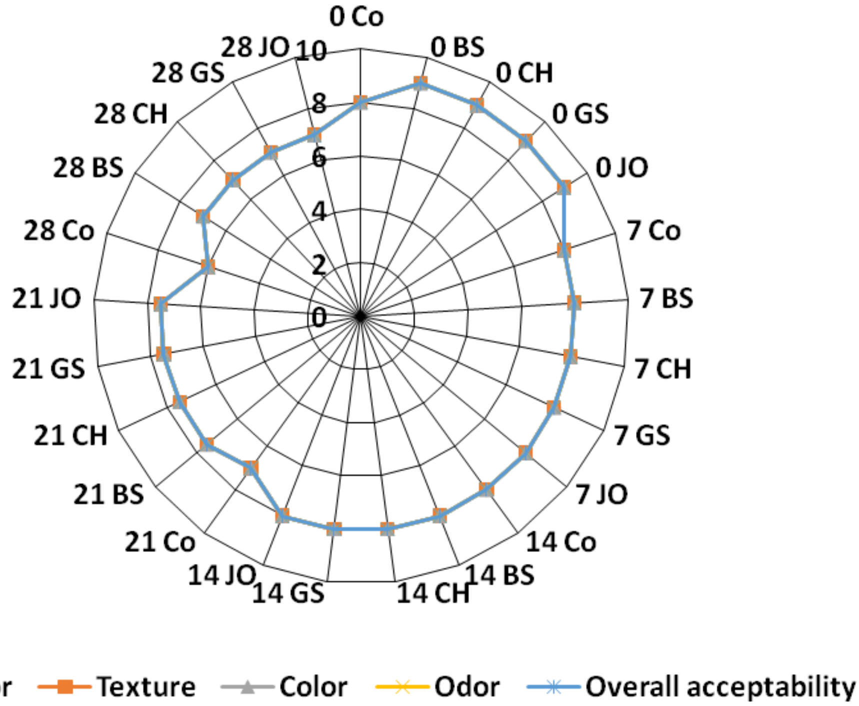

Fig 14: Sensory evaluation of 20% salted grass carp stored at ambient temperature

CONCLUSION

Salting methods have considerable effect on the nutritional value of fish, and in variations of moisture, protein, lipid, and ash contents. It caused significant decreases in moisture, protein, lipids, pH, Ca, K, P, Cd, Cu, Fe, Mn, Ni, and Zn, while it caused a significant increase in ash, carbohydrates, caloric values, TVBN, TBA and Na concentrations. On the other hand, moisture, protein, lipids were significantly decreased during storage, while ash, pH, TVB-N and TBA were significantly increased but not exceed the maximum permissible levels. Such changes in chemical composition and physicochemical aspects during salting and storage of grass carp gave rise to recommend that salting of fish using natural antimicrobial and antioxidants compounds were better than control and they were in the following order: black seed> chitosan>grape seed> jojoba.

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