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PREPARATION OF SMOKED BISSARIA *(Atherina boyeri)* AND UTILIZATION OF ITS POWDER IN CERTAIN POPULAR FOOD PRODUCT

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ABSTRACT

The fish called "Bissaria" used in the present investigation has no industrial use up to now. Bissaria deteriorates rapidly because of its small size, fragile body and high activity of gut enzymes. The study aimed to prepare different products of bissaria fish, mainly hot smoked bissaria as a snack, fish fingers (Kofta) and powdered smoked bissaria (PSB). This powder (PSB) was incorporated as a natural flavouring agent into different popular food products such as fish fingers (kofta), Pizza, paste, mayonnaise, tahina and potato chips. The degree of consumer acceptability for these products was evaluated. Most of the products were highly accepted because of the pleasant flavour of the smoked bissaria. The optimum conditions required to prepare each of these products were described. The influence of processing and storage conditions on the oxidative stability and the microbial count was also conducted.
Keywords: Small Pelagic Fish " Bissaria", Smoking, Flavouring Agent, Sensory and Chemical Evaluation.

INTRODUCTION

Fish is a highly nutritive value food, it contains polyunsaturated fatty acids and all the essential amino acids. Smoking is used mainly to impart a characteristic pleasant smoke flavour in fish. Smoked fish are considered a delicacy and very popular product in several countries and also more popular in Egypt.

The demand for sea food products is increasing; accordingly, greater attention is being directed for expanding production and increasing added value especially in trashed fishes. The results will be a range of new sea food products entering the market. Developing new products is of utmost importance; firstly to increase the demand of these types of trashed fish and secondly to upgrade its acceptability as well as its quality (Kreuzer and Day 1974) and to the consumer by use of new types of raw material and improved methods of production (Kreuzer and Day 1974).

It is necessary to introduce diversified products from low cost fish for local market having appealing characteristics to gain popularity and reasonable good shelf-life to increase its consumption sale.

According to FAO data, the demand for fish will increase due to the population increases and also to food awareness related to the higher nutritive value of fish as a source of high quality proteins and lipids. One of the resources which could gradually narrow the gap between production and consumption of fish are small pelagic fish species (Wood and Poulter, 1983). To obtain some fishery products which have high quality and low price, Bissaria fish have been used for this purpose (Akende, 1991). The main

constrain for that is due to the handling and processing difficulties, high fat content, seasonal nature of catch, susceptibility to rapid spoilage at ambient temperature within few hour after catch because of its small size and high activity of its gut enzymes resulting in wasting huge amounts of fish catch (Disney et. *al*., 1983).

Bissaria *(Atherina boyeri)* is small pelagic shoaling fish feeds on animal plankton, worms, fish larvae and algae but is itself an important part of the diet of many species of big size fishes (Muus and Dahlstrom, (1981) and Housby, *et. al,* (1991).

Little attention has been paid to utilize bissaria (*Atherina boyeri*) fish (El-Sahn et. *al*., 1990 and El-Sherif, 2007). Therefore, this research was undertaken to achieve the following points:

1- Extend/increase the availability of this fish for human consumption by preparing edible, acceptable and nutritive hot smoked product which can be used as a snack or appetizer.
2- Influence of frozen storage (-18°C) on quality attributes of smoked bissaria.
3- Production of powered smoked bissaria (PSB) which can be utilized as a natural flavouring agent instead of synthetic one.
4- Production of fish fingers (Kofta) using minced bissaria fish and low price broken rice.
5- Incorporation of (PSB) into different popular food products such as fish fingers (Kofta), pizza, paste, mayonnaise, tahina and potato chips and evaluation the degree of consumer acceptability for these products were also studied.

MATERIALS AND METHODS

Materials:

Fresh bissaria *(Atherina boyeri)* as a pelagic fish were used in this study. It was obtained from Edku landing fish area during spring season 2010. The fresh fish were transported directly after catching in an insulated ice box to Alexandria Fish Technology Center (AFTC), Faculty of Agriculture, El-Shatby Alexandria, and were subjected to organoleptical, chemical, microbiological examinations followed by some technological treatments aiming at upgrade this type of fresh fish.

The basic data of the fresh fish entering the process including length measurements, weight composition, specific area and specific weight were carried out according to Zaitsev *et. al.* (1969).

