J. Food and Dairy Sci., Mansoura Univ., Vol. 3 (12): 707 - 714, 2012

STUDIES ON THE EFFECT OF COOKING METHODS ON THE STABILITY OF MONO AND POLYUNSATURATED FATTY ACIDS CONTENTS IN BOLTI FISH

El-Gammal, Om El-Saad I. and Amal A. Matter
Food Science& Technology Department, Faculty of Home Economics, Al-Azhar University. Egypt.

ABSTRACT

Current study was designed to evaluate the effects of grilling and frying process as the traditional and quick home –made meal by the house-holder, fish shops and restaurants on mono and polyunsaturated fatty acid (ω3 , ω6, ω7,and ω9)-MUFAs &PUFAs. Comprising 32.67% for fresh and 32.92% for grilled samples as total monounsaturated fatty acids (C16:1, C17: 1 and C18:1), respectively revealed total increase up to 0 .77%. Omega ω9 oleic acid achieved a considerable increase up to 13.77%.On the other hand, "Omega 7" (9Hexadecannoic) showed a highly decrease of all samples reached to 53.71% owing to the same processing method. By the same manner; (Polyunsaturated fatty acids (PUSFA) showed considerable decrease for both ω3& ω6 fatty acids(C18:2, C18:3,C20:2,C20:3,C2o:4,C20:5and C22:6 with the aforementioned treatment achieving 20.77,and 15.16%, respectively by total percentage 27.01%.

On the opposite, the frying process comprised considerable increase in total MUSFA that fluctuated between 32.67 to 44.48% with an average change 36.15% in increase for fresh and fried fleshes, respectively. It is also obvious that oleic acid ω9 was the main MUSFA one having the large amount of this increase at all that achieved 51.82% increase. Linolic acid ω6 the PUSFA comprised a magnitude level of this increase with the process frying. Finally, It could be said frying increase both mono& polyunsaturated fatty acids especially Linolic acid ω6 & oleic acid ω9 moreover, it decreases the total ratio of the SFAs that cause many health troubles. .

INTRODUCTION

There are three types of fat are consumed by us, Saturated, monounsaturated and polyunsaturated. Fish oil attracted worldwide attention after the European congress of Ca September 2008, "statins"-the supposed Omnipotent medicine heart ailments were not enough to provide comprehensive management possible complications (*Dumaguing Omacor, 2009)*.The fish oil have the essential fatty acids omega-3 and omega -6 which are polyunsaturated (EPA and DHA) have five and sex double bonds and liquid at room temp. and at the same time is heat-sensitive and should be stored in the refrigerator to avoid oxidation *(J:\foodOmega.htm 2008)*. Currently, there is major emphasis on the beneficial effects of including Omega"3"fatty acids in the diet *Yashodhara et al.,(2009).*Over the past 20 years many studies and clinical investigations have been carried out on the metabolism of polyunsaturated fatty acids (PUFAs) in general and on n-3 fatty acids in particular.

Today we know that n-3 fatty acids are essential for normal growth and development. Desaturation and elongation of n-6 and n-3 fatty acids;

evolutionary aspects of diet relative to **n-3** fatty acids and the **n-6:n-3** balance; eicosanoid metabolism and biological effects of n-6 and n-3 fatty acids; nutrigenetics–interaction between the n-6:n-3 fatty acids and the genome; effects of dietary α-linolenic acid compared with long-chain n-3 fatty acid derivatives on physiologic indexes; human studies in growth and development; coronary heart disease; inflammation–a common base for these mtabolitic effects *(Reaven et al., 1993).* .

