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EFFECT OF COOKING METHODS ON PROXIMATE AND FATTY ACIDS COMPOSITION OF TWO NILE FISH SPECIES

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ABSTRACT

Three cooking methods microwave, deep-oil frying and baking were used to cook fresh fillets of two Nile fish species Bolti (*Tilapia nilotecs*) and Bayad (*Bagrus Bayad)*. Averaging weight was ١٦٢١.٠g for Bayad and ٤٢٢.٥g for Bolti. The fillets yield of Bayad was higher (٤٥.٣٠٪) than Bolti (٣٤.٤٠٪). Cooking methods resulted in variable values of protein, fat and ash content. Deep-oil frying decreased protein content from ٨٣.٢٤٪ to ٧٥.١٧٪ for Bayad and from ٨٥.٠١٪ to ٧٤.١٠٪ for Bolti fish, but increased lipid contents. While, ash content was slightly affected. Deep oil frying samples had lower moisture content than that of other cooking methods. The least moisture lost was in microwave cooked fillets, also frying caused a great loss of weight (٣١.١٧٪). Total saturated fatty of fish species fillets increased after baking and microwave cooking. Fatty acid profile of Bolti and Bayad fillets changed greatly after deep -oil frying. Deep-oil frying increased total unsaturated fatty acids due to the uptake of unsaturated fatty acids from the frying oil. Bolti and Bayad fillets had smallest amount of DPA and DHA less than g/١٠٠gfatty acids. linolenic acid ١٨:٣n٣ levels were ١.٣٤٦ for raw Bolti and ٢.٧٠٦g/١٠٠g for raw Bayad . Baking and microwave cooking caused little changes in UFA/SFA ratio but deep -oil frying caused great change.

INTRODUCTION

Recently, had been growing there in fish and fish products as a source of polyunsaturated fatty acids (PUFA), mainly ω-٣. Polyunsaturated fatty acids, eicosapentaenoic (EPA. C٢٠:٥n٣) and docosahexaenoic acid (DHA. C٢٢٦n٣) are the dominant n٣ fatty in marine fish (Ackman, ١٩٨٩). These fatty acids are of great importance to human for prevention of coronary artery disease (Conner, ٢٠٠٠). DHA is a major component of brain, eye retina and heart muscle and considered as important for brain, eye development and good cardiovascular (Birch et al., ١٩٩٨). EPA has been reported to be useful for brain disorders and cancer treatment (Fenton, et al., ٢٠٠٠). General recommendation for daily intakes of DHA/EPA is ٠.٥ for infants and ١g/day for adults (Kris-Etherton et. al., ٢٠٠٢). Freshwater fish content had lower proportions of long-chain n٣ PUFA than marine fish , and ratio total n٣/n٦ fatty ratio acids is much higher in marine fish than freshwater fish, ranging from ٥ to ١٠ or more (Rahman, et. al., ١٩٩٥). The fatty acids composition of fish oils results from the fatty acids composition of their natural foods (Grigorakis, et. al., ٢٠٠٢). According to the American Heart Association (Krauss et al.,٢٠٠٠)at least two servings of fish per week are recommended to confer cardioprotective effects .However, although the beneficial effect of fish has been mainly ascribed to its particular fatty acid composition (Mataix & Gil .٢٠٠٢),some studies showed that fish protein also play a role in that respect.

Handling and processing can cause alterations in fish component, i.e increase in the amount of free fatty acids and compounds derived from lipid oxidation (Sarma, et al., ٢٠٠٠). Other factors, such as species, size, surface contact, lipid contents and cooking temperature can effect lipid composition in fish after cooking (De Castro, et al., ٢٠٠٧).Cooking methods of fish before consumptiom include boiling, steaming, baking, broiling or grilling, frying and microwave (Hearn et al., ١٩٨٧). Multiple external changes and interaction between fried oil and fish oil may be occurred during fish frying (El-Sharnouby and Attia ٢٠٠٣).Heat (boiling, baking, roasting, frying and grilling) is applied to food in different ways to improve the hygienic quality (by inactivation of pathogenic microorganisms) enhancing flavour and taste ,and increasing shelf life(Bongar ,١٩٩٨ and Pokorny ,١٩٩٩). During cooking ,chemical and physical changes take place that may improve or impair food nutritional value e.g. increase in digestibility due to protein denaturation in food but thermolabile compounds ,fat-soluble vitamins or polyunsaturated fatty acids content are often reduced (Bongar ,١٩٩٨). Several Nile fish species are available for human consumption. Many studies have been carried out on nutrient composition and quality of some fresh Nile fish species (Abd El-aal ١٩٩١, ١٩٩٦, and Mohamed, and Abd El-aal, ١٩٩٧).However, few studies were carried out on the nutrient composition of cooked nile fish. Therefore, freshwater fish Nile Bolti and Bayad were chosen for this study for their good market acceptance in Egypt.

The study included evaluation of the effect of cooking methods (microwave cooking, deep -oil frying and baking) on fatty acid profile, proximate composition and cooking loss of there two Nile fish species.

MATERIALS AND METHODS

Samples (fifteen Kg each) of the two fish species Bolti (*Telapia nilotecs*) and Bayad (*Bagrus bayad*), averaging ١٦٢١.٠g each for Bayad and ٤٢٢.٥g for Bolti, were obtained from a local fish market in El-Minia, Egypt. Fish samples were immediately kept in ice and transported to Food Science Department, Minia University. They were washed, headed, eviscerated, skinned and filleted. The fillets were randomly divided into ٤ samples one samples was used as a raw and the others conversion were cooked in microwave, deep-oil frying and in oven.