Methods:

1- Technological methods:

The fish were thoroughly washed and drained then used for preparing smoked bissaria, Powered smoked bissaria (PSB) and smoked fish fingers (Kofta). The PSB was incorporated as a natural flavouring agent into different popular food products such as Kofta, Pizza, Paste, Mayonnaise, Tahina and Potato chips.

a- **Production of Smoked bissaria:** The whole fish were salted using 15% (w/ w) sodium chloride solution for 5 min. The fish were drained for about 5 min, then placed on clean metallic rask inside a stainless steal semi-automatic smoking kiln (AFOS). The process of smoking included three phases; drying phase (30°C/ 30 min), cooking phase (50°C/45 min) and intensive hot smoking phase (80°C/45 min). Temperature of bissaria during the three phases was measured using a thermocouple thermometer. Prepared smoked whole bissaria were packed in polyethylene bags, heat sealed and stored at -18°C until used.

b- **Production of Powered smoked bissaria (PSB):** The whole smoked bissaria was dried at 50°C for 8h in an air drying oven (~ 10% moisture content). The obtained dried product was ground using an electric blender into powder to pass through a 60 mesh sieve. The obtained PSB was packed in polyethylene bag, heat sealed and stored (at -18°C) until used.

c- **Preparation of food products containing PSB:** Fish fingers (kofta) were prepared by mixing 70% fresh fish minces with 30% rice flour, 2% spices mixture, 1.5% table salt, 5% onion, 1% garlic, 5% tomato sauce, some water, 5% seasoning leaves and 2 – 10% PSB. The mixture was mixed up to get the kofta texture. The mixture was formed/ shaped into a finger like shape of ~ 1 cm diameter, ~ 10 cm length and ~ 20 g weight. The fingers were arranged on a plastic plate (12 fingers per plate) and covered with polyethylene bag then sealed. The sealed plates were kept under frozen conditions (-18°C) in a deep freezer. The smoked fish fingers (Kofta) were fried at 180°C for 1 – 2 min before being subjected to sensory evaluation.

Paste Product was prepared by mixing the following ingredients: 40g sesame batter (tahina), 60 g boiled and mashed Potato, 5g corn oil, 1% table salt and 1 – 7% PSB. The mixture was mixed up in a blender at a low speed until a uniform texture of the paste was obtained. The paste was packed in 100 g tubes to make it easy for spreading. The resulted paste was subjected to sensory evaluation.

Pizza was prepared by mixing ~ 500g wheat flour, 100g oil, 5g active yeast, 250g mozirella cheese, 200g tomato sauce, 120g chopped green pepper, 100g olive and 1 – 4% PSB. The resulted mixture was formed into a round shape of ~20 cm diameter, ~ 1cm thickness and 100g weight, and baked at ~ 180°C in an oven up to 20 min. The resulted pizza was subjected to sensory evaluation.

Tahina and mayonnaise containing PSB were prepared by mixing white tahina (El-Mezan)with PSB (0.5 – 4%) and mayonnaise (Gobber) with PSB (0.5 – 3%), then mixed well before subjected to sensory evaluation. Potato chips were spattered well with PSB (1 – 4%) before subjected to sensory evaluation.

2- Analytical method:

Proximate analysis of fresh and smoked bissaria including moisture content, crude ether extract, crude protein (NX 6.25) and total ash were carried out according to the AOAC (1990) procedures. Carbohydrate was calculated by difference. PH was measured after blending 5g sample with spicol PH meter. Salt content as % NaCl was determined by Mohr's titration method as described by Woyewoda et al (1986). Minerals including Na, K, Zn, Fe, Mn, Cu and Pb were measured as described in the AOAC (1990) using Perkin Elmer Atomic Absorption Spectrophotometer (Model 2380). Amino acid composition was determined using a Beckman Model 119 CL analyzer following hydrolysis with 6NHCL containing 0.1% mercaptoethanol at 100°C for 24 hrs described by Spackman *et. al.,* (1958)

Total lipids were extracted with chloroform: Methanol (2:1, v/v) as outlined by the procedure of Bligh and Dyer (1959). Total lipid extract was fractionated into different classes using a TLC technique according to the method of Mangold and Malins (1960) on glass plates (20 × 20 cm) precoated with 0.25 mm silica gel, G-60. The developing solvent system used was petroleum ether: diethyl ether: glacial acetic acid (70:30: 2, v/v/v). After running, the plate was air dried and the separated spots were visualized by iodine vapour. Lipid classes were identified by their RF values according to Rahma and Abd El-Aal (1988).

Preparation of fatty acid methyl esters from total lipids of bissaria fish (fresh/smoked) was performed according to the procedure of Chlvardjian (1964), using 1% sulphuric acid in absolute methyl alcohol. The obtained fatty acid methyl esters were separated by using Perkin–Elmer Gas Chroma tograph (SIGMA3)., under the following conditions: column, 10% Silar CP on 80/100 Chromosorb Q, detector, FID; column temp., 190 - 240°C, detector temp., 270°C, flow rate, 20 ml/min, Gas flow, N_2 and chart speed 5 mm/min. The area under each peak was measured by the triangulation method and percentage of each fatty acid was expressed in regard to the total area.

Peroxide value (PV as meq O_2/kg oil), free fatty acids (FFA as % oleic acid) and thiobarbituric acid (TBA) as mg malondialdehyde/kg of smoked bissaria oil were determined according to the methods of Woyewoda et al (1986). Standard fatty acid methyl esters were used as internal standard for identification.

3- Microbiological Methods:

Total viable count (CFU/g), moulds and yeasts, coliforms, and psychrophilic bacteria were carried out according to the methods given by Kiss (1994).

