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EFFECT OF SOME PROCESSING FACTORS ON QUALITY AND SHELF-LIFE OF SMOKED MAKEREL FISH

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ABSTRACT

In this work mackerel fish (*Scomber scombrus*) was used. Two methods of shape preparation (butterfly and gutted), low percentage of salting (3% salt), dry and wet salting methods, treatments with sodium erythorbate, potassium sorbate as antioxidants and natamax as antifungal agent were carried out.

After cold smoking all samples were packaged in carton boxes lined with parchment paper and stored at room temperature (24°C). After smoking process, the organoleptic evaluation indicated that the prepared samples as butterfly shape had the best quality specially the dry salted samples. The physicochemical properties showed that the moisture content, water activity and pH values of butterfly shape decreased more than those of gutted shape, while salt and ash contents were higher in butterfly than those of gutted shape. The butterflied samples kept the highest percentage of protein content. The results indicate that the prepared samples as butterflied shape had the longest shelf-life (24 and 27 days) for dry and wet salted samples, respectively compared with gutted shape samples which it had 14 days shelf-life for both salting methods. All that samples dry and wet salted, butterfly and gutted shapes which had longest shelf-life were the samples treated with both of sodium erythorbate and natamax

INTRODUCTION

Smoking is one of the oldest methods of fish preservation, it is less expensive than other methods and preferred product to Egyptian consumers. The smoked fish production in Egypt was mainly depended on imported herring. In this investigation, mackerel fish was chosen in steed of herring fish because it's cheaper than herring fish, and also it contains a suitable fat ratio. Ahmed (1991)reported that the ash content and also salt (NaCl) were increased attributing to the addition of salting mixture and the loss of water during smoking process. Hussein *et al*. (1980) reported that after salting of horse mackerel in saturated brine solution for 3 min, the sodium chloride increased from 0.64 to 7.46%, while the total nitrogen (TN), total soluble nitrogen (TSN) and amino nitrogen (AN) contents decreased by 23.87, 22.45 and 25.93% of original values, respectively. Chiau and Chai (1985) reported that the smoking process reduced moisture content, while it highly increased ash, however lipid and protein content slightly decreased.

Etman (1985), and Hammad (1985) reported that total volatile nitrogen, trimethylamine nitrogen and amino nitrogen tended to increase during storage, according to the storage conditions, i.e. temperature and time. This could be mainly due to hydrolysis and autolysis of proteins.

MATERIALS AND METHODS

Materials:

- Fish: Imported mackerel fish (*Scomber scombrus*) obtained from the Food Star Comp. for Import and Export, Alexandria, Egypt.
- Antioxidant: as sodium erythorbate (SE), and antifungal agents: Natamax (NM) which consists of (natamicin, and lactose by ratio 1:1), potassium sorbate (PS) obtained from Egyptian Promoting Center (EPC), Cairo, Egypt.
- Salt: Sodium chloride grade No. 2 produced by El-Nasr Salines Company.
- Smoke source: Sawdust and shaves of beech wood used in proportion (1:1 w/w), respectively.

Methods:

Preparation of fish samples:

The frozen fish were thawed at room temperature (24°C) for 4 hours to internal fish temperature of -2 : 0°C and then was divided into two groups. The first group was only gutted, while the second was dressed as a butterfly.

Treatment with antioxidant:

The two groups were immersed for 5 min into sodium erythorbate (SE) solution (30 gm/L). Each of the forward groups were divided into two subgroups for salting process. The first two subgroups were salted by dry method and the others were salted by wet method.

Salting:

Wet salting:

The gutted and butterflied samples were immersed in saturated brine solution (400 gm NaCl/liter) for 30 and 15 min. at room temperature, respectively. All samples were rinsed with the tap water.

Dry salting:

The other gutted and butterflied samples were dry-salted with a mixture which composed of 96% salt, 2% spices, 2% sugar at a ratio of 1 salting mixture : 3 fish (w/w) for 30 and 15 min at room temperature, respectively. The mixture of spices composed of hot paprika, sweet paprika, black pepper, cumin and thimath. All samples were washed with the tap water to remove the excess of dry salt.

Treatment with antifungal agents:

The two groups (gutted and butterflied samples) were treated with antifungal agents during the dry salting process by mixing potassium sorbate (PS) as 3% from the added salt or 4 g of natamax / kg fish. In the case of wet salting, the samples were dipped into 1.2% potassium sorbate (PS) solution or/and into 4000 ppm natamax solution for 5 min after salting.

Drying:

The salted and treated samples were kept on a net shelves and allowed to drain and semi-dried for over night (16 hours) inside ventilated room at (24°C) before smoking process.