Cooking Methods

Microwave cooking: Fish fillets were weighted and placed in a microwaveable plastic baking dish. The sample was cooked for ١ min at full power in a ٨٥٠ watt maximum energy (Microwave oven, Moulinex Type ٠٤٩, France).

Deep-oil frying : Fish samples were fried without butter and breading in sunflower oil at ١٨٠°C for ٢-٢.٥ min according to Charley (١٩٧٠)

Cooking in convection oven (Baking): Fish fillets were wrapped in aluminum foil, placed in aluminum baking pan and cooked in preheated convection oven at ٢٠٠ °C for ١٠ min. Omega Thermocouple, Model ١٩٩ (Engineering; INC. Stanford, Conn. USA) was used to measure the internal temperature of cooked samples as illustrated in Table ١.

Table ١: Conditions used for cooking fillets of two Nile fish species

Cooking methods	Bolti	Bayad
Microwave cooking [a]		
Cooking time (min)	١	١
Internal temperature °C	٨٣	٨١
Deep-oil frying [b]		
Cooking time (min)	٢	٢.٥
Internal temperature °C	٨٥	٨٣
Convection oven [c]		
Cooking time (min)	١٠	١٠
Internal temperature °C	٨١	٨٠

[a] Maximum power ٨٥٠ watt microwave oven, Moulinex, France

[b] Deep -oil frying temperature =١٨٠ °C [c] Convection oven temperature = ٢٠٠ °C

Analysis :

Cooking loss: Cooking loss was calculated according to Santos and Regenstein (١٩٩٠).

Proximate composition of raw and cooked fish fillets: Moisture, protein, fat, and ash contents were determined according to the methods outlined in AOAC, (١٩٩٥).

Fatty acid composition: Total lipids were extracted with chloroform/methanol (٢:١) (Folch, et al., ١٩٥٧). Fatty acids methyl esters of total lipid extracts from fresh and cooked fish fillets were prepared using (١٪ $H_٢SO_٤$ in methanol) for ٣ hour at ٧٠°C (Makrides et al.,١٩٩٤). After cooling the resulting Fatty Acid Methyl Esters (FAMS) were extracted with n-hexane, dried with anhydrous sodium sulfate and concentrated to a small volume with a steam of nitrogen and transferred to micro vials for gas chromatographic (GC) injection. The fatty acid methyl esters were identified and quantified on a Hewlett packard ٦٨٩٠ (GC) equipped with (FID) flame ionization detector (Hewlett Packard, USA). The samples were separated on a ٣٠m HP.٥ capillary column (Hewlett Packard USA), ٠.٣٢ mm diameter, ٠.٢٥ µm film thickness) using N٢ at a flow rate of ٠.٨ml/min. The chromatographic run parameters included an oven starting temperature of ١٠٠ °C then increased by the rate of ٥°C/min to ١٧٥°C and held for ١٠ min before increasing temperature to ٢٢٠°C at ٨°C/ min, with a final hold of ١٠ min. The injector and detector temperature were both constancy at ٢٥٠°C. Peaks were identified by comparison of retention times with external standard mixture (Sigma, St. Louis, MO, USA; ٩٩٪ purity specific for GLC) on the same conditions.

Indicates of lipid quality: From fatty-acid composition data, the following were calculated :

Index of atherogenicity (IA): indicating the relationship between the sum of main saturates and the that of main unsaturated, the former being considered pro-atherogenic (favoring of lipids to cells of immunological and circulatory),and the latter anti-thrombogenic (inhibiting the aggregation of plaque and diminishing the levels of esterified fatty acid, cholesterol, and phospholipids ,thereby preventing the appearance of micro- and macrocoronary) (Ulbritcth &Southgate, ١٩٩١ and Senso et al,٢٠٠٧).

IA =[(١٢:٠ +(٤x ١٤:٠)+١٦:٠)]/ [MUFSAs +PUFA-**n٦** + PUFA-**n٣]**.

Index of thrombogenicity (IT): showing the tendency to form clots in blood vessels . This is defined as the relationship between the pro-thrombogenetic (saturated) and FA (MUFSA , PUFA-n٦ y PUFA-n٣) Ulbritcth &Southgate,١٩٩١ and Senso et al,٢٠٠٧).

IT = (١٤:٠ ١٦:٠)+١٨:٠)]/ [(٠.٥ × MUFSAs +٠.٥ ×PUFA-n٦ +٣× PUFA-n٣) + PUFA-n٣/ PUFA-n٦].

RESULTS AND DISCUSSION

Fillet yield

The yield of fillet was expressed as the total weight of skinned fillets divided by total weight of whole fish. Bayad had higher yield value (٤٥.٣٠٪ than Bolti fish ٣٤.٤٠٪). The yield of Bolti fish fillet was lower than that reported by Abd El-aal, (١٩٩٦) and Farah, (٢٠٠٢), who showed that the yield of skinned fillets of Bolti was ٣٨.١٠ and ٣٩.٧٤٪. Rebhein and Oehlenschlager, (٢٠٠٩) reported that the proportion of fish flesh to total body weight varies between ٤٠٪ and ٦٠٪, depending on species, shape, age and physiological status of the fish. Fish with more elliptical cross sections (tuna, herring and salmon) exhibit a much higher proportion of edible muscles than flat fish species or species with very big heads such as monkfish. Bolti fish had higher contents of viscera (١١.٨٠٪), and skin and scales (٦.٣٠٪) than Bayad fish. The edible yield of fish flesh vary considerably and depending on period of intensive feeding, time of capture and amount of waste during heading, gutting, and deboning, (Gall et al., ١٩٨٣).