. Despite the impressive therapeutic advance made over the past 15 years, main components of the overall burden of cardiovascular morbidity illness. Several epidemiological and experimental studies suggest that n-3 or Omega 3 pufa can favorable effects on artherothrothombotic cardiovascular disease *(Albert et al.,1998*

Omega-3 fatty acids are polyunsaturated fats liquid at room temperature and remains liquid when frozen considered essential to human health. However, they cannot be manufactured by the body and have to be obtained from food we eat. Fats like cocoa butter, lard and butter are saturated fats. These fats are solids at room temperature and are one of the main factors responsible for raising blood cholesterol. Olive oil, flax seeds, walnuts, hemp seeds, soybeans, dark green leafy vegetables, corn oil, sun flour , canola oil, also fish been reported for a number of years *(Shahidi& Miraliakbari, 2004)*. A high intake of long chain omega-3 PUFAs (n-3 LC-PUFAs), such as docosahexaenoic acid (DHA, C22:6n-3) and eicosapentaenoic acid (EPA,C20:5n-3) from marine organs resulting in a lower CVD in Greenland Eskimos was first proposed by *Bang and Dyerberg (1980)*.Currently, the predominant dietary sources of very long- chain omega-3 PUFAs are oily fish and fish supplements. PUFAs concentrates are used commercially in pharmaceutical products, food additives, and in health supplements.*Zhao et al.(2004)* investigated the effects of an average American diet, a linoleic acid (LN, 18:2n-6) diet, and ALA diet. These authors found that the level of C-reactive protein, a marker of inflammation strongly associated with heart disease, declined for both the LN and ALA diets, but much more significantly for the ALA diet. Therefore, they concluded that ALA seems to lower CVD by inhibiting vascular inflammation beyond its lipid-lowering effects. High fatty fish species, which are the main supply of n-3 PUFA in the diet, also show the significant cholesterol content. The two compounds, n-3 PUFA and cholesterol are lipids highly susceptible oxidation giving risk to free radicals(*Echarte et al., 2001*.As fatty acids content are affected by the technological or preparation processes; many investigations have been performed *(Hearn et al.,(1987), Sebedio et al.,(1993), Ammar,(2004), Fatima et al., (2006) and Gladyshev et al.,(2007)* The objective of current study was to evaluate the effects of the cooking methods (grilling and frying) on the composition of fatty acid profile of freshwater fish -Bolti fish (*Nile tilapia*) especially on the stability of mono and polyunsaturated fatty acids (ωs) contents as a high quality and healthy source of protein and fat in the human diet. Moreover, as a quick home-made meal by the house-holder and in restaurants. The search also aimed to determine optimal determination technique that can be recommended to

obtain optimal nutritional qualities in the form of retaining"omega-3" fatty acids

MATERIALS AND METHODS

Sampling: Bolti fish samples were collected from 9 different local markets at El-Ismailia governorate. The mean weight and length of fish were 301.56± 45.64 gm and 22.24± 2.11 cm. respectively .

Technological Methods: Some Bolti fish samples are subjected to grilling process in an electrically operated grill **at 180 C** for **3o** min. The other samples were subjected to deep frying process in abundant amount of the locally produced oil at 200 C for 20 min.

Chemical Analysis:

1- Determination and the fractionation of fatty acids was attained by GLC according to *ISO. 5509 (2000)* at Food Technology Res. Institute, Ministry of Agriculture and Land Reclamation, Agriculture Res. Center

2- The gross chemical composition of Fresh, grilled and fried Bolti flesh fish samples was performed according to the *AOAC (2ooo)* after mincing in a meat miner for moisture, crude protein, ash and ether extract. Carbohydrate contents were determined by differences, while Total solids***(T.S.)***were calculated by the following equation. :

$$T.S = \frac{\text{Weight of fresh or processed fish flesh – its moisture content}}{\text{Weight of fresh or processed fish flesh}} \times 100$$

RESULTS AND DISCUSSION

Table (1): Gross Chemical Composition of Fresh, Grilled and Fried Bolti Fish Flesh

Treatments	Moisture	Ether-** Extract	Crud * protein	Ash	Carbo-hydrates**
Fresh flesh	75.08	2.75	81.46	6.10	1.40
Grilled flesh	74.78	4.20	75.74	5.46	1.64
Fried flesh	72.86	7.20	66.43	5.08	1.95

*** Based on dry weight** **** Based on dry weight**

***** Calculated by difference**

Table (1) demonstrates the gross chemical composition (Moisture, ether extract, crude protein, ash, and carbohydrates) of fresh, grilled and fried bolti fish fleshes. Obtained data obviated that the sequence of the average values of these parameters were 75.08, 2.75, 81.46, 6.10, and 1.40

for the fresh flesh samples and 74.78, 4.20, 75.74, 5.46 and 1.64 for grilled flesh samples and 72.86, 7.20, 66.43, 5.08, and 1.95 for fried ones, respectively. These results were relatively agreed with those of *Ammar 2005. And Andrad et al., 1995* .