Smoking:

The fish samples were smoked in smoking kilns using sawdust and shaves of beech wood at 27°C for 24 hours at the Seafood's Misr Company for Fish Trading and Processing, Kafr El-Sheikh, Egypt.

Packaging:

All samples were packaged in carbon boxes provided with parchment paper and stored at room temperature (24°C).

Analytical procedures:

Preparation of samples for analysis:

Samples were beheaded, skinned and dressed. The backbone with ribs drived out. The cut fillets of raw fish only clipped in 1% chilled brine solution to remove the excess blood. All samples were passed through a meat chopper twice. The ground samples were packaged into polypropylene sacks and stored at -18°C for analysis.

Chemical determinations:

The moisture content, crude protein content, crude fat, ash, sodium chloride, free amino nitrogen (FAN) were determined using methods described by A.O.A.C. (1990). Total soluble nitrogen (TSN) was extracted according to the method mentioned by El-Garbawi and Dugan (1965), the obtained extract was used for the determination of total soluble nitrogen (TSN) as described by A.O.A.C. (1990). Non-protein nitrogen (NPN) was determined by the method of Jacobs (1962). Total volatile nitrogen (TVN) was determined according to the method of Mwansyemela (1973). pH value of fish slurry was determined at room temperature according to the method of Aitken *et al*. (1962). Water activity (a_w) was calculated by the equation mentioned by Demeyer (1979).

Sensory evaluation

Smoked fish were sensory evaluated by ten panelists from the members of Food Industries Dept., Fac. of Agric., Mansoura Univ., according to Atlant NIRO evaluation method which described by Shehata (1980).

RESULTS AND DISCUSSION

Evaluation of smoked mackerel fish immediately after processing:

The sensory evaluation of smoked mackerel fish prepared as butterfly and gutted shape (Table 1) indicated that the dry salted butterflied is the best sample. It has a highest score, which has a superior taste (10) and texture (5) were found in this treatment. It was observed that the high composite score (32.5) was noticed for this treatment, while the gutted samples has (30.5) for the same dry salted samples. Also, the wet salted fish prepared as butterfly realises (31), while the same wet salted fish prepared as gutted has (29) composite score.

Table 1. Sensory evaluation of smoked mackerel fish after smoking process at zero time.

Sensory Properties	Final score	Preparation shape			
		Gutted		Butterfly	
		Dry Salting method	Wet Salting method	Dry Salting method	Wet Salting method
Appearance	5	4.0	4.0	4.5	4.5
Color	5	4.5	4.5	4.0	4.0
Texture	5	4.5	4.0	5.0	4.5
Taste	10	9.0	8.0	10.0	9.0
Odor	10	8.5	8.5	9.0	9.0
Composite score	35	30.5	29.1	32.5	31.0

On the other hand, the physico-chemical properties also indicate that the moisture content decreased in all samples compared with raw fish as a result of salting and smoking (Table 2). The decrease was higher at the case of butterfly shape, when was dry salted than the gutted shape. This may be due to the relative greater surface area of the butterfly shape. This result is in agreement of those obtained by Hussein *et al*. (1980). On the other hand, the salt content in all samples increased, the percentage of salt was around 3%, this percentage is one of the aims of this investigation. The increase was more in the dry salted butterfly than the gutted shape. Ash content was also increased as a result of dehydration causing by salting and smoking (Chian and Chai, 1985). Ash content of the butterfly shape was higher, specially in dry salted samples than the gutted dry or in wet salted samples. The water activity (a_w) decreased for all smoked samples compared with the initial value (0.9986). The water activity (a_w) of butterfly shape were less than that of the gutted shape. All the above parameters indicated the reason that the dry salted butterfly shape had a longest shelf-life.

About the protein content of smoked fish, it was lower in the smoked fish than the raw fish. The butterfly shape kept the highest percentage of protein content. It was remarked that the wet salted fish as butterfly shape had a higher percentage of protein content than the dry salted butterfly shape. It may be due to the loss of some salt soluble proteinbs during dry salting (Hammad, 1985).

Non-protein nitrogen (NPN), total volatile nitrogen (TVN) and free amino nitrogen (FAN)increased after smoking for all samples. This may be due to the activity of enzymatic hydrolysis of protein by the smoking temperature (Plahar *et al*., 1991). The pH value of smoked fish decreased from 6.4 for raw fish to 6.30, 6.25 for dry and wet gutted smoked fish and to 5.8, 5.7 for dry and wet butterfly smoked fish, respectively. These results proved that the butterfly shape were exposed to the action of organic acids which generated during the smoking process than the gutted shape.

The fat content increased in all samples, this increment may be due to the loss a part of water content throughout drying and smoking processes.

On the other hand, it could be noticed that fat content is higher in dry salted than in wet salted for both gutted and butterfly shape. It may be due to the more leaching of some of water content caused by dry salting method.