Table ٢: Weight composition of two Nile fish species

Component	Fish species			
	Bayad		Bolti	
	Weight g	١٠٠٪	Weight g	١٠٠٪
Fillet	٧٣٥.٠ ±٧٣.٥	٤٥.٣	١٤٥.٥ ±٢٠.٨	٣٤.٤
Head	٣٣٢.٥ ±٣٢.٥	٢٠.٥	٧٧.٠ ± ٤.٩	١٨.٢
Frame	٣٣٥.٠ ±٧٣.٤	٢٠.٧	٩٨.٠ ±٣.٠	٢٣.٢
Viscera	٩٧.٥ ±٦.٢	٦.٠	٤٩.٥ ± ٢.٠	١١.٨
Skin*	٥٨.٥ ±١.٥	٣.٦	٢٦.٥ ±١.٢	٦.٣
Fins	٦٢.٥ ±٦.١	٣.٩	١٤.٠ ±.٢.٥	٣.٣
Whole body	١٦٢١ ±١٧٤.٧	١٠٠	٤٢٢.٥ ±٢٠.٨	١٠٠

N = ٤ ± = Standard deviation
* Skin and scales for Bolti

Proximate composition

Cooking methods gave variable values of protein, fat and ash content for fish samples on dry weight basis (Table ٣). Deep-oil frying decreased protein content from ٨٣.٢٤٪ to ٧٥.١٧٪ for Bayad and from

٨٥.٠١٪ to ٧٤.١٠٪ for Bolti. These results may be due to losing, of protein nitrogen during cooking (Gall. Et al., ١٩٨٣).It Also, caused apparent lower protein content due to oil absorption during frying. El- Sharnouby and Attia, (٢٠٠٣) found that deep -oil frying decreased protein content of grey mullet from ٧٦.٨٧٪ for fresh sample to ٦٦.١٦٪ for fried sample. Fried samples had higher fat content than that of fresh, baked and microwave cooked samples, possibly due to absorption of oil during frying process. No changes were found in fat content of fillets by baking and microwave cooking. Hoffman et al., (١٩٩٤) reported that deep-oil frying significantly increased lipid content from ٣.٢١٪ to ٨.٧٧٪ (wet weight basis) but baking and microwave cooking did not have significantly effect on lipid content of African sharptooth catfish (*Clarias gariepinus*). Ash content was slightly affected after deep-oil frying and microwave cooking it decreased from ٥.١٩٪ to ٤.١١٪ and ٤.٧٧٪ for Bayad and from ٥.٤٥٪ to ٤.١٤٪ and ٤.٧٥٪ for Bolti. Ash constituents were lost when fillets from low fat species were broiled, baked, deep fried or cooked with microwave Gall et al., (١٩٨٣). Changes in proximate composition were more prominent in fried fillets.

Table ٣: Effect of cooking method on protein, oil and ash content of fish fillets (on dry weight basis)

Samples	Protein %	Oil %	Ash%
Bayad			
Fresh	٨٣.٢٤ ± ٠.٠٧	١٤.٠٥ ± ١.٦٨	٥.١٩ ± ٠.١٨
Deep -oil fried	٧٥.١٧ ± ٠.٦٠	١٩.٥٠ ± ١.٦٠	٤.١١ ± ٠.١٠
Baked	٨٢.٧٥ ± ١.١٩	١٤.٨١ ± ٠.٤٨	٥.٠٢ ± ٠.٠٦
Microwave cooked	٨٣.٨٨ ± ٠.٤٧	١٤.٥٥ ± ٠.٧٠	٤.٧٧ ± ٠.٠٥
Bolti			
Fresh	٨٥.٠١ ± ١.٣٠	١٢.٢٦ ± ١.٣٤	٥.٤٥ ± ٠.١٢
Deep -oil fried	٧٤.١٠ ± ١.٦٦	٢٠.٥٤ ± ١.١٨	٤.١٤ ± ٠.٠٩
Baked	٨٤.٥٦ ± ١.١١	١٢.٣١ ± ١.٠٩	٥.١١ ± ٠.٠٩
Microwave cooked	٨٣.٧٠ ± ١.٦٢	١١.٦٨ ± ٠.٩٤	٤.٧٥ ± ٠١٢

± = Standard deviation

Moisture content and cooking loss

Results in Table ٤ show the changes in moisture content after cooking of Bolti and Bayad fish fillets. Generally, moisture contents of both Bolti and Bayad fillets were decreased after cooking. The moisture contents of fresh and cooked samples ranged from from ٧٨.٤٨ to ٦٤.٤٠ % for Bolti fillets and from ٧٨.١٨ to ٦٥.٣٧٪ for Bayad fillets. Fried samples had lower moisture content than that of other cooking methods. The least moisture was lost from microwave cooked fillets. These results agreed with the data reported by Abdel-aal et al., (٢٠٠٠). Cooking methods reduced moisture content of Grey mullet due to evaporation of moisture during heat treatment and muscle protein denaturation (Aman, ١٩٨٣ and El-sharnouby and Attia ٢٠٠٣, Garcia-Arias et al., ٢٠٠٣) .

Cooking loss

Results in Table ٤ showed that, cooking of fish fillets caused loss of weight. Frying process caused a great loss of weight (٣١.١٧٪) compare to the other two cooking methods. Microwave cooking had the lower value of cooking loss for Bayad than that of Bolti fillets. Baked Bolti fillets had lower cooking loss values than Bayad. The major factors for weight loss were evaporation of water, fat loss and moisture picked up by the cooking material (Costello et al., ١٩٩٠). Sample size and fiber protein structure are important factors when determining the cooking loss (Bouton et al., ١٩٧٦).