4- Sensory analysis:

Fresh bissaria was evaluated according to the Table given by NRI (1996). Steaming test was carried out by using ~ 100g of dressed (gutted and beheaded) bissaria placed in individual 250 ml lidded casserole dishes, steamed in a water bath at 100°C for 30 min (NRI, 1996) and presented in these dishes to the panelists for sensory evaluation according to the Table given by Huss (1995).

Colour, taste, odour, texture, appearance and overall acceptability of hot smoked bissaria (fresh and frozen storage at ~ 18°C) as well as food products including Kofta, Pizza, Paste, Mayonnaise, potato chips and tahina containing different concentrations of PSB were subjected to sensory evaluation. A group of 10 trained panelists from Food Science and Technology Dept. were asked for scoring the organleptic properties of the samples by given grades ranged between 0 to 10 according to the following scheme: 10 ideal; 9 excellent; 8 very good; 7 good; 6 fairly good; 5 acceptable; 4 fair; 3 poorly fair; 2 poor; 1 very poor and 0 repulsive; as mentioned by Rangana (1977) and Huss (1995).

5- Statistical analysis:

Data were transformed using square root then analyzed using randomized complete block design (R.C.B.D.). Least significant differences at 0.05 probability level (L.S.D. 0.05) was used to compare between means of the studied treatments according to Gomez and Gomez (1983).

RESULTS AND DISCUSSION

Length-Weight composition, quality assessment of wet and steaming test of bissaria:

The basic data for the fresh raw bissaria *(Atherina boyeri)* including length measurements, weight composition, specific area and specific weight are summarized in Table (1). The average weight of the fish entering the process was 3.66 g, average total length was 7.89 cm, and maximum thickness of 0.5 cm.

The results of quality assessment of wet bissaria *(Atherina boyeri)*. are presented in Table (2). The external and internal quality attributes revealed that raw wet bissaria were of high quality (very fresh fish). This was due to that bissaria were brought from the fish market in the early morning and then transported directly in an insulated ice box.

The quality assessment of cooked dressed (gutted & beheaded) bissaria (Steaming test) are given in Table (3). The results revealed that fish after cooking by steaming were of a pleasant odour; looks like boiled meat soup odour, good taste and texture (free of any objectionable taste or odour). The cooked dressed fish were excreted a very little amount of exudates (~ 1.8%) of a pleasant taste and odour. The less amount of exudates reflects the higher quality of the raw bissaria entering the proassing operations.

Table (1): The basic data including length-weight composition, specific area, specific weight and dressing yield/ loss of fresh bissaria fish

Parameters	Average Value
Weight Composition	%
Fillets (Skin on)	63.0
Head	25.0
Tail	0.6
Fins	1.0
Skeleton	5.2
Viscera	5.0
Dressing Yield* (Gutted & Beheaded)	69.2
Dressing loss (Gutts & Head)	30.54
Length measurements	**cm**
Total length	7.89
Fork length	7.69
Standard length	6.69
Length of body (Trunk)	4.18
Length of tail	1.79
Length of caudal fin	1.26
Length of head	1.88
Cross section (depth of body)	1.28
Maximum thickness	0.50
Specific area (cm^2/ g)	3.75
Specific weight (g/ cm^3)	0.8
Sex	Mixed
By catch** (%)	0.91

*** Dressing yield (Muscle + skeleton and belly flap)**

**** By catch included algae and other species of fish such as sardenella macaroni, shrimps, bivalves and crabs.**

Technological characteristics

Fig. (1) illustrates the smoking curve of bissaria which consists of three stages (phases): drying (30°C for 30 min); cooking (50°C for 45 min) and smoking (80°C for 45 min). It can be noticed that the total time needed to obtain a good smoked bissaria was around 2 hr.

The time of salting (brining) and smoking depends mainly on several factors such as the size of fish, its fat content, temperature used and the shape after dressing (Whole, gutted and beheaded, kippered or not, and fillets) (Abu-Tor 2002).

Table (4) shows weight loss/ yield during the different steps of smoking bissaria. Weight loss (%) and yield (%) due to dressing were 30.54% and 69.46% respectively. There was a slight increase in weight (weight gain) after brining step being 0.72%. Chellappan (1993) stated that the increase in weight during brining before smoking is an indication of the freshness of fish meat.

Table (2): Quality assessment of fresh bissaria

Quality attributes	Observation(Descriptive Judgment)	Score(Max.10)
A- External Quality Attributes (Whole Fish)		
1- Skin:		
a- Surface appearance	- Shining metallic sheer appearance, glossy skin, silver gray bright colour and no colour bleaching	9±0.02
b- Slime	- Transparent or water white	
2- Odour:	- Fresh seaweed; free of any objectionable odour.	9±0.02
3- Eyes:		
a- Shape	- Convex in shape	8±0.03
b- Clarity	- Clear and Translucent cornea, sparkling black pupil.	
4- Gills:		
- Colour	- Bright red	9±0.02
- Odour	- Fresh seaweed, no fishy, objectionable and off – odour present	
- Covers	- Silvery	
5- Firmness:	- Stiff and firm	8±0.03
6- Scales:	- Adherent strong	8±0.03
7- Gut wall & Peritoneum	- Strong & brilliant	8±0.03
8- Internal Quality Attributes		
- B.1. Fresh flesh:		
- Colour	- White grey	8±0.02
- Odour	- Odourless-free of any objectionable odour.	9±0.02
- Texture	- Firm, no gabbing	9±0.02
B.2. Belly Cavity:	- Cavity is well cleaned, no viscera remaining, no bones protrude	7±0.03
C. Overall quality	- Very good freshness	9±0.02

Table (3): Quality assessment of cooked bissaria(steaming test).

