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EFFECTS OF COOKING METHODS ON THE PROXIMATE COMPOSITION OF BLACK SEA ANCHOVY (*Engraulis encrasicolus*, Linnaeus 1758)

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Abstract
The effects of different cooking methods (grilling, baking, frying, microwave cooking) on proximate composition of anchovy (*Engraulis encrasicolus* Linnaeus 1758) were determined. Mean moisture, fat, protein, ash, carbohydrate contents and calorie value of raw fish were 62.85%, 10.64%, 22.71%, 1.48% , 2.31% and 195.88 kcal, respectively. On comparing the raw and cooked fish, the results indicated that cooking methods had considerable effect on the proximate composition. The highest value of water loss was found in fried anchovy (49.55%). Protein and fat contents of cooked anchovy by grilling, baking, frying and microwaving were 25.55%, 17.51%; 22.58%, 20.54%; 24.44%, 23.30%; 22.63%, 22.34%, respectively. The highest protein, the lowest fat and energy contents were found in grilled fish; therefore, grilling can be recommended as the best cooking method for healthy diet.

Keywords: Anchovy, cooking methods, proximate composition.

PİŞİRME YÖNTEMLERİNİN KARADENİZ HAMSİSİNİN (*Engraulis encrasicolus*, Linnaeus 1758) BESİN KOMPOZİSYONU ÜZERİNE ETKİSİ

Özet
Çalışmada farklı pişirme yöntemlerinin (ızgara, fırında pişirme, kızartma, mikrodalgada pişirme) hamsinin (*Engraulis encrasicolus*, Linnaeus 1758) besin kompozisyonu üzerine etkisi araştırılmıştır. Çiğ balığın ortalama su, yağ, protein, kül, karbonhidrat içeriği ve kalori değeri sırasıyla; %62.85, %10.64, %22.71, %1.48, %2.31 ve 195.88 kcal'dir. Çiğ ve pişmiş balıklar karşılaştırıldığında pişirme yöntemlerinin balık eti besin kompozisyonu üzerine önemli derecede etkili olduğu saptanmıştır. En yüksek su kaybı kızartılan hamside bulunmuştur (%49.55). Izgarada, fırında, yağda ve mikrodalgada pişirilmiş hamsilerin ortalama protein ve yağ içerikleri sırasıyla; %25.55, %17.51; %22.58, %20.54; %24.44, %23.30; %22.63 ve %22.34'tür. Sağlıklı beslenme için en iyi pişirme metodu olarak, en yüksek protein ve en düşük yağ ve enerji içeriğine sahip olan ızgara önerilebilir.

Anahtar kelimeler: Hamsi, pişirme yöntemleri, besin kompozisyonu

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INTRODUCTION

All over the world, the significance of sea foods has gained attention because of high content of n-3 polyunsaturated fatty acids (n-3 PUFAs) such as eicosapentaenoic acid (EPA; C20:5n-3) and docosahexaenoic acid (DHA; C22:6n-3). These fatty acids have beneficial effects on diseases such as coronary heart disease (1), cancer (2), inflammatory disease (3, 4). They also support brain development and function besides mental health (4).

Fish is usually cooked in different ways before consumption. Cooking (boiling, baking, roasting, frying and grilling) improves hygienic quality of the food by inactivation of pathogenic microorganisms and enhances digestibility and bio-availability of nutrient in the digestive tract. Frying is one of the oldest method of food preparation. It improves the sensory quality of food by formation of aroma compounds, attractive colour, crust and texture (5). Cooking can be both beneficial and detrimental to nutrient content of foods.

During cooking, chemical and physical reactions take place which either improve or impair the food nutritional value (e.g. digestibility is increased because of protein denaturation in food) but the content of thermolabile compounds, fat-soluble vitamins or polyunsaturated fatty acids is often reduced (5).

Total fish production in Turkey was reported as 646310 tons and 623000 tons in 2008 and 2009, respectively. A significant portion (205000 tons) of this harvest was anchovy (6). The amount of total export and import of fish were 54500 tons and 63000 tons in 2008, respectively. In 2008, while the amount of fresh and chilled anchovy exported was 8 tons, the amount of frozen anchovy was 871 tons. In contrast with, the import amount of fresh-chilled, dry-not smoked, salted-brined-not smoked anchovy were informed as 7000 tons, 2 tons, 22 tons, respectively (7). Anchovy is usually caught commercially by purse seine between the November and January. It is a fish in great demand especially in Black Sea region of Turkey and generally consumed as fresh.

Although there are some researches on the proximate composition and fatty acids of anchovy (8-13), the available food composition tables provide minimal data on nutritive values of cooked anchovy. Therefore, the aim of this research was to determine the effects of different cooking methods (grilling, baking, frying, microwave cooking) on proximate composition of anchovy.

MATERIAL AND METHODS

Anchovy (approximately 10 kg) used in this study were purchased from a local fish market in Sinop on November 24, 2009. They were kept inside the iced-boxes and transferred to the laboratory in 1 h. On arrival to the laboratory, fish were washed with tap water to remove adhering blood and slime. They were then prepared using common household practices, namely eviscerating and beheading. Cleaned fish were washed with tap water several times to remove blood. Then, fish were divided into five for cooking according to different cooking methods.

The first group was uncooked. The other four groups were cooked in the grill (180 °C, 30 min), baked in the oven (170 °C, 35 min), fried (185 °C, 10 min) and in the microwave oven (2450 Mhz, 10 min). Sunflower oil was used for pan-frying. Raw and cooked samples were homogenised in blender and each group was analysed.