Table ٤ : Effect of cooking method on moisture content and cooking loss of Bolti and Bayad fish fillets

Samples	Moisture %	Cooking loss%
Bayad		
Fresh	٧٨.٤٨ ± ٠.٢١	
Fried	٦٤.٤٠ ± ٠.٢٤	٣١.١٥ ± ٢.٣٢
Baked	٧٥.٠١ ± ٠.٤٤	٢٠.٩٧ ± ١.٨٧
Microwave cooked	٧٥.٣٥ ± ٠.١٢	١٦.٦٧ ± ١,٢٥
Bolti		
Fresh	٧٨.١٨ ± ٠.٨٢	
Fried	٦٥.٣٧ ± ٠.٦٧	٣١.١٧ ± ٢.٥٢
Baked	٧٣.٤٥ ± ٠.٩٤	١٤.٥١ ± ١.١٧
Microwave cooked	٧٤.٦٥ ± ٠.٥٦	٢٠.٦٣ ± ٢.٣١

± Standard Daviation

Fatty acid composition

Results in Table ٥ show fatty acids composition of raw and cooked Bolti and Bayad fillets. Raw Bolti and Bayad fillets had high levels of oleic acid (C١٨:١), ranged from ٢٢.٧٧٩ to ٣٣.٦٨٤ g/١٠٠g fatty acids, while , palmtic acid (C١٦:٠) was the main saturated fatty acid in raw Bolti and Bayad fillets (١٨.٩٥٨ and ٢٦.١٧٧ ,respectively).

Table ٥ :Effect of cooking method on fatty acids composition of fish fillets (% of total fatty acids)

Fatty acids	Bolti fillets				Bayad fillets			
	raw	baked	Micro wave	fried	raw	baked	micro wave	fried
SFA(Saturated fatty acids)								
C٦:٠	٠.٠٣٣	٠.١٣٨	٠.٠٦٠	٠.٠٠٠	٠.٢٧٢	٠.٠٥٠	٠.١٠٩	٠.٠٠٠
C٨:٠	٠.٠٣٢	٠.١٠٨	٠.٠٥٨	٠.٠٠٠	٠.١٧٠	٠.٠٠٠	٠.٠٠٠	٠.٠٠٠
C١٠:٠	٠.٣٢٠	٠.٠٧٦	٠.٠٠٠	٠.٠٠٠	٠.٠٠٠	٠.٠٠٠	٠.٠٠٠	٠.٠٠٠
C١٢:٠	٠.٣٦٥	٠.٠٩٩	٠.٠٠٠	٠.٠٠٠	٠.١٧٩	٠.٠٩٩	٠.١٨١	٠.٠٠٠
C١٤:٠	٧.٧٧٩	٧.٩٠٩	٨.٣١٨	١.١٠٣	٥.٤٧٣	٣.٨٧٢	٤.٦٨٦	١.٠٠٦
C١٥:٠	٠.٥٩٧	٠.٥٦٤	٠.٥٨٦	٠.٠٠٠	٠.٠٠٠	٠.٤٩٦	٠.٨٨٨	٠.١٥٨
C١٦:٠	١٨.٩٥٨	٢٠.٠٩٥	١٩.٩٧١	٩.٤٨٩	٢٥.٦٦٨	٢٦.١٧٧	٢٦.٠٨٣	٩.٠٧٣
C١٧:٠	٠.٤٣١	٠.٧٤١	٠.٢٢٧	٠.٠٠٠	٠.٩٦٣	١.٦٢٢	٠.٤٣٥	٠.١٩٠
C١٨:٠	٠.٥٢٧	٠.٠٣٢	٢.٥٧١	٠.٠٠٠	٠.٠٠٠	٠.١٢١	٠.٢٤٤	٠.٠٨٠
C٢٠:٠	٠.١٨٩	٠.٢٧٧	١.٠٦٩	٠.١٧٤	٠.٢٧١	٠.٣٩٤	٠.٣٥٥	٠.٣٦٨
C٢٢:٠	٠.٠٠٠	٠.٥٤١	١.٩٩٣	٠.٥١٩	٠.٧٢٦	٢.١٩٠	١.٧٦٤	٢.٦١٨
MUSFA(Monounsaturated fatty acids)								
C١٤:١	٠.١٣١	٠.١٦٧	٠.١٥٤	٠.٠٠٠	٠.٢٩٢	٠.٠٠٠	٠.١٥٣	٠.٠٠٠
C١٥:١	٠.١٧١	٠.١٢٠	٠.٢٧٠	٠.٠٠٠	٠.٩٧٠	٠.١٠٢	٠.١٨٧	٠.٠٠٠
C١٦:١	١٨.٣٥٨	١٧.٠٤٨	١٨.٦٧٢	٢.٧٩٧	١٢.٢٢٨	١٠.٤٣٧	٩.٢٦٥	٢.٤٧٢
C١٧:١	٠.٤٤٠	٠.٤١٤	٠.٣٧٧	٠.٠٠٠	٠.٢٤٢	٠.٠٧١	١.١٩٣	٠.١٧١
C١٨:١	٢٢.٧٧٩	٣١.١٣٢	٢٣.١١١	٦٩.٥٨٣	٣٣.٦٨٤	٣٥.٠٤٥	٣٢.٢٠٠	٦٩.٣٠٢
C٢٠:١	٣.١٠٨	٢.٦٩٨	٢.٦٥١	٠.٤١٢	٠.٦٤٢	٢.٠٧٠	٣.٧١٣	٠.١٧٠
PUSFA(Poly unsaturated fatty acids)								
C١٨:٢n٦	٥.٤٣٦	٠.٠٠٠	٠.٠٠٠	٨.٠١٩	٧.٧٤٧	٦.٩٦٥	٧.٨٢٧	٦.٥٢٥
C٢٠:٢n٦	٠.٦٥٨	١.٤٧٧	٠.٩٣٧	٠.١٢١	٠.٧٠٨	١.٥٩٤	١.١٥٤	٢.٥٣٢
C٢٠:٣n٦	١.٩٩٣	١.٨٩١	٢.٠٠٢	١.٦٣١	٢.٤٦٩	٢.١٩٦	٢.٢٦٢	١.١٧١
C٢٠:٤n٦	٠.٢٩٦	٠.٦٧٨	٠.٩٣٧	٠.٤٢٥	٠.٣٠٩	١.٤٣٦	٠.٩٩٥	٠.٦٣٤
C٢٢:٤ n٦	١٣.٨٧٠	١٢.٢٣٣	١٤.٥١٩	٤.٠١٦	٣.٦٤٥	٣.٢١٦	٣.٢٦٩	٢.٣٦٥
C١٨:٣ω٣	١.٣٤٨	٠.٧٨٢	٠.٩٥٤	٠.١٠٤	٢.٧٠٦	١.٠٠٢	١.٢٩٠	٠.٤٨٢

