INFLUENCE OF DIFFERENT HEATING METHODS ON FATTY ACIDS AND AMINO ACIDS CONTENT OF HERRING CAVIAR

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ABSTRACT

The influence of four heating methods (microwave, steam, baking, direct heat and control) on the fatty acid composition and amino acid composition of herring caviar was evaluated. The highest total unsaturated fatty acids were found in baked herring caviar while herring caviar heated by microwave was the lowest one in its total unsaturated fatty acids. Amino acids concentration in all treatments was ranged between 230.68 – 246.20 mg/ g. The maximum value of the total amino acid was observed also in baked herring caviar, while the minimum amount was induced by microwave treatment. This study indicate that oven baking is the best treatment for heating herring caviar and give the highest percentage of total unsaturated fatty acid, total amino acid and total essential amino acids.

Key words: Herring caviar, fatty acids, amino acids, baking, direct heat, steam and microwave

INTRODUCTION

The caviars have a high nutritional value for their high contents from protein and fat. It can be processed as refrigerated, frozen, smoked, and canned. Altug and Bayrak, (2003).

Herring caviar is eaten raw but is usually heated by different ways inside herring before consumption. The type of heating cause chemical and physical reactions which improve or impair the food nutritional value (e.g. digestibility is increased due to protein denaturation in food but the content of polyunsaturated fatty acids is

often reduced). Heating induces water loss in the food that in turn increases its lipid content in most cases. Garcia-Arias *et. al*. (2003).

Bledsoe *et. al.,* (2003) mentioned that several types of caviar from different fish species are marketed as shelf stable products. Few studies have addressed fatty acids and amino acids requirements and the percentage of foundation of them in herring caviar. Also, Jeong *et. al*., (2000) reported that the difference in fatty acids composition refers to the differences in fish diet.

The consumption of herring caviar increased in Egypt and the habit of eating herring were different between people. Tokur (2007) reported that cooking fish improves the digestibility, enhanced palatability and improved a safe eating by killing harmful bacteria, other microorganisms and parasites. On the other hand, fish and there products recognized as a valuable source of high quality protein in the human diet and assumed great nutritional significance because of their high polyunsaturated fatty acid levels. Weber *et. al.* (2008).

Heating (boiling, baking, roasting, frying and grilling) are applied to food in different ways to improve its hygienic quality by inactivation of pathogenic microorganisms and to enhance its flavor and taste and increase shelf life Bognar, (1998) and Pokorny, (1999).

The aim of the present investigation was to study the fatty acids and amino acids profiles and the effect of different heating methods used in smoked herring before eating.

MATERIALS AND METHODS

Material

Smoked herring (*Clupea harengus*) were purchased from local fish market in Cairo governorate. The samples were then treated with different heat treatments. Three samples were used for each heat treatment after which subjected to the following analysis. The experiment was repeated three successive times.

Methods

Heat treatments

Four common ways of heat treatments and control were used:

a- **Control:** Untreated smoked herring.

b- **Microwave heating**: Samples were arranged in a microwaveable dish so that the dish was rotated half way for 2 min.

c- **Steaming:** Samples were placed in a lidded casserole dish and steamed for 15 min. in a water bath.

d- **Baking:** Samples were wrapped in an aluminum foil in conventional electric oven at 200˚C for 15 min.
e- **Direct heat:** Samples were exposed to direct heat for about 2 min. for each side as Egyptian habits.

After treatments, the herring caviar was taken for chemical analyses.

Fatty acids profile

The lipids of dried samples were extracted with a mixture of chloroform: methanol (2:1 v/v) according to Kates (1972). The lipids were saponified and the liberated fatty acids were methylated by methylation agent (Farag *et al.,* 1992). The fatty acids methyl esters were extracted by ether and dried over anhydrous sodium sulphate. Chromatographic separation was performed using Gas Chromatograph-Mass at National Center for Radiation Research and Technology (NCRRT). Selective Detector instrument "GC-MS" type HP, 6890 series, equipped with a flame ionization detector using innowax-cross linked polyethylene glycol fused silica column.