Evaluation of smoked mackerel fish at the end of shelf-life:

The results in Tables (3 and 4) showed that the butterflied samples had longer shelf-life (24 and 27 days) for dry and wet salted samples, respectively than the gutted samples which showed 14 days for both of dry and wet salted method. The increase of shelf-life in the wet salted than the dry salted butterfly shape may be due to the perferability of antifungal agents and antioxidant absorption during salting at the liquid phase.

All that samples, dry and wet salted butterflied and gutted samples, which had longer shelf-life, were the treated samples with sodium erythorbate and natamax. The another variations of treatment with antioxidant and antifungal agents had a shorter shelf-life.

The water content decreased with different rates (Table 3), the percentage of water losses (as percentage of the initial water content) were 7.9 and 41.86 for dry and wet gutted shape , 18.61 and 23.07% for dry and wet butterfly shape, respectively. This decreasing water content may be due to the decrease of water holding capacity as a result of continuous autolysis of protein and then the decrease of water holding, and evaporation of water during semi-drying and smoking processes (Etman, 1985), separation of some fluid as drip, increased sodium chloride of fish tissues (Karara *et al*., 1981). The different of decrease of water content which were higher in the butterflied than gutted shape fish may be due to the relative greater surface area of the butterflied than the gutted shape.

Also, it could be noticed that the amount of salt content continuously increased during the shelf-life period. This may be due to the adverse relationship between the amount of sodium chloride and water content and to the loss of a part of dry matter (as volatile substances) (Chian and Chai, 1985). Data in Table (3) revealed also that the dry and wet salted butterflied samples showed lower water activity values (0.943 and 0.942, respectively) than that of both dry and wet salted gutted samples (0.957). It may be due to the higher rate of water content in the gutted shape at the end of it's shelf-life. All these factors "higher salt content, lower water content and lower water activity" indicate the longer shelf-life of the prepared samples as butterfly. Data in Table (4) indicated the FAN, NPN, and TVN were increased during the storage period in all samples, but in different rates, which it was more in the butterflied samples than the gutted samples specially the NPN and TVN. This increase in TNPN and VN content could be attributed to the degree of decomposition of protein constituents by the effect of the protolytic enzymes on the tissues and by the microbial contamination, which may occur during the storage periods. This result is in agreement with Etman (1985), and Hammad(1985).

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4

Increases of FAN and NPN were more in the wet salted samples than the dry-salted samples. From Table (4), it could be seen a clearly increase in pH value for fish samples prepared as butterflied, and a slight increase for fish samples prepared as gutted. This increase in pH value may be due to the increase of FAN and TVN during storage period.

CONCLUSION

Preparation fish for smoking processing as butterfly shape with dry salting method is more acceptable method whether for its panel properties or for its physico-chemical properties and long shelf-life, which using sodium erythorbate 30 g/liter and natamax 4 g/kg fish. This work needs more study using another packaging methods and refrigeration storage

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تأثير بعض عوامل التصنيع على جودة وفترة صلاحية أسماك الماكريل المدخنة

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إستخدم فى هذا العمل أسماك الماكريل *Scomber scomberus* وتم إعداد الأسماك بطريقتين الشكل Butterfly والشكل Gutted ثم التمليح بإستخدام نسبة منخفضة من ملح الطعام ٣% وبإتباع طريقتين ، الجافة والرطبة مع إستخدام أيروثوربات الصوديوم ، سوربات البوتاسيوم كمضادات للأكسدة والناتامكس كمضاد للفطريات

وكذلك إستخدام مضادات الأكسدة بعد التدخين على البارد ، عبئت كل العينات فى علب كرتون مبطنة بأوراق البارشمنت وخزنت على درجة حرارة الغرفة وبعد عملية التدخين أظهرت إختبارات التذوق أن أحسن مواصفات حصلت عليها العينة المعدة على شكل butterfly وبخاصة العينة المملحة بالطريقة الجافة٠

أظهرت نتائج التحليل الفيزوكيمائية أن هناك-:

- نقص فى الرطوبة والنشاط المائى a_w والـ pH فى العينة المعدة على شكل butterfly عن العينة المعدة على شكل gutted ٠
- وعلى العكس زادت نسبة الأملاح وبالتالى الرماد فى الـ butterfly عن الـ gutted ٠
- إحتفظت الأسماك المعدة بطريقة butterfly بنسبة أعلى من البروتين٠
- أظهرت النتائج أن فترة الصلاحية أطول بالنسبة لعينات (٢٤ ، ٢٧ يوم) butterfly يوم للأسماك المملحة بالطريقة الجافة والطريقة الرطبة على التوالى٠ بالمقارنة بأسماك الـ guttedحيث أن فترة صلاحيتها ١٤ يوم بكلا طريقتى التمليح٠
- كل تلك العينات الـ butterfly والـ gutted المملحة بالطريقة الجافة والرطبة التى أظهرت فترة أطول وصلاحية العينات التى عوملت بواسطة ايروثوربات الصوديوم والناتامكس٠

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Table 2. Physico-chemical properties of smoked mackerel fish after smoking process at zero time on wet weight basis.