C٢٢:٥ ω٣	١.٦٧٢	٠.٦١٣	٠.٥٦٣	٠.٨٥١	٠.٠٠٠	٠.٨٤٦	٠.٤٩٦	٠.٦٨٣
C٢٢:٦ ω٣	٠.٤٨٩	٠.٠٠٠	٠.٠٠٠	٠.٧٥٧	٠.٦٠٩	٠.٠٠٠	١.٢٥١	٠.٠٠٠

The present results agree with the data reported by De castro et al., (٢٠٠٧), who stated that palmtic and oleic acids present in lager proportion ٢٦.٥٥٪ and ٢٣.٨٦٪of total fatty acids of Nile tilapia, respectively. Oleic acids (١٨:١) increased after deep -oil frying to ٦٩.٥٨٣ for Bolti and to ٦٩.٣٠٢ g/١٠٠g fatty acids due to oil uptake. The fatty acids identified as polyunsaturated fatty acidsω٣(PUFAω٣) were docosapentaenoic acid DPA (C٢٢:٥n٣) in Bolti lipid only, decosahexaenoic acid DHA (C٢٢:٦n٣) in Bolti and Bayad lipid. EPA, which one of the most important fatty acids in fish lipids, was not found in raw Bolti and Bayad. Bolti and Bayad fillets had smallest amount of DPA and DHA in terms of less than g/١٠٠g fatty acids . linolenic acid ١٨:٣n٣ levels were ١.٣٤٦ for raw Bolti and ٢.٧٠٦g/١٠٠g fatty acid for raw Bayad. For the group of (PUFAω٦) the primary fatty acid was C٢٢:٤ n٦ decosatetraenoic acid (١٣.٨٧٪), followed linoleic acid C١٨:٢n٦ (٥.٤٣٦٪) for Bolti lipid. While, the main (PUFAω٦) of Bayad lipid was linoleic acidC١٨:٢n٦ (٧.٧٤٧٪), followed by C٢٢:٤ n٦ decosatetraenoic acid (٣.٦٤٥٪).

Results in Table ٦ show fatty acid groups of raw and cooked Bolti and Bayad fillets. Raw Bolti and Bayad fillets had high levels of monounsaturated fatty acid accounting ٤٤.٩٨٦ and ٤٨.٠٥٨ g/١٠٠g fatty acids, respectively. Total MUFA ranged from ٤٤.٩٨٦ to ٧٢.٧٩٢ for Bolti and from ٤٦.٠٥٨ to ٧٢.١١٥ g/١oog fatty acid for Bayad. Total saturated fatty acids content of fillets of the two fish species increased after baking and microwave cooking. Gall et al., (١٩٨٣) found that baking did not affect fatty acid profile of Grouper fish fillets but microwave cooking increased the total SFA from ٣٠.٤٩٪ to ٣٣.٢٨٪. Fatty acid profile of Bolti and Bayad fillets changed greatly after deep -oil frying. Deep -oil frying increased total unsaturated fatty acids due to the uptake of oleic acid from the frying oil. These results are in a good agreement with the data reported by Larsen et al., (٢٠١٠). There are minor differences in fatty acid composition of Bolti and Bayad fillets after baking and microwave cooking. Fatty acid profile of silver catfish (*Rhamdia quelen*) fillets marginally affected by baking and was greatly affected by deep -oil frying due to oil absorption (Weber et al., ٢٠٠٨).

De castro et al., (٢٠٠٧) reported that Nile tilapia had high levels of saturated fatty acids and lower amounts of polyunsaturated fatty acids compared to other freshwater fish species. The results of raw Bolti and Bayad fillets showed the unsaturated fatty acids(UFA) content almost doubled that saturated fatty acid (٢.٤٢٠ and ١.٩٦٣, respectively.

Data in Table ٦ show that (PUFAω٦) content was higher than that of the (PUFAω٣); total PUFA decreased after cooking. Fried samples had lower PUSFA than that of baked and microwave cooking. Omga-٣ fatty acids decreased after cooking for all cooked samples. Baking and microwave cooking caused little changes in USFA/SFA ratio but deep -oil frying caused a great change in UFA/SFA ratio (٧,٨٦١) for Bolti and (٦.٤١١) for Bayad fillets. A minimum value of PUFA/SFA ratio recommended is ٠.٤٥ (HMSO,١٩٩٤),which was lower than those obtained from all sample studied.