Quality attributes	Observation (Descriptive Judgment)	Score (Max. 9)
1- Odour of flesh and drain solution:	- Like boiled fresh meat soup, free of any objectionable odour.	9±0.03 Excellent
2- Taste of flesh and drain solution	- Pleasant taste of cooked meat, free of any objectionable taste like rancid, sweety, sour, putrefactive, bitter or salty.	9±0.03 Excellent 8±0.02 v.good
3- Texture of flesh	- Firm juicy, not chewy, not rubbery, not adhered with the mouth, no residues remaining between teath after chewing and no gabbing in appearance.	9±0.03 Excellent
4- Colour:		
a- Flesh	- Whitish, homogenous	8±0.03 v.good
b- Exudates	- Clear and translucent (water-white). Fat droplets are fleated on the surface, no coagulated proteins are present.	8±0.03 v.good
5- Drain solution%	- 1.8%	9±0.03 Excellent
6- Overall quality	- Very fresh	--

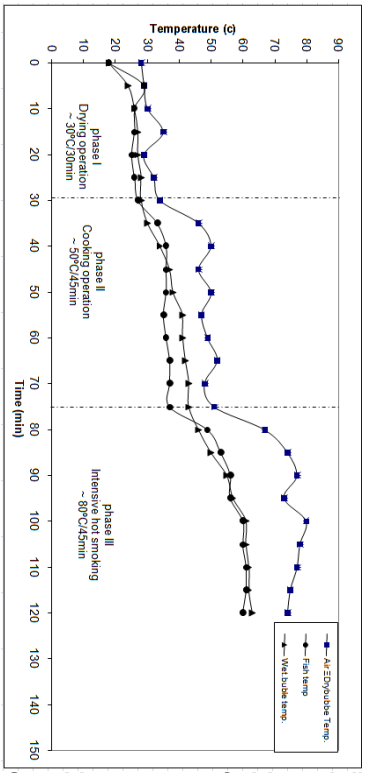

Fig. (1): Smoking curve of "bissaria" *(Atherina boyeri)*

Table (4): Weight loss/ yield during the different steps of smoking bissaria

Step	Weight Loss (%)	Yield %
Dressing (Gutted & Beheaded)	30.54	69.46
Brining (Whole fish)	--	0.72
Smoking (Whole fish)	46.06	53.94

Total loss and yield due to smoking step were 46.06% and 53.94%, respectively. The increased weight loss during smoking is an indication of moisture loss.

General appearance of fresh and smoked bissaria is shown in Fig (2). It can be noticed that smoking imparts a golden silver light brownish colour to bissaria fish.

Fig (2): General appearance of fresh (1) and smoked (2) bissaria

Chemical composition of fresh and smoked bissaria

Data in Table (5) indicated that moisture was the major component of fresh bissaria. Therefore it was subjected for rapid deterioration if it was kept at ambient temperature. After smoking, moisture content decreased from 72.5% to 45.30%.

Generally fresh bissaria contained higher levels of crude protein and crude ether extract. After smoking, a relative decrease was noticed with respect to crude protein and crude ether extract, while total ash showed apparent increase. These results are in a good agreement with those reported by El-Sahn *et. al.,* (1990) and El- Sherif (2007).

PH values of both fresh and smoked bissaria are quite similar. On the other hand NaCl content increased four times after smoking bissaria which may be due to the brining process before smoking and moisture loss after smoking.

As seen in Table (5), fresh bissaria had higher content of Na and K and slightly lower amounts of Zn, Fe, and Mn. On the other hand, fresh bissaria contained trace amounts of Cu and Pb. The levels of these minerals increased after smoking process. In general, these minerals could be arranged according to their concentrations in the following decreasing order Na, K, Zn, Fe, Mn, Cu and Pb, respectively. These results agreed well with those reported by Otitologbon *et. al.,* (1997), and Abu-tor (2009).

Data in Table (5) showed that a steady reduction in counts of total viable content and moulds was observed after smoking process. Both fresh and smoking bissaria were free from coliforms and pyschrophilic bacteria.

These results are in a good agreement with those reported by Moustafa *et. al.,* (2000), and Abo-Tor (2002).