Table (2): Effect of Grilling Process on Fatty acids (ωs) contents in Bolti fish flesh.

Fatty acids	Molecular formula	Code	Fresh flesh	Grilled flesh	% Change
A) Saturated fatty acids(SFA) (					
Lauric acid	C12H24O2	C12:0	3.83	1.88	-50.91
Myristic acid	C14H28O2	C14:0	5.04	4.63	-8.13
Pentadecanoic acid	C15H30O2	C15:0	0.48	1.00	+108.33
Palmitic acid	C16H32O2	C16:0	21.74	21.57	- 0.78
Margarir	C17H34O2	C17:0	0.77	0,54	- 29.87
Stearic acid	C18H36O2	C18:0	6.23	6.28	+ 0.80
Arachidic acid	C20H40O2	C20:0	0.65	0.37	- 43.08
Docosanoic acid	C22H44O2	C22:0	0.56	1.54	+175.00
Ligoceric acid	C24H48O2	C48:0	3.34	2.37	29.04-
$\sum_{(SFA)}$			42.64	40.18	-5.77
(B) Mono unsaturated fatty acids(MUSFA)					
ω7 9Hexadecannoic	C16H30O2	C16:1	6.20	2.87	- 53.71
Heptadecanoic acid	C17H32O2	C17:1	0.32	0.30	6.25-
Oleic acid ω9	C18H34O2	C18:1	26.15	29.75	+ 13.77
$\sum$ (MUSFA)			32.67	32.92	+0.77
(B Poly unsaturated fatty acids (PUSFA)					
Linolic acid ω6	C18H32O2	C18: 2	11.56	10.03	- 13.24
Linolenic acid ω3	C18H30O2	C18:3	3.00	1.59	- 47.00
Ecosadienoic acid ω6	C20H36O2	C20:2	0.55	0.56	+ 1.82
Cis 5,8,11,14,17-Ecosapentadecnicacidω3	C20H30O2	C20:3	1.26	0.29	-76.98
8,11,14- Ecostrienoic acid ω6	C20H34O2	C20:3	0.58	0,67	+15.52
Arachidonic acid ω6	C20H32O2	C20:4	0.47	0,23	51.o6
Docosapentadecanoic ω6	C22H34O2	C20:5	0.54	0.89	+ 64.81
Docosahexadecanoic ω3	C22H32O2	C22:6	2.81	0.90	-67.97
$\sum$ (PUSFA)			20.77	15.16	-27.01

Table 2: shows the fatty acids constituents in fresh and grilled bolti fish flesh, the total fractionated saturated fatty acids (SFA) from C12: o to C48: o as shown in this table comprised 42.64% and 40.18%, respectively by an overall decreased reached to 5.77% as affecting by grilling process. The same table also comprised 32.67% for fresh and 32. 92% for grilled samples as total monounsaturated fatty acids (C16:1, C 17: 1 and C18:1), revealing total increase reached to 0 .77%. (Oleic acid) ω9 achieved a considerable increase reached to 13.77%; this acid has an important acid part of the cell membranes and it has antioxidating qualities that can protect the "omega-3" from oxidation. On the other hand, Omega ω7 (9Hexadecannoic) showed a

highly total decrease representing 53.71% owing to the same processing. By the same manner(Poly unsaturated fatty acids (PUSFA) showed considerable decrease for both ω3& ω6 fatty acids (C18: 2, C18:3,C20:2, C 20:3, C2o:4,C20:5 and C22:6) for the aforementioned treatment achieving 20.77 to 15.16%, respectively by total percentage27.01%.The highest decrease fluctuated between Cis 5, 8,11,14,17 Ecosapentadecnic acid ω3 Docosahexadecanoic ω3,Arachidonic acidω6, Linolenic acid ω3 followed by Linolic acid ω6 comprising 76.98, 67.97,51.06, 47.00 and 13.34%, respectively. These results were in agreements with those of *Fátima et al., (2006).* From these results it could concluded that, during cooking process, fatty acids were oxidized by forced oxidation which case differences on fatty acids especially the unsaturated ones depending on cooking temp. (Frankel,1982). .