Table ٦: Effect of cooking method on fatty acid groups of fish fillets

Fatty acid groups	Bolti fillets				Bayad fillets			
	raw	Baked	microwave	fried	raw	baked	microwave	fried
Total SFA	٢٩.٢٣١	٣٠.٧٥٨	٣٤.٨٥٣	١١.٢٨٥	٣٣.٧٢٢	٣٥.٠٢١	٣٤.٧٤٥	١٣.٤٩٣
Total MUFA	٤٤.٩٨٦	٥١.٥٧٩	٤٥.٢٣٥	٧٢.٧٩٢	٤٨.٠٥٨	٤٧.٧٢٥	٤٦.٧١١	٧٢.١١٥
Total PUFA	٢٥.٧٦٢	١٧.٦٧٤	١٩.٩١٢	١٥.٩٢٤	١٨.١٩٣	١٧.٢٦٥	١٨.٥٤٤	١٤.٣٩٢
Total UFA	٧٠.٧٤٨	٦٩.٢٥٣	٦٥.١٤٧	٨٨.٧١٥	٦٦.٢٥١	٦٤.٩٧٩	٦٥.٢٥٥	٨٦.٥٠٧
Total ω٣	٣.٥٠٩	١.٣٩٥	١.٥١٧	١.٧١٢	٣.٣١٥	١.٨٤٨	٣.٠٣٧	١.١٦٥
Total n٦	٢٢.٢٥٣	١٦.٢٧٩	١٨.٣٩٥	١٤.٢١٢	١٤.٨٧٨	١٥.٤١٧	١٥.٥٠٧	١٣.٢٢٧
n٦/ω٣	٦.٣٤٢	١١.٦٧٠	١٢.١٢٦	٨.٣٠١	٧.٨٠١	٨.٣٤٣	٥.١٠٦	١١.٣٥٤
ω٣/ n٦	٠.١٥٨	٠.٠٨٦	٠.٠٨٢	٠.١٢٠	٠.٢١٥	٠.١٢٠	٠.١٩٦	.٠٨٨
UFA/ SFA	٢.٤٢١	٢.٢٥٢	١.٨٦٩	٧.٨٦١	١.٩٦٤	١.٨٥٥	١.٨٧٨	٦.٤١١
PUFA/ SFA	٠.٨٨١	٠.٥٧٥	٠.٥٧١	١.٤١١	٠.٥٩٣	٠.٤٩٣	٠.٥٣٤	١.٠٦٧
IA*	٠.٧١٣	٠.٧٤٨	٠.٨١٧	٠.١٥٧	٠.٧٢١	٠.٦٤٣	٠.٦٨٩	٠.١٥١

IT**	٠.٦٢٤	٠.٧٣٤	٠.٥٦٣	٠.٢١٧	٠.٧٤٨	٠.٨١٠	٠.٧٦٧	٠.٢٢٠

IA*Index of atherogenicity
IT** Index of thrombogenicity

The highest PUFA/SFA ratio was obtained from both fried Bolti and Bayad fillets ١.٤١١and١.٠٦٧, respectively. These results agree with the data reported by Ozogul et al., (٢٠٠٧), who stated that PUFA/SFA ratio of all freshwater and seawater species studied was higher than the minimum value of PUFA/SFA ratio recommended (٠.٤٥). The ratios of n٦/ω٣ were high in all studied samples and ranged from ٥.١٠٦ to١٢.١٢٦. The ratios of ω٣/ n٦ were low and ranged from ٠.٠٨٢ to ٠.٢١٥. With regard to quality indices considered , IA and IT presented low values, which is good nutritional quality . These are in agreement with the data reported by Seno et al., (٢٠٠٧).

CONCLUSION

Bayad fish had higher fillets yield than Bolti. Deep-oil fried decreased the protein content of Bolti and Bayad. Fried samples had higher oil content than that of fresh, baked and microwave cooked samples due to absorption of oil during the frying process. Frying process caused a great loss of weight (٣١.١٧٪) compare to the other two cooking methods. Fatty acid profile of Bolti and Bayad fillets changed greatly after deep-oil frying. Generally, Nile fish species (Bolti and Bayad) were a suitable sources of PUFAs and the ratio PUFA/SFA was higher than that value (٠.٤٥) recommended by UK Department of health.

REFERENCE

Abd El-aal, H. A.١٩٩١. Biochemical and physico-chemical characteristics of dehydrated quick-salted fish cakes processed from Nile fish muscle. MSc. Thesis, Faculty of Agric., Minia Univ., Egypt.

Abd el-aal, H. A. ١٩٩٦. Factors affecting the quality of surimi and surimi products processed from freshwater fish. Ph. D., Thesis, Faculty of Agric., Minia Univ., Egypt.

Abd el-aal, H. A., Badawy . R.M.and El-Ghazali , M . N. ,٢٠٠٠. Proximate composition and mineral contents of fresh , deep–fat fried and microwave cooked edible fillets of six Nile fish species. , Zagazig J. Agric . Res ., Vol ٢٧ No.(٥) . ١٣٠٥-١٣١٨.

Ackman, R. G., ١٩٨٩. Nutritional composition of fats in seafoods. Progress in food and nutrition science, ١٣, ١٦١-٢٤١.

Aman, M. B. ١٩٨٣. effect of cooking and preservation methods on the water holding capacity (WHC) of mullet fish in relation with changes occurred in muscle protein. Z. Lebensm Unters Forsch. ١٧٧:٣٤٥-٣٤٧

AOAC. ١٩٩٥. Official Methods of Analysis , ١٦the ed., Association of Official Analytical Chemists international, Arlington, Virginia, USA.

Birch,E. E., Hoffman, D. R., Uauy, R., Birch, D. G., and Prestidge, C. ١٩٩٨. Visual activity and the essentiality of docosahexaenoic acid and arachidonic acid in the diet of term infants. Pediatric research. ٤٤, ٢٠١-٢٠٩.

