

EFFECT OF USING SOME ANTIOXIDANTS AND COATING THE DRIED FISH WITH A FILM OF GUM ARABIC ON QUALITY AND SHELF-LIFE OF SALTED SUN-DRIED BOLTI FISH

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Abstract

Bolti fish are the predominate fish caught from Nasser lake which is near by the national project of Toushky. This region has the optimum weather conditions to achieve the sun-drying of fish. Sundrying of fish is the cheapest and simplest method compared to the other preservation methods. But, the main problem of salted dried fish during manufacturing and storage is lipid oxidation which influence the quality and shelf-life of these products.

Therefore, dressed bolti fish were treated during drysalting by adding sodium ascorbate at levels 0.1% (A), 0.2%(B), 0.3% (C) in addition to a mixture of sodium ascorbate 0.1% + sodium metabisulfite 0.1% (D), (as antioxidants). Salted sundried treatments were coated by forming a film of gum arabic on the surface of dried fish. All the products were stored at room temperature till the onset of spoilage.

Chemical and microbiological attributes and absorption and rehydration percent (immediately after drying) were evaluated for all the products. During the storage period, changes of some chemical and microbiological attributes as well as sensory evaluation of cooked and uncooked samples were investigated. Moreover, the ranking method and the critical differences were used to find out the best treatment and to determine the significance between the treatments at the end of the storage period.

The results indicated that the best treatments were B followed by D. On the whole, treatment of the dressed bolti fish (during salting step) by adding sodium ascorbate 0.2% and coating the salted sun-dried fish by forming a film of gum arabic were suggested for better keeping quality and extending the shelf-life of salted sun-dried bolti fish.

INTRODUCTION

Bolti fish (*Tilapia niloticus*) is an important fish produced in numerous parts of A.R.E. Specially from Nasser lake. The predominant fish caught from Nasser lake is the bolti fish. About one third of the total caught fish spoils after catching, during, handling and transportation (Omar et al. 1976). On the other hand Nasser lake is near by the national project at toushky region which has an optimum weather to achieve the

sun-drying process and to produce the salted sun-dried bolti fish at low cost and acceptable quality.

Although fish production hardly meets demand in developing countries, losses in fresh and cured fish are high (FAO 1981, James 1984, Poulter et al. 1988). These losses have in part been attributed to problems associated with curing techniques such as salting and drying that may contribute to the development of off sensory qualities (e.g. texture, color and aroma) leading to influence their utilization as food (Sefaddeh 1995).

The main Problem in the production and storage of salted dried fish is lipid oxidation which may lead to browning, potential loss of nutritional value (Davis et al. 1993) and probably the development of toxicity (Ames 1983). Therefore, this matter has important consequences concerning the salted-dried fish as a source of protein in the developing countries.

Keeping quality of salted-dried fish during storage and extending the shelf-life are desirable. Therefore if the surface of the cured fish is covered and protected by a film of Gums. It could extend the shelf-life of cured product. These gums are non-toxic (Whistler, 1973) and many of them are not conducive to the growth of microbes, for example, gum arabic offers the following advantages: natural ingredient, clean taste, free from sediment and less expensive (Press Conference Report, 1993 and Shetty *et al.*, 1996).

The aim of this work was to process salted sun-dried bolti fish and to evaluate the effect of added antioxidants during the salting step and coating the salted-dried fish by forming a film of gum arabic as means to improve the quality and shelf-life.

MATERIALS AND METHODS

Fresh bolti fish (*Tilapia niloticus*) were used in this study. Commercial white crystalline salt was used for the process of dry salting.

Fish were washed, eviscerated, dressed in butterfly style, cleared thoroughly and divided into five batches. All the batches were dry-salted where the crystalline salt was put in layers exchanged with fish provided that the bottom and surface layers were heavily salted using a salt to fish ratio of 1:1, the first batch (control) was not given any treatment, the other four batches were treated during salting process by adding sodium ascorbate 0.1% (A), 0.2% (B), 0.3% (C) and sodium ascorbate 0.1% + sodium

metabisulfate 0.1% (D) on dressed fish weight bases. Dry salting was carried out at 4°C for 24 hours. Then the salted fish were sun-dried (temperature of air was $40 \pm 3^\circ\text{C}$) for about 16 hours by covering with a net drying and keeping it at the night. After drying, the salted sun-dried fish (except the control samples) were coated by a film of 4% gum arabic solution (acacia gum). Gum solution was prepared by boiling and cooling the solution to 50°C before dipping for coating. The products coated were then dried under sunlight for three hours. All the products were packed into polyethylene bags and stored at room temperature (around $28 \pm 5^\circ\text{C}$) till the onset of spoilage.