Table(3):Effect of Frying Process on Fatty acids (ωs)contents in Bolti fish flesh

Type of fatty acid	Molecular formula	Code	Fresh	Fried	Change %
A)Saturated fatty acids(SFA)(					
Lauric acid	C12H24O2	C12:0	1.97	0.28	85.79-
Myristic acid	C14H28O2	C14:0	4.72	2.72	- 42.37
Pentadecanoic acid	C15H30O2	C15:0	1.07	0.13	87.85-
Palmitic acid	C16H32O2	C16:0	26.06	20.81	- 20.15
Margarinic acid	C17H34O2	C17:0	0.77	0.20	- 74.03
Stearic acid	C18H36O2	C18:0	6.23	5.17	17.01-
Arachidic acid	C20H40O2	C20:0	0.65	0.03	- 95.38
Docosanoic acid	C22H44O2	C22:0	0.56	0.49	12.50-
Ligoceric acid	C24H48O2	C48:0	3.34	0.60	- 82.04
Σ (SFA)			45.37	30.43	32.93 -
(B)Monounsaturated fatty acids (MUSFA)					
ω7 9Hexadecannoic	C16H30O2	C16:1	6.20	4.57	- 26.29
Heptadecanoic acid	C17H32O2	C17:1	0.32	0.21	- 34.37
Oleic acid ω9	C18H34O2	C18:1	26.15	39.70	51.82+
$\Sigma_{(MUSFA)}$			32.67	44.48	36.15+
(B)Polyunsaturated fatty acids(PUSFA					
Linolic acid ω6	C18H32O2	C18: 2	11.56	23.86	106.40+
Linolenic acid ω3	C18H30O2	C18:3	3.00	1.09	- 63,67
Ecosadienoic acid ω6	C20H36O2	C20:2	0.55	0.55	0.00
8,11,14-Ecostrienoic acid ω6	C20H34O2	C20:3	0.58	0.72	24.14+
Cis 5,8,11,14,17-Ecosapentadecnicacid ω3	C20H30O2	C20:3	1.26	0.25	- 80.16
Arachidonic acid ω6	C20H32O2	C20:4	0.47	0.12	- 74.47
Docosapentadecanoic ω6	C22H34O2	C20:5	0.54	0.35	35.18-
Docosahexadecanoic ω3	C22H32O2	C22:6	2.81	1.01	-64.06
$\Sigma_{(MUSFA)}$			20.77	27.95	34.57

Table 3 illiterates the effect of frying process on the different fatty acid constituents in bolti fleshes (Telapia). Concentration of the total saturated fatty acids (SFA) from C12:0 to C48: O in both fresh and fried fleshes revealed considerable levels of decrease from 45.37 to 30.43% with a total

change up to 32.93%,respectively. On the opposite, the same cooking process comprised considerable increase in total MUSFA fluctuated between 32.67 to 44.48% with an average change 36.15% in increase for fresh and fried fleshes respectively. These results were in agreement with those of *Fatima et al., (2006) and Ammar,(2004).* It is obvious from the same table that oleic acid ω9 was the main MUSFA one having the large amount of increase at all that achieved 51.89% change in increase .

REFERENCES

Albert CM, Hennekens CH, O'Donnell CJ, Ajani UA, Carey VJ, Willett WC, Ruskin JN, Manson JE. (1998). Fish consumption and risk of sudden cardiac death. JAMA, 279: 23-28

Ammar, A.K.(2004). Effect of Some preparation and Technological Processes on Bolti Fish Quality. P.1.Ph.D. Thesis, Dept. Food Tech.,Fac. Of Agric.Tanta Univ.,Egypt

Andrade, A.F.Rubira, M.Matsushita and N.E. Souza (1995):"ω"-3 Fatty acids in fresh waters fish from south Brazil Journal American Oil Chemistry, 72 10, pp. 1207-1210.