Bognar, A. ١٩٩٨.Compartive study of frying to other cooking techniques .Influence on the nutritive value . Grsasa y Aceites ,٤٩,٢٥٠-٢٦٠.

Bouton, P. E., Harris, P. V., Shorthose, W. R. ١٩٧٦. Factors influencing cooking loss from meat. J. Food Sci., ٤١: ١٠٩٢-١٠٩٥.

Charley, H. ١٩٧٠. Food Science. The Ronald Press Company, New York.

Conner, W. E. ٢٠٠٠. Importance of n-٣ fatty acids in health and dieses. The American journal of clinical nutrition, ١٧ (١), ١٧١s-١٧٥s.

Costello, C. A., Morris, W. C., and Barwick, J. R. ١٩٩٠. Effect of heating bacon and sausage in nonwoven melt-blown material. J. Food Sci. ٥٥:٢٩٨-٣٠٠.

De Castro, F. A., F 'Ana, H. M. P., Campos, F. M., Costa, N. M. B., Silva, M. T., Salaro, A. L., and Franceschini, S. C. C. ٢٠٠٧. Fatty acid composition of three freshwater fishes under different storage and cooking processes. Food chemistry, ١٠٣, ١٠٨٠-١٠٩٠

El-sharnouby, S. A., and Attia, R. S. ٢٠٠٣. Effect of cooking methods on ultra structure, some physical, chemical, and nutritional properties of grey mullet (Mugil cephalus) fish. Alexandria journal of agricultural research, ٤٨(٢), ٥٣-٥٩.

Farah ,N.U. ٢٠٠٢. Factors influencing the quality of frozen fresh water fish during processing. Ph.D.Thesis. Faculty of Agriculture, Minia Univ.,El- Minia, Egypt.

Fenton, W. S., Hibbeln, J., and Kanble, M. ٢٠٠٠. Essential fatty acids, lipid membrane abnormalities and the diagnosis and treatment of schizophrenia. Biological psychiatry. ٤٧ (١), ٨-٢١.

Folch, J., Lees, M., and Sloane-Stanley, G. H. ١٩٥٧. A simople method for the isolation and purification of total lipids from animal tissues. Journal of biological chemistry, ٢٢٦, ٤٩٧-٥٠٩.

Gall, K. L., Otwell, W. S., Koburger, J. A. and Appledorf, H. ١٩٨٣. Effects of four cooking methods on the proximate , mineral and fatty acid composition of fish fillets. J. Food Sci. ٤٨:١٠٦٨.

Garcia-Arias,M.T.,Alvarez Pontes , E., Garcia-Linares , M.C. Garcia-Fernandez, M.C. and Sanchez-Muniz ,F.J. ٢٠٠٣.Cooking-freezing-reheating(CFR)of sardine (*Sardina pilchardus)*fillets. Effect of different cooking and reheating procedures on the proximate and fatty acid compositions . Food chemistry, ٨٣. ٣٤٩-٣٥٦.

Grigorakis, K., Alexis, m. N., Taylor, K. D. A., and hole, M. ٢٠٠٢. Composition of wild and cultured gilthead sea bream (*Sparus Aurata*): Composition, appearance and seasonal variation. International journal of food science and technology, ٣٧ (٥). ٤٧٧-٤٨٤.

Hearn, T. L., Sgoutas, S. A., Sgoutas, D. S., and Hearn, J. A. ١٩٨٧. Stability of polyunsaturated fatty acids after microwave cooking of fish. Journal of food science, ٥٢ (٢), ١٤٣٠-١٤٣١.

HMSO, UK.١٩٩٤. Nutrition aspects of cardiovascular disease (report on health and social subjects N.٤٦).London: HMSO.

Hoffman, L. C., Prinsloo, J. F., Casey N. H., and theron, J. ١٩٩٤. Effect of five cooking methods on the proximate, fatty acid and mineral compostion of fillets of African sharptooth catfish (*Clarias gariepinus*). Die Sa Tydskrif vir Voedeslwetenskap en voiding ٦ (٤) ١٤٦-١٥٢.

Krauss, R.J., Eckel, H.R., Howard ,B. A,ppel, L.J., Daniels, S.R., Deckelbaum ,R.J., Erdman, J.W., Kris-Etherton , P., Goldberg, I.J., Kotchen,T.A., Lichtenstein , A.H., Mithch , W.E.,Mullis , R. ,Robinson , K., Wylie-Rosett, J., Jeor, S.S., Suttie ,J., Tribble ,D.L. and Bazzarre. T.L.٢٠٠٠.AHA dietary guidelines .Revision ٢٠٠٠:a statetement for healthcare professionals from the nutrition Committee of the American Heart Association .Circulalion ,١٠٢,٢٨٤-٢٩٩.

Kris-Etherton, P. m., Harris, W. S., and Appel, L. J. ٢٠٠٢. Fish consumption, fish oil, omegs-٣ fatty acids and cardiovascular disease. Circulation. ١٠٦, ٢٧٤٧-٢٧٥٧.

Larsen, D., Quek, S. Y.and Eyres, L. ٢٠١٠. Effect of cooking method on the fatty acid profile of New Zealand king salmon (*Oncorhnchus tshawytscha*). Food Chemistry, ١١٩, ٧٨٥-٧٩٠.

Makrides, M. M., Neumann, R. W., Byard, K. S., and Gibson, R. A. ١٩٩٤. Fatty acid composition of brain, retina and erythrocytes in breast and formula fed infants. Am. J. Clin. Nuti. ٦٠: ١٨٩-١٩٤.