Immediately after sun-drying, each product was rehydrated by dipping in tap water till constant weight (about 3-4 hours) provided that water was changed three times during dipping period. The absorption % (related to the weight of product after drying) and the rehydration % (related to the total water loss) were calculated as the percentage of weight change from the dried to rehydrated state.

All the products were analyzed for chemical, microbiological and sensory parameters after drying and during storage every 2 months for up to 6 months. Proximate composition of fresh fish and the products was estimated according to the methods recommended by AOAC (1990). Sodium chloride was determined using the method of silver nitrate titration as given by Pearson (1970). Total volatile base nitrogen (TVBN) was determined as described by Winton and Winton (1958). Thiobarbituric acid value (TBA) was determined using the method given by Pearson (1970). Acetic acid-soluble color (AASC) was determined by the method of Smith *et al.* (1990). Total plate count (TPC) and halophilic bacterial counts (HC) were enumerated using the methods suggested by APHA (1976).

Sensory evaluation of the products was carried out for both the cooked and uncooked forms using a 9-point hedonistic scale. A 20-member panel was employed to evaluate organoleptically the appearance, color, odor and texture for the uncooked form and appearance, color, texture and flavor for the cooked form (rehydrated and cooked by deep frying in cotton seed oil). Ranking method was used (the same panel) to find out the best product among the treatments (by the end of storage, based on the nearness of the fresh fish) which had the lowest sum of ranks, moreover, according to Basker (1988), the critical values of differences among the sum of ranks were used for testing the significant difference between the products (by the end of storage), where, the significance is attained when the rank sum difference are greater than or equal to the critical differences.

RESULTS AND DISCUSSION

Data presented in Table 1 show the chemical and microbiological attributes of fresh and salted sun-dried bolti fish (SSDBF) immediately after sun-drying. From these results, it could be noticed that all the SSDBF products either control or treatments had lower moisture content and higher protein, fat, and ash contents compared to the fresh bolti fish (on wet weight base). This is expected, since, the dry-salting and sun-drying of fish reduced the moisture content of the fresh fish by more than 50%. This means that under the conditions of this study, each one hundred kilogram of dressed fresh fish produces nearly about 45 Kg of salted sun-dried fish.

From the same table, it can easily be noticed that total volatile base nitrogen (TVB-N), thiobarbituric acid value (TBA), acetic acid soluble color (AASC) were increased after the dry salting and sun drying of fresh bolti fish. However, concerning the salted sun-dried products as affected by using some antioxidants during salting and coating with gum arabic after sun-drying, it could be noticed that the treatments (A,B,C and D) were better than the control. Concerning the above parameters, treatment B was the best among all the other treatments. Followed by treatments D, C, A and control, respectively. This indicated that the effect of sodium ascorbate as antioxidant is preferred at certain level (0.2%) during salting in order to reduce lipids oxidation, rancidity and browning (determined as TBA value and AASC unit in salted sun-dried fish).

Also from the same table, concerning the microbiological characteristics, it could be reported that the salted sundried fish had lower bacterial load than the fresh fish. All these treatments had slightly lower bacterial loads when compared to control. The halophilic count was absent (immediately after sun-drying) either for the fresh fish or salted sun-dried products. The previous results were confirmed by the finding of Omar et al., 1976 and Shetty et al., 1996.