Amino acid composition:

The effect of smoking on the amino acid composition of bissaria proteins is given in Table (6). It could be clearly pointed out from Table (6) that both fresh bissaria and its hot smoked product contain the same patterns of amino acids. The data showed that aspartic acid, glutamic acid and leucine were the major amino acids. Considerable amounts of lycine, isoleucine, alanine and glycine were also found in bissaria muscles. The rest of the amino acids shown in Table (6); threonine serine, valine, tyrosine, and arginine were in moderate amounts. Comparing with the FAO/ WHO/UNU (1985) pattern, most of the essential amino acids were either higher or close to the recommended level. These results indicated that bissaria muscles protein possessed to be a good potential source of essential amino acids. The data in Table (6) revealed that some amino acids such as isoleucine, leucine, phenylalanine and histidine were decreased as affected by smoking process. Other amino acids such as threonine serine, glutamic, proline, glycine, alanine, valine, methionine, tyrosine and arginine were less sensitive to heat treatment. These results agreed with those reported by Garcia-Arias *et. al.,* (2004) and Abu-Tor (2009).

Table (5): Proximate composition, NaCl*, PH minerals* and microbiological examination of fresh and smoked bissaria

Constituent	Fresh bissaria	Smoked bissaria
Moisture (%)	72.5 ±1.20	45.30±0.21
Crude protein (%)	65.18±0.15	61.94±0.54
Crude ether extract (%)	23.64±0.03	22.90±52
Total ash (%)	8.45±0.10	10.66±0.49
Carbohydrate** (%)	2.73 ±0.05	4.50±0.03
NaCl (%)	2.18±0.30	9.87±0.09
PH	**6.6±0.12**	**6.5±0.09**
Minerals (PPm)		
Na	1929.60±1.49	2014.3±1.2
K	720.01±0.25	998.61±0.35
Zn	37.40±0.30	38.64±0.50
Fe	28.94±0.10	31.66±10.43
Mn	5.94±0.20	6.38±0.15
Cu	3.67±0.32	4.22±0.09
Pb	0.80±0.01	0.80±0.01
Total viable count (CFU/ g)	2×10^2	0.4×10^2
Moulds (CFU/ g)	0.5×10^2	0.3×10^2
Coliforms	Nil	Nil
Psychrophillic	Nil	Nil

*** Mean ±S.D. on dry weight basis**

**** Calculated by difference**

Table (6): Amino acid composition of fresh and smoked bissaria

Amino acid (g/ 100 g protein)	Fresh bissaria	Smoked bissaria	FAO* Pattern
Aspartic acid	12.38	16.5	
Threonine	4.79	3.32	
Serine	4.13	3.07	
Glutamic	14.58	13.29	
Proline	0.53	0.76	
Glycine	5.32	5.47	
Alanine	5.74	6.05	3.5
Cystine	0.00	0.00	
Methionine**	1.01	1.01	2.5
Valine**	4.01	3.03	
Isoleucine**	7.71	3.76	1.9
Leucine**	9.36	6.84	2.8
Tyrosine**	2.64	3.07	6.3
Phenylalanine**	5.07	3.62	6.6
Histidine	5.02	2.98	1.1
Lysine**	7.48	9.43	5.8
Arginine	3.98	5.01	
Sum	93.67	87.06	

*** FAO/ Who/ UNU (1985)**
**** Essential amino acids**

Lipid classes and fatty acid composition:

The results of the fractionation of the total lipid classes of fresh and smoked bissaria oil are shown in Fig (3).

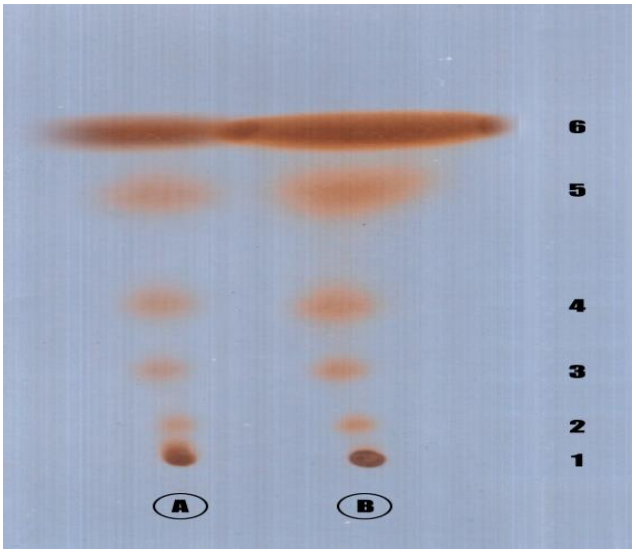

Fig (3): Thin layer chromatography of lipid classes of fresh (A) and smoked (B) bissaria

1. Polar lipids 2. Monoacylgycerols 3. Diacylglycerols
4. Free fatty acids 5. Triacylglycerols 6. Hydrocarbons

These results showed that total lipids consisted mainly of 5 fractions of glyceride and non-glyceride compounds in addition to the polar class located on the base line.

The identified fractions are monoacylglycerals, diacylglycerols, free fatty acids, Triacylglycerols and hydrocarbons.