AOAC (2000). Official Methods of the Association of Analytical Chemists 17th Ed.1:588.Published by the Association of Official Agriculture Chemists, Washington, D.C. ithersburg, MD, USA.

Bang,H.O.,& Dyerberg, J. (1980). Lipid metabolism and ischemic heart disease in Greenland Eskimos. In H. Draper (Ed.), Advances in nutrition research (pp.1-22). New York: Plenum Press.

Copper Wiki, (2008) "Omega-3 fatty acids."File:\\ J: 1 Omega- 3_fatty_acids. Htm.

Dumaguing Omacor (2009).Healthy fish oils for the health "Home Sun- Star Baguio Opinion. Saturday, February 28.
Echarte, M.Zulet, M.A. and Astiasáran, I. (2001): Oxidation Process affecting fatty acids and cholesterol in fried and roasted salmon. Journal of Agricultural and Food chemistry, 49, PP. 5662-5667. Fátima Aparecida Ferreira de Castro, Helena Maria Pinheiro

Sant`Ana,Flávia Milagres Campas Neuza Maria Brunoro Costa, Marco Tûlio Coelho Silva, Ana Lûcia Salaro, Syvia do Carmo Castro Fraceshini (2006). Fatty acid Composition of three fresh water fishes under different storage and cooking processes. Fedral Univ.of Viscosa, Av.PH Rolfs, Vic0sa, 36571- 000 Minas,Gerais, Brazil. Accepted 1October, available online 27 November 2006.

Frankel, E. N.(1982).Volatile lipid oxidation products. Prog.Lipil Res.,22,1-33. Gladyshev, M.I.,Sushchik N.N.,Gubanenko G.A.,Demirchieva S.M. and Kalachova,G.S.(2007):Effect of boiling and frying on the content of essential polyunsaturated fatty acids in muscle tissue of four fish species. Food chemistry,101;4,pp.1694-17oo.

Hearn, T.L. Sgoutas, S.A. Sgoutas, D.S. and Hearn, J.A.(1987).Stability of polyunsaturated fatty acids after microwave cooking of fish. Journal Food Science, 52 2(1987),pp. 1430-1431.

ISO. 5509(2000): Identification of fatty acid methyl esters by GLC technique.
Reaven P.,Parthasarathy S.,Grasse BJ,Miller E,Steinberg D, WitztumJL (1993) Effects of oleate-rich and linoleate-rich diets the Susceptibility of low density lipoprotein to oxidative modification in mildly hypercholesterolemia subjects. J Clin Invest, 91: 660-678.

Sebedio, J.L., Ratnake, W.M.N., Ackman,W.M.N.and Prevost, J . (1993). Stability of polyunsaturated "omega"-3 fatty acids during deep frying of Atlantic mackerel (Scomber scombrus L.) Food Research International, 26, pp.163-172.

Shahidi, F., & Miraliakbari,H.(2004). Omega-3(n-) fatty acids in health and disease: Part 1- cardiovascular disease and cancer. Journal of Medicinal Food, 7. 387-401.

Zhao, G., Etheron, T.D., Martin, K.R., West, S.G., Gillies, P.J. & Kris-Etherton, P.M.(2004). Dietary α-linolenic acid reduces inflammatory and lipid cardiovascular risk factors in hypercholesterolemic men and women. Journal of Nutrition, 134, 2991-2997.

J:\foodOmega.htm (2008). Food that high in Omega-3 .Page 3 of 3.