Absorption and dehydration percent of salted sun-dried bolti fish are given in Table 2. From these results, it can be seen that all the treatments (A, B,C and D) had high ability (40.6-57.1%) for absorption and rehydration of 28.4 and 24.3% respectively. In general the best treatment was recorded for the B treatment which had the highest absorption (57.1%) and rehydration (41.4%) compared to the other treatments. On the other hand, it is worth to mention that after dry-salting and sun-drying of treatment B, 66 Kg rehydrated fish were obtained per 100 kg dressed fresh fish. This is considerable matter if the fish were sun-dried at a region (like tushky) near by

Table 1. Chemical and microbiological attributes of fresh and salted sun-dried boliti fish (SSDF)*

Parameter*	Fresh Boliti Fish	Salted sun-dried boliti fish*				
		Control	A	B	C	D
1. Parameter*						
Composition:						
Moisture %	77.25	23.39	21.72	20.91	22.56	20.73
Protein %	20.12	57.29	58.55	59.16	57.92	59.26
Fat %	1.85	3.10	3.16	3.19	3.13	3.21
Ash %	0.98	16.22	16.57	16.74	16.39	16.80
II Chemical Characteristics:						
T.V.B-N.	8.55	50.85	50.75	50.00	50.60	49.50
T.B.A.	0.136	0.40	0.32	0.20	0.30	0.28
A.ASC	-	4.14	4.09	2.94	3.48	3.10
Salt %	0.385	15.05	15.32	15.69	15.25	15.80
III Microbiological characteristics:						
T.P.C.	2.5×10^6	9.9×10^5	9×10^5	8.2×10^5	8.6×10^5	7.5×10^5
H.C.	Nil	Nil	Nil	Nil	Nil	Nil

* Control = ssDBF without treatments (only salting and sun-drying).

A = SSDBF treated with sodium ascorbate (0.1 % on dressed fish weight base) during salting.

B = SSDBF treated with sodium ascorbate (0.2% on dressed fish weight base) during salting.

C = SSDBF treated with sodium ascorbate (0.3 % on dressed fish weight base) during salting.

D = SSDBF treated with sodium ascorbate and sodium metabisulfate (0.1% + 0.1% on dressed fish weight basis)

TVB-N = Total volatile base nitrogen (as mg / 100 gm sample).

TBA = Thiobarbituric acid (as mg malonaldehyde kg sample).

AASC = Acetic acid soluble color (Absorbency units ml. / gm).

TPC = Total plate count (cfu/gm).

HC = Halophilic count (cfu/ gm).

The salted-dried products A,B,C and D were coated by a film of 4% gum arabic solution then dried under sunlight.

Table 2. Absorption and rehydration percent of salted sun-dried bolti fish (SSDBF).*

Sample *	Weight (g) of sample					Absorption ** %	Rehydration *** %
	Dressed fresh fish	After drying (1)	Total loss of water	After rehydration (2)	Rehydrated water		
Control	100	46.1	53.9	59.2	13.1	28.4	24.3
A	100	42.8	57.2	63.0	20.2	47.2	35.3
B	100	42.0	58.0	66.0	24.0	57.1	41.4
C	100	44.6	55.4	62.7	18.1	40.6	32.7
D	100	43.0	57.0	63.2	20.2	46.9	35.4

* For explanation see Table 1.

** Attributed to the weight after drying.

*** Attributed to the total loss of water.

**** wt (1) - wt (2)

the place of catching (like Nasser Lake), thereby, the costs will be reduced in every respect.

Changes in total volatile base nitrogen (T.V.B-N), thiobarbituric acid value (T.B.A.), acetic acid soluble color (AASC), total plate count (TPC) and halophilic count (HC) of salted sun-dried boliti fish during storage period at room temperature till the onset of spoilage are presented in Table 3. Concerning the TVB-N contents of salted sun-dried products (control and treatments) during the storage period, it can be seen that the amounts of T.V.B-N. of all the products were increased by increasing the storage period but, the control sample showed higher amounts of TVB-N than all treatments. The control samples were nearly rejected by the end of the fourth month, while, all the treatments were accepted till the sixth month. Moreover according to the content and increasing rate of TVB-N during the storage period, the best treatment was recorded for the treatment B followed by D. These results were confirmed by the finding of Velankar, 1952 and Astawan *et al.*, 1994 who reported that the cured products are acceptable even when the TVB-N value is 200 mg per 100 gm sample.