The hydrocarbon fraction represents a very minor band in fresh bissaria oil compared to the same band in smoked bissaria. This observation may be due to the hydrocarbons present in the wood used during the smoking step.

Fatty acid composition

Table (7) shows the changes in fatty acid composition in the total lipids brought about by smoking of bissaria. Seventeen fatty acids were identified in both raw and smoked bissaria. In raw bissaria the total saturated fatty acids was 46.86%, while the total unsaturated fatty acids was 53.14%. On the other hand, the total saturated and unsaturated fatty acids in case of smoked bissaria were 51.37% and 48.63%, respectively. Among the saturated and unsaturated fatty acids in both raw and smoked bissaria, C14:0, C16:0, C18:0, C16:1, C18:1, C18:2, C20:5 and C22:6 were the predominant. Small amounts (less then 2%) of the other identified fatty acids were also detected.

The results in Table (7) also indicate that both raw and smoked bissaria contain large amounts of long-chain polyunsaturated fatty acids of the family w-3 such as C20:5 and C22:6. These fatty acids have been shown to lower serum triglyceride levels in normal and hyperlipidemic subjects (Von. Schancky, 1987; Nileson, 1992 and Al-shagrawi and Hewedy, 1995).

After smoking, levels of saturated fatty acids were relatively increased, while both the mono and polyunsaturated fatty acids were relatively decreased. These results are in agreement with those set out by Salama and Khalafalla, (1993); El-sharnouby *et. al.* (1991); Abdel-Nabey, (1995); Abo-Zeed, (2004) and Abu-Tor, (2009). They reported that fatty acid composition underwent changes, mainly, a certain decrease in the undsaturated fatty acids mainly C20:5 and C22:6. Such changes in fatty acid composition of fish lipids during smoking could be due to oxidative deterioration during this process.

Storage stability of smoked bissaria

Physicochemical properties and bacterial count

Table (8) shows the pattern of change in free fatty acids (FFA), peroxide value (PV), thiobarbituric acid (TBA), total viable count (CFU/g) as well as moulds and yeast in smoked bissaria during the storage periods (3 months) at -18°C. A considerable increase was observed in FFA, PV and TBA during the entire storage periods. The increase in PV was more pronounced compared to FFA and TBA. The PV increased from 1.1 $mEqO_2$/ kg at zero time to 4.6 $mEqO_2$/ kg after 3 months of storage at -18°C.

Peroxides are intermediate fat breakdown products and hence accumulate in the early stages of oxidative rancidity and are then broken down (Abu-Tor *et.al.,* 2001). As shown in Table (8), FFA increased from 0.9 at Zero time to 3.2% after 3 months of storage at -18°C, While TBA increased

from 0.4 to 1.6 mg malondialdehyde/ kg sample after 3 months of storage at -18°C.

The data in Table (8) indicated that even after 3 months of storage at -18°C, smoked bissaria is still acceptable and save from the nutritional point of view.

TBA method ia an accurate determination for assessing quality changes during cold storage. Thus, the TBA value appear to give better indication of lipid as well as the product deterioration compared to PV. Moreover, TBA shows a good correlation with organoleptic tests.

Table (8) also shows the results of total viable count (TVC) and the moulds and yeasts of smoked bissaria at -18°C. There was a considerable increase in both TVC and moulds & yeasts during the entire storage period at -18°C. The increase of TVC was more at the end of the storage period (3.0×10^3) compared to moulds & yeasts (2.0×10^3).

Table (7): Fatty acid composition of fresh and smoked bissaria

Fatty acid (weight%)*	**Fresh bissaria**	**Smoked bissaria**
SFA_s**		
C12:0	0.82	1.09
C14:0	9.82	10.96
C15:0	1.47	1.94
C16:0	27.41	30.6
C17:0	1.47	1.94
C18:0	5.87	4.75
Total SFA	**46.86**	**51.37**
$MUFA_s$***		
C16:1	15.58	10.29
C17:1	0.34	0.26
C18:1	9.52	8.18
C20:1	2.72	2.56
C24:1	0.83	0.68
Total MUFAs	**23.97**	**21.97**
PUFAs:******		
C18:2	4.99	4.18
C18:3	1.98	1.67
C20:2	0.23	0.21
C20:4	1.18	1.08
C20:5	11.40	10.87
C22:6	9.39	8.65
Total PUFAs	**29.17**	**26.66**
SFA/ USFA	1:1.13	1:0.95
W3 FA	20.79	19.52
W6 FA	8.15	6.93
W3/ w6	2.55:1	2.82:1

*** Values are average of three determinations as percentage of total fatty acids.**
**** Saturated fatty acids.**
***** Monounsaturated fatty acids.**
****** polyunsaturated fatty acids.**

Table (8): Changes in peroxide value, free fatty acids, total viable count, moulds and yeast of smoked bissaria during frozen storage.