Amino acids composition

A known amount of defatted samples (50 mg) was hydrolyzed with HCl (5ml, 6N) and heated in a sealed test tube at 110˚C for 24 hr according to Suzanna, (1998). The content of each tube was filtered, evaporated until dryness and dissolved in a suitable volume of sodium citrate buffer, followed by ultra filtration using a 0.2 µm membrane filter Nellet, (1996). Analysis was performed using a high performance amino acid analyzer Biochrom 20 (Auto sampler version) Pharmacia Biotech constructed at NCRRT. The data of each chromatogram was analyzed by EZ chrom ^{TM} chromatography data system tutorial and user guide-version 6.7.

Statistical analysis

The five treatments were smoked herring caviar which subjected to microwave, steaming, baking and direct heat. The value given in each treatment category is the mean value for four treatments in comparing with control of three individual fish. One way analysis of variance and least significant difference tests were performed on the tested parameters (ANOVA). Duncan's multiple ranges, was also used to test the least significant differences (LSD) between the mean values Costat, (1986).

RESULTS AND DISCUSSION

Heat (microwave, steam, backing and direct heat) was applied to food in different ways to improve its hygienic quality by inactivation of pathogenic microorganisms and to enhance its taste. The methods which used in herring caviar were considered as reheating treatments because we can eat smoked herring caviar only without any treatments.

The major constituents of the total fatty acids in smoked herring caviar (control) were docosanoic (C22:0) 28.23%, oleic (C18:1) 19.54%, palmitic (C16:0) 14.5% and myrisitic (C14:0) 11.59%. The percentage between those fatty acids was exchange by heating treatment. There is a highly significant different between all treatments in each fatty acid (Table 1). The total unsaturated fatty acid was 29.18, 28.29, 28.23, 26.51 and 25.99 in baking treatment, steam treatment, control, direct heat and microwave, respectively.

There is a significantly difference in C18:1 in baking and other treatments. The percentage of C18:1 in baking treatment was 19.93%. There is no significantly difference between microwave and direct heat. C18:2 has no significantly different between microwave, steam and baking. The percentageof C18:2 was 1.77%, 1.22% and 0.93% for the previous treatments, respectively. Also there is no significant different between control and direct heat. C18:3 has no significantly different between all treatments except steam (1.50%). There is no significantly different in C20: 1 between steam (7.06%) and baking (7.25%), also between control (5.93%) and direct heat (6.13%) but there is a significantly different between microwave (6.59%) and all treatments.

The high percentage of C20:0 was 17.63% in direct heat and 17.18% in microwave. Arachidonic acid (C20:0) is an important fatty acid because it is the precursor of prostaglandins. The prostaglandins are transformed into a number of compounds known as tissue hormones. Herring caviar has higher percentage of this fatty acid Gessner *et al*., (2002).

Modification of fatty acids during heating could be related to oxidation Glodyshev *et. al*., (2005). This study agrees with Garcia *et. al., (*2003) who mentioned that oven baking minimally affected the sardine fillet fatty acid content. However the observed changes were

not homogeneous for the different fatty acids because some fatty acids were decreased some increased and others did not change.

Table (1): Effect of different heating methods on fatty acids composition of smoked herring caviar.