Mataix ,J.and Gil ,A.(Eds).٢٠٠٢ .Libro blance de los omega-٣. Granada:Editorial Puleva Food.(C .F. Garcia-Arias et al .٢٠٠٣)

Mohamed, h. M. A., and Abd El-aal, H. A. ١٩٩٧. Proximate composition and nutritive value of Nile electric catfish (Malaptreurus electricus). Journal Agric. Sci. Mansoura Univ., ٢٢ (١٢), ٤٤٧٧-٤٤٨٧.

Ozogul , Y., Ozogul , F., and Alagos ,S. ٢٠٠٧. Fatty acid profiles and fat contents of commercially important seawater and freshwater fish species of Turkey :Acompartive study , Food chemistry, ١٠٣. ٢١٧-٢٢٣.

Pokorny ,J.١٩٩٩.Changes in nutrients at frying temperature .In Boskous, D. and Elmadfa, I (Eds),Frying of food .Oxidation, nutrient and non- nutrient antioxidants, biologically active compounds and high temperatures(pp.٦٩-١٠٣).Lancaster :Technomic Publishing CO.Inc.

Rahman, S. A., Huah, T. S., Hassan, O., and Daud, N. M. ١٩٩٥. Fatty acid composition of some Malaysian freshwater fish Food chemistry, ٥٤, ٤٥-٤٩.

Rebhein, H., and Oehlenschlager, J. ٢٠٠٩ Fishery products quality, safety and authenticity. Lackwell Publishing Ltd, United kingdom, Chapter (١), page ١-١٨.

Santos, E. E. M. and Regenstein, J. M. ١٩٩٠. Effects of vacuum packaging, glazing, and erythorbic acid on the shelf-life of frozen white hake and mackerel. J. Food Sci. ٥٥:٦٤.

Sarma, J., VidyaSagarReddy, G., and Srikar, L. N. ٢٠٠٠. Effect of frozen storage on lipids and functional properties of proteins of dressed Indian oil sardine (Sardinalla longiceps). Food research international, ٣٣, ٨١٥-٨٢٠.

Senso . l , Suarez .M .D , Ruiz-Cara .T, and Garica-Gallego .M. ٢٠٠٧. On the possible effects of harvesting season and chilled storage on the fatty acid profile of the farmed gilthead sea bream (*Sparus aurata*) , Food chemistry, ١٠١. ٢٩٨-٣٠٧.

Ulbritcth ,T.L. and Southgate,H .(١٩٩١). Coronary heart disease :seven dietary factors.Lancer,٤٧,٥٢٤-٥٣٢.

Weber, J., Bochi, V. C., Ribeiro, C. P., Victorio, A. D., and Emanuelli, T. ٢٠٠٨. Effect of different cooking methods on the oxidation, proximate and fatty acid composition of silver catfish (Rhamdia quelen) fillets. Food chemistry, ١٠٦. ١٤٠-١٤٦.

Effect methods of cooking on some Nile fish

تأثير طرق الطبخ على التركيب الكيماوي وتركيب الأحماض الدهنية لنوعين من الأسماك النيلية

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استخدمت في هذه الدراسة ثلاث من طرق الطبخ بالميكروويف والشوي في الفرن والقلي العميق في الزيت لطبخ شرائح طازجة من أنواع الأسماك النيلية (البلطي والبياض).وكان متوسط وزن السمكة ١٦٢١.٠جم و٤٢٢.٥ جم للبياض والبلطي على التوالي .وتم دراسة تأثير طرق الطبخ على التركيب الكيماوي وتركيب الأحماض الدهنية والفقد فى الطبخ .وأظهرت النتائج أن ناتج شرائح البياض (٤٥.٣%) كانت أعلى من البلطي(٣٤.٤%). أعطت طرق الطبخ اختلافات فى محتوى البروتين والزيت والرماد فى عينات الأسماك .وأدى استخدام القلى العميق فى الزيت إلى انخفاض المحتوى البروتينى من ٨٣.٢٤% إلى٧٥.١٧% في عينات السمك البلطي بينما ارتفع المحتوى الدهنى وتأثر محتوى الرماد تأثرا بسيطا بعد الطبخ .وأظهرت النتائج انخفاض المحتوى الرطوبى فى العينات المقلية عن العينات الأخرى المطبوخة .وكان أقلهم فقدا فى الرطوبة الشرائح المطبوخة بالميكروويف بينما تسببت عملية القلي فى فقد كبير فى الوزن (٣١.١٧%) مقارنة بطريقتي الطبخ الأخرى . وأظهرت النتائج زيادة محتوى الأحماض الدهنية المشبعة فى شرائح الأسماك الطازجة بعد الطبخ بالميكروويف و الشوى فى الفرن ، بينما تغير تركيب الأحماض الدهنية فى كل من البلطي والبياض أثناء القلي العميق في الزيت،حيث يؤدى القلي العميق في الزيت إلى زيادة الأحماض الدهنية غير المشبعة الكلية بسبب امتصاص الأحماض الدهنية غير المشبعة الكلية من زيت القلى .يحتوى البلطى على كميات قليلة من DPA&DHA أقل من ١جم /١٠٠جم أحماض دهنية ، ويحتوى على حامض اللنيولنيك C١٨:٣n٣ ١.٣٤٦ للبلطى الطازج و٢.٧٠ للبياض الطازج .ولقد تسببت طرق الطبخ بالميكروويف والشوى فى الفرن فى تغيرات قليلة فى نسبة الأحماض الدهنية غير المشبعة/ الأحماض الدهنية المشبعةUFA/SFA بينما يتسبب القلي العميق في الزيت فى تغيرات كبيرة فى هذه النسبة .