Lipid oxidation and browning during the storage period were expressed as TBA value and AASC. From the results presented in table 3 it can be observed that AASC levels increased by increasing the storage period untill the sixth month while the T.B.A values are confirmed by the finding of Smith *et al.* (1990) who reported that the TBA value only indicates the onset of lipid oxidation thereafter decrease, while, the continued increase found in the levels of AASC indicate the advanced lipid oxidation and browning during the storage period. Therefore, AASC appears to be more useful and reliable indicator of lipid oxidation during storage of salted-dried fish than the TBA values. On the other hand, all the treatments were better than the control. The best treatment among all the products was recorded for treatment B followed by D. Any way, the previous results and discussions indicate the importance of using some antioxidants at certain level (sodium ascorbate 0.2% or sodium ascorbate 0.1% + sodium metabisulfat 0.1%) during dry-salting in addition to coating the dried fish by forming a film of gum arabic on the surface to reduce the lipid oxidation and extend the shelf-life of salted sun-dried boliti fish.

Also from the results presented table 3, concerning the microbiological characteristics, it could be observed that the control was rejected by the end of the fourth month due to developing the mould. The TPC of stored treatments showed an increasing trend till the end of the second month then decreased till the end of storage period. The decreasing TPC may be attributed to lower water activity/moisture content

Table 3. Changes in total volatile base nitrogen (TVB-N), thiobarbituric acid (TBA), acetic acid soluble color (AASC) total Plate count (TPC) and halophilic count (HC) of salted sun-dried bolti fish during storage period at room temperature*.

6	4	2	0	Storage (months)	
-	198.65	90.50	58.15	Control	TVB-N
142.20	101.62	75.31	50.75	A	
100.33	84.71	66.40	50.00	B	
138.15	94.00	71.36	50.60	C	
122.00	85.50	65.10	49.50	D	
-	0.72	0.55	0.40	Control	TVB-N
0.47	0.56	0.45	0.32	A	
0.35	0.41	0.30	0.20	B	
0.41	0.50	0.44	0.30	C	
0.40	0.45	0.39	0.28	D	
-	9.22	5.80	4.14	Control	TVB-N
8.16	6.50	4.93	4.09	A	
6.66	4.61	3.75	2.94	B	
7.95	6.13	4.40	3.84	C	
7.00	5.23	3.96	3.10	D	
-	5.6×10^5	1.2×10^6	9.9×10^5	Control	TVB-N
8.7×10^4	4.5×10^5	1.0×10^6	9.0×10^5	A	
5.2×10^4	3.8×10^5	9.6×10^5	8.2×10^5	B	
8.0×10^4	4.3×10^5	1.0×10^6	8.6×10^5	C	
5.4×10^4	3.8×10^5	9.7×10^5	7.5×10^5	D	
-	1.7×10^4	40×10^2	Nil	Control	TVB-N
3.0×10^3	2.0×10^4	2.4×10^2	Nil	A	
8.2×10^2	5.5×10^3	1.0×10^2	Nil	B	
3.5×10^3	3.2×10^4	2.8×10^2	Nil	C	
9.0×10^2	5.0×10^3	1.0×10^2	Nil	D	

* For explanation see table 1.

and high salt content in the cured product and its bactericidal effect (Shetty et al., 1996). On the other hand, halophilic bacteria could be detected only at the end of the 2nd month of storage and a gradual increase was noticed till the fourth month, thereafter it recorded a decreasing trend till the end of storage. Halophilic bacteria can grow between water activity levels of 0.75-0.90 (FAO, 1981). As the water activity of the products remained mostly within this range, it was conducive for their growth. But, at the end of 4th month, water activity probably reduced to less than 0.75. Therefore, this must be the reason for low halophilic count in the treatments. In general, microbiologically, the best product was recorded for the B treatment.

The results presented in Table 4 show the sensory evaluation of uncooked and cooked samples of salted sun-dried bolti fish during the storage period. From these results, it could be noticed that the control was organoleptically acceptable even at the 4th month of storage. But thereafter, it was rejected due to the excessive mould growth. The treatment B (on the whole) scored better average panel scores than the other treatments. Nevertheless, all the treated samples were acceptable even after storage for 6 months. It might be due to using some antioxidants during salting specially sodium ascorbate at level of 0.2% and coating by forming a film of gum arabic on the surface of dried fish. The above mentioned trend was recorded either for cooked or uncooked samples but, the cooked samples had higher scores than the uncooked samples.