Storage period(month)	TVC (CFU/ g)	Moulds and yeast (CFU/g)	FFA as% oleic acid	PV*	TBA**
0	0.4×10^2	0.3×10^2	0.9±0.01	1.1±0.01	0.4±0.00
4	1.1×10^2	0.9×10^2	1.3±0.02	1.7±0.02	0.6±0.01
8	4.5×10^2	1.7×10^2	2.8±0.02	2.8±0.03	0.9±0.01
12	3.0×10^3	2.0×10^3	3.2±0.03	4.6±0.03	1.6±0.01

*** m Eq o_2/ kg oil**
**** Mg malondialde/ kg sample**

Sensory evaluation of smoked bissaria and foods products containing PSB

Results in table (9) showed that panelists accepted the determinetd organoleptic properties of smoked bissaria even after 3 months of storage at -18°C. The results revealed that smoked bissaria had the desirable smoky odour and taste, free of any objectionable one. Colour of hot smoked bissaria was homogenous golden, silver and light brownish colour. The overall acceptability/ quality of the product was very good and of typical high quality to hot smoked product.

Table (9): Changes in Sensory properties of smoked bissaria during frozen storage

Storage period (month)	organoleptic propertes					Overall acceptability
	Colour	taste	odour	texture	appearance	
0	8±0.02[a]	8±0.02 [a]	9±0.03 [a]	8±0.02 [a]	8.2±0.02 [a]	8±0.02 [a]
1	8.10±0.02 [a]	8.05±0.1 [a]	8.9±0.10 [a]	7.88.0±0.3 [a]	8.1±0.04 [a]	8±0.03 [a]
2	7.89±0.02 [a]	7.98±0.0 [a]	8.7±0.02 [a]	7.8±0.05[a]	8.0±0.02 [a]	8±0.01 [a]
3	7.77±0.02 [a]	7.89±0.02 [a]	8.65±0.05 [a]	7.75±0.04 [a]	7.88±0.01 [a]	7.9±0.01 [a]

Means in column that are not sharing the same letter are significantly different at >0.05.

Different concentrations of PSB added to certain popular products such as tahina, mayonnaise, potato chips, kofta, Pizza and Pasta to assess the degree of their consumer acceptability are presented in Tables (10 , 11).

The results of Table (10 , 11) showed the following points:

1- The overall acceptability of tahina and Paste containing up to 3% PSB did not greatly affected.
2- Increasing the amount of PSB more than 1% in mayonnaise and Pizza lowered all the studied parameters especially taste, odour, appearance and overall acceptability.
3- Addition of up to 6% PSB to Kofta improved its Taste, odour, texture, appearance and overall acceptability.
4- Increasing the amount of PSB more than 2% in potato chips decreased the scores given to all the tested parameters.
5- From the above results it can be concluded that PSB can be added to improve the overall acceptability of tahina, Pizza, Paste, mayonnaise,

Kofta and Potato chips especially when PSB is incorporated in these prodects at concentration ranged between 0.5 to 2%.

Table (10): Sensory evaluation of tahina, paste and mayonnaise containing powered smoked bissaria

Product		Organoleptic Properties*					Overall acceptability
		Colour	taste	odour	texture	appearance	
Tahina + PSB (%)	Control	9.85^{a}	9.28^{a}	8.85^{ab}	9.57^{a}	9.57^{a}	9.42^{a}
	0.5	9.57^{a}	9.14^{a}	9.28^{a}	9.42^{ab}	9.28^{ab}	9.42^{a}
	1.0	9.28^{a}	9.00^{a}	9.28^{a}	9.14^{ab}	9.14^{b}	9.28^{a}
	2.0	8.00^{b}	9.00^{a}	8.85^{ab}	9.14^{ab}	8.85^{b}	9.24^{a}
	3.0	7.28^{bc}	8.85^{a}	8.71^{ab}	8.57^{b}	8.42^{b}	9.14^{a}
	4.0	6.57^{c}	8.28^{a}	7.14^{b}	7.71^{c}	7.85^{c}	7.42^{b}
	L.S.D	**0.85**	**-**	**1.36**	**0.69**	**0.56**	**1.04**
Paste + PSB (%)	Control	8.90^{a}	6.2^{b}	6.50^{b}	7.80^{a}	8.81^{a}	7.20^{a}
	0.5	8.45^{ab}	6.85^{ab}	6.75^{b}	7.35^{a}	8.72^{a}	7.35^{a}
	1.0	7.65^{b}	7.65^{b}	7.35^{b}	7.25^{a}	8.63^{a}	7.45^{a}
	2.0	7.60^{b}	8.85^{a}	8.80^{a}	7.25^{a}	8.58^{a}	7.75^{a}
	3.0	6.90^{b}	7.25^{b}	6.95^{b}	6.95^{a}	8.30^{a}	7.10^{a}
	L.S.D	**0.85**	**0.76**	**0.98**	**-**	**-**	**-**
Mayonnaise + PSB (%)	Control	9.4^{a}	7.7^{a}	7.6^{a}	9.1^{a}	8.7^{a}	8.4^{a}
	0.5	8.5^{b}	7.2^{ab}	7.4^{a}	8.3^{a}	8.0^{ab}	7.6^{ab}
	1.0	7.2^{c}	6.8^{ab}	7.1^{a}	8.0^{a}	7.4^{b}	7.4^{ab}
	2.0	5.8^{d}	6.4^{ab}	6.1^{b}	6.0^{b}	6.2^{c}	6.2^{b}
	3.0	4.9^{e}	5.7^{b}	5.3^{b}	5.1^{b}	4.7^{d}	4.7^{c}
	L.S.D	**0.8**	**1.1**	**0.9**	**1.0**	**0.8**	**1.1**