Chemical Analysis

The moisture (925.10) and crude ash (923.03) contents were determined as described by AOAC (14) and the crude protein content (960.52) was calculated by converting the nitrogen content determined by the Kjeldahl method (Nx6.25) (14). Crude lipid content (991.36) was determined by acid digestion prior to continuous extraction using petroleum ether (b.p. 40-60 °C) in a Soxtec system (15). Energy value was calculated by Atwater method (16). The analyses were conducted in triplicate.

Statistical Analysis

Statistical analyses were performed by Minitab Release 13.20 (Minitab Inc., State College, PA). One-way analysis of variance and Tukey test were carried out on the means of values. The significance level was $P<0.05$.

RESULT AND DISCUSSION

The moisture, protein, ash and fat contents of raw and cooked anchovy are presented in Table 1.

Table 1. Proximate composition and calorie values of raw and cooked anchovy

	Moisture (%)	Crude Fat (%)	Crude Protein (%)	Crude Ash (%)	Carbohydrate (%)	Calorie (kcal)
Raw	62.86±0.03^{a}	10.64±0.04^{a}	22.71±0.04^{a}	1.48±0.01^{a}	2.31±0.08^{a}	195.88±0.25^{a}
Grilled	54.63±0.07^{b}	17.51±0.19^{b}	25.55±0.16^{b}	1.97±0.00^{b}	0.33±0.01^{b}	261.13±1.18^{b}
Baked	52.83±0.03^{c}	20.54±0.13^{c}	22.58±0.18^{a}	1.32±0.01^{c}	2.73±0.29^{a}	286.12±0.76^{c}
Fried	49.55±0.08^{d}	23.30±0.09^{d}	24.44±0.16^{c}	2.02±0.01^{d}	0.68±0.00^{b}	310.25±0.28^{d}
Microwave cooked	52.50±0.06^{c}	22.34±0.18^{e}	22.63±0.09^{a}	1.82±0.00^{e}	0.72±0.04^{b}	294.43±1.13^{e}

Values are shown as mean ±standard error
↓a,b,..e: Within the column, values with different letters are significantly different (P<0.05).

The compositions of the different kinds of raw, grilled, baked, fried and microwave cooked samples are shown in Table 1. Proximate composition of raw anchovy was determined as 62.86% moisture, 10.64% crude lipid, 22.71% crude protein, 1.48% crude ash, and 2.31% carbohydrate. Energy value of raw anchovy was 195.88 kcal.

Rate of crude protein, crude lipid, moisture and ash of anchovy were found to be different to rate of crude protein (19.56%), crude lipid (4.72%) and moisture (73.80%), to be similar to ash (1.39%) content of anchovy (*Engraulis encrasicolus*) reported by Ayas (17). In November, the moisture, crude lipid, crude protein, ash, carbohydrate content and energy value of anchovy was found as 72.61%, 9.56%, 15.44%, 2.01%, 0.58% and 140kcal by Boran and Albayrak (18). Comparing with this study, energy value of our sample was found higher. This result may be due to higher crude protein, crude lipid and carbohydrate contents. Kaya and Turan (13) determined that the crude protein content of anchovy ranged from 17.24 to 16.94% during the catching season. Karaçam and Düzgünes (19) also reported that crude protein content changes according to the months (minimum 15.06% to maximum 18.91%). Kaya and Turan (13) determined that the crude lipid content of anchovy was maximum (18.57%) in November and minimum (15.57%) in January. Karaçam and Düzgünes (19) found that the highest and lowest crude lipid content of anchovy (*Engraulis encrasicolus*) was 16.00% in November, 3.10% in March. Gökoğlu et. al. (9) reported that the highest and the lowest lipid content of anchovy harvested between January and December were 13.9% in December, and 4.7% in March. According to these studies, it was obvious that the lipid, protein, moisture, ash, carbohydrate contents and energy value of anchovy can change according to the seasons.

After cooking, moisture content in all treatments (grilled, baked, fried, microwave cooked) decreased while fat increased significantly (P <0.05). These results were similar to those in boiled and fried common *Silver barb, Nile tilapia, Walking catfish*; in boiled and steamed *Striped catfish*, in fried *Spanish mackerel* (20), fried, oven-baked and grilled in *Sardina pilchardus* (21), in oven-cooked and microwave cooked *Oncorhynchus mykiss* (22), in fried, baked and microwave-cooked *Dicentrarcus labrax* (23), in fried *Clarias gariepinus* (24). Moisture contents in baked and microwave cooked anchovy were statistically similar (P >0.05). The lipid content in all the treatments increased significantly (P <0.05). In all groups, grilled anchovy contained the lowest lipid content (P<0.05). Our findings and literature data (20, 21, 23, 25-27) indicate that the frying produced higher water loss and lipid gain than other cooking methods (P <0.05), mainly due to the absorption of fat by fish during frying. The protein content in raw, baked and microwave cooked anchovy were similar (P >0.05). The highest protein content was in grilled and fried anchovy, respectively. This is in accordance with the findings of Gokoglu et al (25) that fried and microwave-cooked fish had significantly higher protein than raw fish. In all groups except of baked, crude ash content increased significantly owing to water loss (P <0.05). In the previous studies it was found that the processing and

cooking methods had little or no effect on the total minerals (20-27). After cooking, the highest carbohydrate content was in baked anchovy and all cooking methods were significantly different in terms of calorie value (P<0.05).

Several factors influence the nutritional content of the food and the type and level of losses due to processing. The heat and flow of gases cause drying of the food item. This decreases the water content thereby causing the changes associated with dehydration such as increasing the protein and fat concentration of the food (28). The nutrient changes that occur during concentration will depend on the contents of the mixture and the temperature at which the process takes place. Generally, there is a decrease in water content and corresponding increase in other nutrients. In our research, the highest protein, the lowest fat content and calorie value were found in grilled fish; therefore, grilling can be recommended as the best cooking method for healthy diet.

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