Results of ranking method and critical differences used to find out the best treatment among the products and to determine the significant differences between the products at the end of storage are given in Table 5. From these results, it could be reported that treatment B had the minimum total sum of ranks and gave the best product followed by the treatments D,C and A respectively. The above mentioned trend was recorded either for the uncooked or cooked samples. On the other hand, with respect to the uncooked samples, there was a significant difference between the best product (B) and the other products at 0.05 significance level while at 0.01 significance level, the products B and D did not differ significantly. In case of cooked samples, there was a significant difference between the best product (B) and the other products with the exception of product D which recorded no significant difference with B (either at 0.05 or 0.01 significance level).

Finally, it can be concluded that treatment of the dressed fish through the dry-salting step with sodium ascorbate 0.2%, in addition to coating the salted sun-dried fish with gum arabic film were found to be the best in preserving the quality-specially lipid oxidation-and extending the shelf-life of salted sun-dried bolti fish because the first treatment acts as antioxidant and the later as barrier to air and moisture.

Table 4. Sensory evaluation of salted sun-dried bolti fish during storage period (6 months) at room temperature.*

Attributes	Control							A							B							C							B						
	0		2		4		6		0		2		4		6		0		2		4		6		0		2		4		6				
Uncooked samples																																			
Appearance	7.5	6.2	5.0	-	7.1	6.9	6.0	5.3	7.3	7.5	7.2	6.3	7.1	7.0	6.1	5.5	7.2	7.4	7.0	6.0	6.0	6.0	7.2	7.4	7.0	6.0	6.0	6.0	6.0	6.0					
Color	6.8	6.0	5.1	-	6.8	6.2	5.8	5.5	7.7	7.7	7.3	6.4	6.9	6.4	6.0	5.6	7.5	7.1	6.4	6.0	6.0	6.0	7.5	7.1	6.3	6.0	6.0	6.0	6.0	6.0					
Odor	7.0	6.2	4.8	-	7.0	6.6	6.1	5.3	7.2	7.6	7.2	6.9	7.0	6.5	6.2	5.5	7.1	7.2	6.7	6.3	6.3	6.3	7.1	7.2	6.7	6.3	6.3	6.3	6.3	6.3					
Texture	7.5	7.1	6.8	-	7.2	7.4	6.2	5.4	7.6	7.5	7.4	7.2	7.2	7.3	6.1	5.7	7.3	7.3	7.3	6.8	6.8	6.8	7.3	7.3	7.0	6.8	6.8	6.8	6.8	6.8					
Cooked samples																																			
Appearance	7.8	7.0	5.7	-	7.6	7.3	6.3	5.6	7.8	7.9	7.5	6.8	7.5	7.1	6.3	5.7	7.5	7.4	6.4	6.4	6.4	7.5	7.4	7.0	6.4	6.4	6.4	6.4	6.4	6.4					
Color	7.0	6.1	5.5	-	7.2	6.7	6.2	5.6	8.0	8.1	7.8	7.1	7.3	6.8	6.4	5.5	7.5	7.4	6.4	6.4	6.4	7.5	7.4	7.1	6.6	6.6	6.6	6.6	6.6	6.6					
Texture	7.6	7.0	6.6	-	7.5	7.1	6.6	5.8	7.6	7.7	7.5	7.0	7.5	7.2	6.7	6.1	7.5	7.5	6.7	6.7	6.7	7.5	7.5	7.2	6.8	6.8	6.8	6.8	6.8	6.8					
Flavor	7.7	6.8	6.2	-	7.7	7.0	6.4	5.7	7.9	8.0	7.5	7.1	7.7	7.2	6.5	5.8	7.9	7.6	6.5	6.5	6.5	8.0	7.6	7.0	6.7	6.7	6.7	6.7	6.7	6.7					

* Values are mean of the scores given by 20 panelists on a 9 point hedonic scale.

* For explanation see table 1.

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Table 5. Results of ranking method and critical differences used for salted sun-dried fish at the end of storage months (at room temperature).