*** means in column that are not sharing the same letter are significantly different at > 0.05**

Table (11): Sensory evaluation of Pizza, Kafta and Potato Chips containing powered smoked bissaria

Product		Organoleptic Properties*					Overall acceptability
		Colour	taste	odour	texture	appearance	
Pizza + PSB (%)	Control	8.61^{a}	7.77^{a}	7.44^{ab}	7.55^{a}	8.33^{a}	8.05^{a}
	1	8.05^{ab}	6.66^{ab}	6.66^{ab}	6.83^{a}	6.94^{b}	6.22^{b}
	2	7.61^{ab}	5.88^{ab}	5.88^{ab}	6.44^{a}	6.61^{b}	6.11^{b}
	3	6.94^{b}	5.66^{b}	5.22^{b}	6.27^{ab}	6.31^{b}	5.77^{b}
	4	6.16^{b}	5.50^{b}	5.22^{b}	6.22^{a}	6.16^{b}	5.22^{b}
	L.S.D	**1.21**	**1.58**	**1.44**	**-**	**1.17**	**1.48**
Kofta + PSB (%)	Control	7.9^{a}	7.20^{ab}	7.30^{b}	7.70^{a}	8.05^{a}	7.60^{ab}
	2	7.9^{a}	7.65^{ab}	8.05^{ab}	7.90^{a}	8.00^{a}	8.00^{a}
	4	7.4^{ab}	7.95^{a}	8.00^{ab}	7.80^{a}	8.00^{a}	8.00^{a}
	6	6.8^{b}	7.90^{a}	8.25^{a}	7.70^{a}	7.90^{a}	7.95^{a}
	8	6.5^{b}	7.60^{ab}	7.70^{ab}	7.30^{a}	7.80^{a}	6.95^{b}
	10	6.4^{b}	6.70^{b}	7.00^{b}	6.60^{b}	7.75^{a}	6.65^{ab}
	L.S.D	**0.7**	**0.74**	**0.89**	**0.75**	**-**	**0.66**
Potato Chips + PSB (%)	Control	9.0^{a}	8.0^{a}	8.0^{a}	9.0^{a}	9.0^{a}	8.0^{a}
	1	8.7^{a}	7.2^{b}	7.5^{a}	9.0^{a}	8.8^{a}	7.8^{a}
	2	7.5^{b}	6.8^{b}	7.0^{b}	8.8^{a}	8.4^{a}	7.5^{b}
	3	7.0^{b}	6.5^{b}	6.9^{b}	8.8^{a}	8.0^{b}	7.0^{b}
	4	6.0^{c}	6.0^{c}	6.0^{c}	6.0^{b}	6.0^{c}	6.0^{c}
	L.S.D	**0.85**	**1.30**	**1.10**	**0.98**	**0.98**	**1.30**

*** means in column that are not sharing the same letter are significantly different at > 0.05**

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تحضير البساريا المدخنة واستخدام مسحوقها فى بعض المنتجات الغذائية الشائعة

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سمكة البساريا من الأسماك التى لا يوجد لها أى استخدام على النطاق الصناعى. ونظراً لصغر حجمها وعدم تحملها للتداول بالإضافة إلى النشاط العالى لإنزيمات الأحشاء فهى تفسد بسرعة.

فى هذا البحث تم إنتاج منتجات مختلفة من سمكة البساريا مثل البساريا المدخنة (كمقبلات/ تسالى) ومسحوق البساريا المدخنة. كما تم تطبيق استخدام هذا المسحوق فى منتجات شائعة الاستهلاك مثل الكفتة والبيتزا ومعجون السمك والمايونيز والطحينة والبطاطس الشيبسى. كذلك تم اختبار وتقييم مدى تقبل المستهلك لهذه المنتجات. كما تم دراسة تأثير التخزين على الحالة المجمدة لمدة ثلاثة شهور على جودة والثبات التخزينى للبساريا المدخنة. ولقد أوضحت النتائج أن معظم المنتجات المحضرة كانت مقبولة بدرجة كبيرة نظراً للنكهة المميزة للبساريا المدخنة. كما أثبتت الدراسات حدوث تغيرات طفيفة أثناء تخزين البساريا المدخنة إلا أنها لم تؤثر على مدى تقبلها بالنسبة للمحكمين.

الكلمات الكاشفة: أسماك البيلاجيك الصغيرة (بساريا)، تدخين، عوامل نكهة وتقييم كيماوى وحسى.

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