Fatty acids	Treatments					SEM	LSD
	Control	Microwave	Steam	Baking	Direct heat		
Myristic C14:0	11.59^{b}	11.41^{bc}	11.17^{c}	11.07^{c}	12.33^{a}	0.23	0.37
Palmitic C16:0	14.5^{d}	14.25^{d}	18.96^{a}	16.73^{b}	15.28^{c}	0.85	0.39
Oleic C18:1	19.54^{b}	17.43^{d}	18.51^{c}	19.93^{a}	17.72^{d}	0.5	0.36
Linoleic C18:2 n-6	1.64^{a}	1.77^{a}	1.22^{b}	0.93^{b}	1.64^{a}	0.18	0.39
Linolenic C18:3 n-3	1.13^{b}	1.00^{b}	1.50^{a}	1.07^{b}	1.02^{b}	0.13	0.28
Arachidonic C20:0	15.76^{c}	17.18^{a}	14.78^{d}	16.16^{b}	17.63^{a}	0.58	0.39
Ecosaenoic C20:1	5.93^{c}	6.59^{b}	7.06^{a}	7.25^{a}	6.13^{c}	0.25	0.30
Docosanoic C22:0	28.23^{a}	28^{a}	24.28^{d}	25.73^{c}	27.37^{b}	0.73	0.35
Tetracosanoic C24:0	1.23^{b}	2.5^{a}	2.2^{a}	1.13^{b}	1.08^{b}	0.31	0.33
Total unsaturated fatty acid	28.23	25.99	28.29	29.18	26.51		
n-3/ n-6	0.69	0.56	1.22	1.15	0.62		

SEM, standard error of the mean among different treatments.
LSD, Least significant different ($p< 0.05$).
Means with different superscript letters (a-d) within the same raw are significantly different ($p <0.05$).

Yanar *et. a*l. (2007) suggested that the n-3/ n-6 ratio could be used as a biomedical index and considered this ratio as the most important indicator of fish lipid quality, which also reflects the quality of fish as a food. In this study, this ratio was 1.22 in steam and 1.15 in baking but was 0.56 in microwave, so baking give a higher percentage of n-3/ n-6 and give a good quality of herring caviar lipids.

These results agree with Weber *et. al*. (2008) who suggested that all cooking condition affect on the free fatty acids by the deactivation of enzyme and losing water during oven baking increasing the fatty acid content. On the other hand Al-Saghir *et. al*., (2004) observed a decrease of free fatty acids in salmon fillets steamed or pan-fried, either with or without different types of oil.

The amino acids composition of herring caviar in the four treatments in comparing with control presented in Table 2. The total amino acid / essential amino acid ratio did not appear difference between all treatments.

The major components of the total amino acid were proline (84.4%), glutamic acid (21.51%), leucine (13.7%), aspartic acid

(13.2%), alanin (13%), arginine (11.2%) and lysine (10.6%), respectively in smoked herring caviar (control). There is a significantly different between all treatments in all amino acids.

Comparison between each amino acid in each treatment explained the following results. Prolein has a significantly different between all treatments. There is no significantly different between steam and baking in glutamic acid but there is a significantly different between control, microwave and direct heat. Comparing means of the leucine illustrate no significantly different between control and microwave also between steam, baking and direct heat. Aspartic acid has no significant differences between baking and steam, also between control and microwave but there is a significantly different between direct heat and all treatment. There is a significant difference between baking and all treatments in alanin.

Table (2): Effect of different heating methods on the amino acids composition of smoked herring caviar.