Preparation shape	Salting Methods	Parameters									
		Moisture (%)	Salt (%)	Ash (%)	a_w*	Protein (%)	NPN Mg/100g	TVN Mg/100g	FAN Mg/100g	pH	Fat (%)
Raw fish	--	67.65	0.317	1.03	0.9986	16.18	106.12	13.06	42.38	6.40	15.14
Gutted	Dry	58.39	3.01	7.83	0.9703	13.37	125.67	37.37	77.81	6.30	20.41
	Wet	60.50	2.87	6.49	0.9727	14.32	117.64	31.78	65.14	6.25	18.69
Butterflied	Dry	52.87	3.09	9.98	0.9660	14.57	135.27	26.39	69.76	5.80	22.58
	Wet	55.39	3.03	8.38	0.9684	15.95	124.90	29.66	74.94	5.70	20.28

*** a_W = Water activity.**

Table 3. Some chemical properties of smoked mackerel fish stored at room temperature (24ºC) at the end of shelf-life.

Treat.	Dry salting gutted fish				Wet salting gutted fish				Dry salting butterflied fish				Wet salting butterflied fish			
	Shelf Life Day	Moisture (%)	Salt (%)	a_W	Shelf life day	Moisture (%)	Salt (%)	a_W	Shelf life day	Moisture (%)	Salt (%)	a_W	Shelf life Day	Moisture (%)	Salt (%)	a_W
1	-	58.39	3.01	0.9703	-	60.50	2.89	0.9727	-	52.87	3.09	0.9660	-	55.39	3.83	0.9684
2	5	55.32	7.83	0.9630	5	53.00	7.70	0.9600	5	48.87	7.42	0.9540	5	49.19	7.09	0.9570
3	5	55.02	7.66	0.9640	5	56.16	7.70	0.9650	6	49.29	7.20	0.9570	8	46.36	7.15	0.9510
4	10	53.21	8.11	0.9530	10	52.67	7.99	0.9580	21	49.05	7.63	0.9530	23	46.32	7.56	0.9480
5	14	53.73	8.43	0.9570	14	51.51	7.71	0.9570	24	43.03	7.34	0.9430	27	42.61	7.34	0.9420
6	10	52.37	7.73	0.9580	10	53.09	7.57	0.9610	10	46.81	7.22	0.9520	10	46.69	7.18	0.9510
7	10	52.91	7.47	0.9610	10	51.64	7.38	0.9590	11	44.34	7.29	0.9460	14	45.10	7.22	0.9480

1. Control (at zero time).
2. Smoked fish.
3. Smoked fish treated with SE.
4. Smoked fish treated with NM.
5. Smoked fish treated with SE + NM.
6. Smoked fish treated with PS.
7. Smoked fish treated with PS + NM.

Table 4. Free amino nitrogen, non - protein nitrogen and total volatile nitrogen of smoked mackerel fish samples (mg/100g) at the end of shelf-life (in days) at room temperature (24ºC)

Treat.	Smoked mackerel fish															
	Dry salting gutted fish				Wet salting gutted fish				Dry salting butterflied fish				Wet salting butterflied fish			
	Shelf life day	FAN	NPN	TVN	Shelf life day	FAN	NPN	TVN	Shelf Life Day	FAN	NPN	TVN	Shelf life day	FAN	NPN	TVN
1	-	78	126	37.87	-	65	118	31.78	-	70	135	26.39	-	75	125	29.66
2	5	334	675	91.29	5	317	703	88.36	5	284	972	86.39	5	269	613	91.59
3	5	348	641	85.31	5	325	632	79.97	6	297	621	87.99	8	341	717	117.3
4	10	366	974	99.66	10	334	887	93.94	21	413	1156	105.8	23	433	1104	124.6
5	14	392	997	105.4	14	363	960	100.1	24	328	1137	162.2	27	379	1126	177.1
6	10	348	1103	96.34	10	364	1089	100.1	10	321	1053	102.7	10	327	1016	100.6
7	10	324	974	93.99	10	314	995	88.46	11	327	1089	119.9	14	340	1204	130.4

1. Control (at zero time).
2. Control sample.
3. Smoked fish treated with SE.
4. Smoked fish treated with NM.
5. Smoked fish treated with SE + NM.
6. Smoked fish treated with PS.
7. Smoked fish treated with PS + NM.