Product	Uncooked				Cooked			
	A	B	C	D	A	B	C	D
Sum of ranks	79	20	60	41	79	21	61	39
Difference Vs A		59	19	38		58	18	40
B			40	21			40	18
C				19				22
Significance level	P=0.05		P=0.01		P=0.05		P=0.01	
Critical difference	21		25.4		21		25.4	
Product B	a		a		a		a	
D	b		ab		b		ab	
C	bc		bc		bc		bc	
A	c		c		c		c	

* The lowest sum of ranks means the best product.

= The preferred products differs significantly (different letters) when the rank sum differences are greater than or equal to the critical difference.

= For explanation A,B,C,D see table 1.

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تأثير استخدام بعض مضادات الأكسدة وتغطية الأسماك المملحة المجففة شمسيا بفيلم من الصمغ العربي علي جودة ومدة صلاحية أسماك البلطي المملحة المجففة شمسيا

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تعتبر أسماك البلطي هي الأسماك السائدة في بحيرة ناصر بالقرب من المشروع القومي في منطقة توشكى والتي يتوفر فيها الظروف الملائمة لتجفيف هذه الأسماك شمسيا، كما أن حفظ الأسماك بالتجفيف الشمسي تعتبر الأرخص والأسهل مقارنة بطرق الحفظ الأخرى، لكن المشكلة الرئيسية بالنسبة للأسماك المملحة المجففة هي أكسدة الليبيدات أثناء الإنتاج والتخزين مما يؤثر على جودة ومدة صلاحية هذه المنتجات .

لذلك تم معاملة أسماك البلطي المجهزة أثناء خطوة التمليح الجاف بإضافة أسكوريبات الصوديوم على مستويات ٠.١٪ (أ)، ٠.٢٪ (ب)، ٠.٣٪ (ج) بالإضافة إلى المعاملة بخليط من ٠.١٪ أسكوريبات صوديوم + ٠.١٪ ميتايسلفيت صوديوم (د) كمواد مضادة للاكسدة .

كما تم تغليف المعاملات المملحة المجففة شمسيا وذلك بتكوين فيلم من الصمغ العربي على سطحها، ثم قورنت المعاملات بعينة مملحة مجففة شمسيا بدون أية إضافات (كنترول)، ثم خزنت جميع المنتجات على درجة حرارة الغرفة حتى هجوم الفساد.

تم تقييم الخصائص الكيماوية والميكروبيولوجية والنسب المئوية للتشرب والإسترجاع لجميع المنتجات بعد التجفيف مباشرة، كما تم بحث التغيرات في بعض الخصائص الكيماوية والميكروبيولوجية وكذلك الخواص الحسية للعينات المطبوخة وغير المطبوخة لكل المنتجات أثناء مدة التخزين. علاوة على ذلك تم تحديد المعاملة الأحسن بالـ Ranking method وقياس المعنوية بين المعاملات المفضلة باستخدام الفروق الحرجة وذلك في نهاية مدة التخزين .

أظهرت النتائج أن المعاملات كانت أفضل من الكنترول علاوة على أن المعاملة (ب) كانت الأحسن من بين المعاملات وذلك من ناحية الخصائص المقدرة بعد التجفيف مباشرة. كما - بينت النتائج أثناء التخزين أن جميع المعاملات كانت أفضل من الكنترول وأن المعاملة (ب) كانت أفضل المعاملات طبقا للمقاييس المقدرة أثناء التخزين . وفي نهاية مدة التخزين أوضحت بالـ Ranking method أن أفضل المعاملات هي المعاملة (ب) متنوعة بالمعاملة (د)، كما تبين طبقا للفروق الحرجة وجود فروق معنوية بين المعاملة الأفضل (ب)

وبقية المعاملات باستثناء المعاملة (د).

يوجه الأجمال ، يقترح معاملة أسماك البلطى المجهزة بإضافة ٠,٢ ٪ أسكوريات صوديوم أثناء خطوة التمليح بالإضافة إلى تغليف الأسماك المملحة الجففة بفيلم من الصمغ العربى للمحافظة على الجودة وإطالة مدة الصلاحية لهذه المنتجات إلى ٦ شهور بدلا من ٤ شهور للكنترول .