دراسات على تأثير طرق الطهى على ثبات محتوى الأحماض الدهنية وحيدة وعديدة عدم التشبع فى سمك البلطى

أم السعد اسماعيل الجمال و أمل عبد الله مطر
كلية الاقتصاد المنزلى – جامعة الأزهر- طنطا – مصر

استهدفت الدراسة الحالية تقييم تأثير عمليات الشى والقلى المعتادة والمستخدمة كطرق لتحضير وجبة سريعة فى المنازل ومحلات بيع الأسماك والمطاعم على محتوى أسماك البلطى من كل من الأحماض الدهنية المشبعة والغير مشبعة (مجموعة أحماض الأوميجا)٠

أوضحت النتائج المتحصل عليها من تفريد الأحماض الدهنية احتواء عينات الأسماك الطازجة والمشوية على ٣٢،٦٧% ، ٣٢،٩٢%كمجموع للأحماض الدهنية وحيدة عدم التشبع على الترتيب(C18:1 ,C17:1 C16:1) بزيادة قدرها ٧٧ ،٠% كنتيجة لعملية الشى وقد وجد أن حامض الأوليك (أوميجا٩) قد حقق زيادة كبيرة بلغت ١٣،٧٧%٠

وعلى الجانب الأخر فقد تناقص حمض٩- هيكساديكانويك (أوميجا٧) بدرجة كبيرة بلغت ٥٣،٧١% كنتيجة لنفس الطريقة من الطهى وعلى نفس المنوال فقد أوضحت مجموعة الأحماض الدهنية عديدة عدم التشبع (PUSFA) نقص واضح بالنسبة لمجموعتى اوميجا٣،أوميجا٦ للأحماض (C22:6, C20:4، C20:4 ,C20:3 C20:2 ,C18:3, C18:2) مع نفس طريقة الطهى(الشى) محققة النسب الاجمالية ٢٠،٧٧%، ٢٧،٩٥ % بالنسبة للعينات الطازجة والمقلية على الترتيب٠هذا وقد تبين أن حامض اللينوليك كأحد أفراد مجموعة الأحماض الدهنية عديدة عدم التشبع قد أوضح زيادة كبيرة نتيجة لعملية القلى بلغت ١٠٦،٤٠%

وعلى النقيض فقد أوضحت مجموعة الأحماض وحيدة عدم التشبع زيادة معنوية مابين ٣٢،٦٧ الى ٤٤،٤٨% بمتوسط زيادة اجمالية بواقع ٣٦،١٥% للعينات الطازجة والمقلية على الترتيب٠ أما حمض الأوليك (أوميجا ٩) كأحد أهم أفراد مجموعة الأحماض وحيدة عدم التشبع فقد حقق زيادة ملحوظة بلغت ٥١،٨٢% نتيجة لعملية القلى ،أما باقى أفراد هذه المجموعة فقد أظهرت انخفاضا ملحوظا خاصة (أوميجا ٧) فى عملية الشى ،ومن ناحية أخرى، فقد أوضحت هذه العملية انخفاضا ملحوظا أيضا فى مجموعة الأحماض الدهنية عديدة عدم التشبع بلغ هذا

الانخفاض٢٧،٠١%٠وباستثناء حمض اللينوليك (أوميجا ٦) فقد كان هناك انخفاضا واضحا فى نسب مجموعة الأحماض الدهنية عديدة عدم التشبع نتيجة لعملية القلى وقد بلغت هذه الزيادة فى هذا الحمض ١١،٠٣%٠وبالنسبة لحمض ٨-١١-١٤ايكوستيانويك (أوميجا٦)٠ بلغت هذه الزيادة ٢٤،١٤%٠ نتيجة لنفس العملية٠

من ذلك يمكن القول أن عملية الشى أدت الى ارتفاع طفيف فى مجموع الأحماض الدهنية وحيدة عدم التشبع فى مقابل انخفاض كبير فى مجموع الأحماض الدهنية عديدة عدم التشبع وعلى النقيض فقد أدت عملية القلى الى زيادة لكل من الأحماض الدهنية وحيدة وعديدة عدم التشبع زيادة كبيرة خاصة حمض الأوليك (أوميجا٩) وحمض اللينوليك (أوميجا٦) ، هذا علاوة على انخفاض النسب الاجمالية للأحماض المشبعة انخفاضا كبيرا والتى تسبب العديد من المشاكل الصحية ومنها أمراض القلب والسمنة٠

قام بتحكيم البحث

أ.د / مسعد عبد العزيز ابو ريه — **كلية الزراعة – جامعة المنصورة**

أ.د / عبد الباسط عبد العزيز سلامه — **كلية الزراعة – جامعة كفر الشيخ**