Amino acids	Treatments					SEM	LSD
	Control	Microwave	Steam	Baking	Direct heat		
Aspartic	13.2^{C}	13.07^{c}	14.97^{a}	15^{a}	14.4^{b}	0.23	0.43
Threonine*	9.57^{b}	9.93^{ab}	10.09^{a}	10.1^{ab}	9.7^{ab}	0.08	0.5
Serine	8.5^{b}	8.6^{b}	9.93^{a}	10.0^{a}	9.93^{a}	0.2	0.49
Glutamic	21.51^{c}	21.6^{bc}	23.06^{a}	22.9^{a}	22^{b}	0.18	0.42
Proline	84.4^{d}	81.3^{e}	97.26^{b}	99.3^{a}	91.7^{c}	1.88	0.43
Glycine	7.7^{a}	7.93^{a}	7.93^{a}	8^{a}	7.2^{b}	0.09	0.41
Alanine	13^{c}	12.93^{c}	14.5^{b}	14.93^{a}	14.6^{ab}	0.23	0.4
Cystine	2.5^{a}	2.2^{a}	1.03^{b}	0.9^{b}	0.7^{b}	0.2	0.35
Valine*	8.4^{c}	8.5^{bc}	8.83^{ab}	9^{a}	8.6^{bc}	0.07	0.38
Methionine*	3.27^{a}	1.07^{bc}	1.37^{b}	0.7^{d}	0.93^{cd}	0.25	0.36
Isoleucine*	8^{c}	8^{c}	8.4^{ab}	8.7^{a}	8.2^{bc}	0.08	0.35
Leucine*	13.7^{b}	13.5^{b}	14.8^{a}	15^{a}	14.6^{a}	0.17	0.46
Tyrosine	8.13^{bc}	8.02^{c}	27^{a}	9.4^{a}	8.57^{b}	0.16	0.46
Phenylalanine*	7.6^{b}	7.5^{b}	8.6^{a}	8.8^{a}	7.57^{b}	0.16	0.44
Histidine*	4.6^{b}	4.63^{b}	5^{ab}	5.2^{a}	4.9^{ab}	0.08	0.41
Lysine*	10.6^{b}	11.2^{a}	11.2^{a}	11.2^{a}	11^{a}	0.08	0.36
Arginine	11.2^{c}	10.7^{d}	12.5^{a}	12.5^{a}	11.6^{b}	0.19	0.36
Total Amino Acid (mg/g)	235.87	230.68	258.74	261.7	246.2		
Total essential amino acid	74.2	72.6	77.5	78	74.7		
Total EAA / Total non EAA	3.17	3.17	3.33	3.35	3.3		

SEM, standard error of the mean among different treatments.
LSD, Least significant different ($p< 0.05$).
Means with different superscript letters (a-d) within the same raw are significantly different ($p <0.05$).
* : Essential amino acids (EAA).

Leucine has no significant different between control (13.7%) and microwave (13.5%) also between steam (14.8%), baking (15%) and direct heat (14.6%). Lysine has no significant different in all treatments except control (10.6%) and arginine has no significant different in steam (12.5%) and baking (12.5%) but there is a significantly different between control (11.2%) , microwave (10.7%) and direct heat (11.6%).

Comparing means showed that baking has a maximum value in phenylalanine (8.8%), histidine (5.2%), lysine (11.2%) and arginine (12.5%). The total essential amino acids were found in baking (78.0%), steam (77.5%), direct heat (74.7%), control (74.2%) and microwave (72.6%). The highest value of the total essential amino acid was in baking treatment comparing with other treatments and microwave treatment has the lowest value of the total essential amino acid. These results agree with Unusan (2007), who showed that there is a significant effect of cooking methods on amino acids and fatty acids content of rainbow trout. Also, Rosa ***et. al.***, (2007) noticed that the different cooking procedures have a significant effect on their biochemical composition.

It could be concluded that baking method is the best treatment in heating herring caviar as resulted from the fatty acid and amino acids composition.

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تأثير طرق التسخين المختلفة على محتوى بطارخ الرنجة من الأحماض الدهنية و الأحماض الأمينية

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تم دراسة تأثير أربع طرق تسخين وهى الميكروويف ، البخار ، الطهى فى الفرن ، الحرارة المباشرة على محتوى بطارخ الرنجة المدخنة من الأحماض الدهنية و الأحماض الأمينية. و كانت أعلى نسبة من الأحماض الدهنية غير المشبعة فى الطهى فى الفرن . و أقل كمية من الأحماض الدهنية غير المشبعة كانت فى الميكروويف. وكان تركيز الأحماض الأمينية فى كل المعاملات يتراوح ما بين 230.68 – 246.2 مجم / جم. أعلى نسبة من الأحماض الأمينية الكلية كانت فى الطهى فى الفرن و أقل نسبة كانت فى الميكروويف. وأوضحت النتائج أن أحسن المعاملات فى التأثير على بطارخ الرنجة المدخنة هى الطهى فى الفرن حيث أنها أعطت أعلى نسبة من الأحماض الدهنية غير المشبعة ، الأحماض الأمينية الكلية وكذلك الأحماض الأمينية الأساسية.