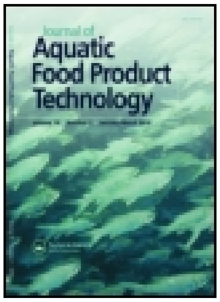

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Effect of three different cooking methods on proximate and mineral composition of Asian Sea bass (Lates calcarifer Bloch)

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Effect of three different cooking methods on proximate and mineral composition of Asian Sea bass (*Lates calcarifer* Bloch)

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The influence of three different cooking methods (boiling, baking, and frying) on proximate and mineral composition of Asian sea bass (*Lates calcarifer*, Bloch) was studied. The mean moisture, protein, fat, and ash contents of raw fish were 67.87±0.68, 18.2±0.05, 5.13±0.14, and 0.88±0.07 %, respectively. The protein and ash contents increased in all the cooked fish samples. The increase in fat content of fried fish samples was found to be significant compared to other fish samples. The moisture content of cooked fish decreased except in boiled fish. Magnesium and zinc content decreased in fish cooked by almost all methods. No significant changes were noticed for manganese and potassium contents in raw and cooked fish samples. However, there was an increase in copper content and decrease in the calcium and iron contents in fried fish samples. Loss of mineral content in fried fish was higher than in fish cooked by baking or boiling. Comparing the raw and cooked fish, the results indicated that cooking had considerable effect on the proximate composition and mineral contents. Baking was found to be the best among the three methods tested in the present study for healthy eating.

Keywords

Sea bass**,** *Lates calcarifer*, cooking methods, proximate composition, minerals

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Introduction

Fish is considered a source of high quality dietary protein in a healthy human diet. Fish contains an excellent source of omega-3 polyunsaturated fatty acids, predominantly eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). These fatty acids have been shown to lower the risk of heart diseases, support good health, and promote brain development and eye function in infants (Birch et al., 1998; Uauy et al., 2003). Fish also is considered a rich source of minerals and vitamins compared to other animal protein sources such as poultry, eggs, and dairy products. It has been reported that fish and other aquatic invertebrates contain minerals ranging from 0.6–

1.5% of body mass. The essential minerals in fish include iron (Fe), calcium (Ca), zinc (Zn), iodine (I), phosphorus (P), selenium (Se), and fluorine (F), and they are easily absorbed by the body during consumption (Sikorski et al., 1990). Fish is usually processed for consumption by several cooking practices, such as boiling, baking, and frying. The heating process is applied to enhance the flavor and taste and to inactivate microorganisms present in fish products (Bognar, 1998). The influence of various cooking methods on proximate and mineral composition of several fish species have been reported (Ersoy et al., 2006; Gokoglu et al., 2004; Kucukgulmez et al., 2006; Rosa et al., 2007; Weber et al., 2008; Marimuthu et al., 2011). It has been predicted that the nutritive value of fish, especially minerals, vitamins, flavoring compounds, and polyunsaturated fatty acids were affected by various cooking methods. In order to conserve the essential nutrients and elements in the fish, it is vital to determine the suitable cooking method for healthy food preparation.

The Asian sea bass (*Lates calcarifer*, Bloch) is commonly known as barramundi, one of the commercially important and most farmed brackish water fish species in Malaysia. Sea bass is an ideal candidate species for aquaculture due to its high market value and rapid growth and has been cultured successfully in Australia, Thailand, and Israel in the fresh and brackish water and also in underground brackish and geothermal water (MacKinnon, 1989; Percival et al., 2008; Volvich and Appelbaum, 2001). Its ability to tolerate salinities from freshwater to 55 ppt salt water (Rasmussen, 1991) also makes it a candidate for culture in inland saline water (Shirgur and Siddiqui, 1998) where salinity levels vary both locally and regionally (Mazor and George, 1992).

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Hence, there is a growing interest among farmers to diversify the culture of sea bass in Southeast Asian countries (Thirunavukkarasu et al., 2001). The proximate composition and mineral contents in captive reared sea bass (*Dicentrarchus labrax*) have been reported (Sayam and Trevor, 2003). The effect of different cooking methods on the proximate fatty acids and heavy metal concentrations of sea bass (*Dicentrarchus labrax*) also have been studied (Ersoy et al., 2006; Turkkan et al., 2008). It has been reported that texture, proximate composition, minerals, vitamins, flavor compounds, and polyunsaturated fatty acids vary among fish species and the cooking methods practiced (Gladyshev et al., 2006; Marimuthu et al., 2011). However, no information is available on the nutritional values of raw fish and cooked Asian sea bass. Hence, the present study investigated the influence of different cooking methods (boiling, baking, and frying) on the proximate and mineral composition of Asian sea bass.

Materials and Methods

Fish sample preparation and cooking methods

A total of 24 sea bass (*Lates calcarifer*), with a length of 25–35 cm and weight of 250–350 g, were obtained from the local fish market in Sungai Petani, Kedah Darul Aman, Malaysia. They were kept in ice boxes and transported to the laboratory. On arrival at the laboratory, fish were washed with tap water several times to remove adhering blood and excessive mucus. They were then processed using common household practices, namely eviscerating and beheading. The fish

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samples were filleted, and the fillets were divided into four groups consisting of six fillets each. The first group was uncooked and considered as raw. The other three groups were cooked by the following methods: boiling, baking, or frying. Boiling was performed at approximately 98ºC (water temperature) for 12 min. Baking of fillets was performed in a conventional oven, and the pre-heating temperature was set at 200 ºC for 20 min. The frying of fillets was performed in a domestic frying pan of 2L capacity at an initial temperature of 180 ºC for 15 min. Sunflower oil was used as the medium for frying. The fresh and cooked fish were hand de-boned and ground in a kitchen blender to ensure homogeneity; representative samples were taken for analysis. Samples were packed in polythene bags and kept at - 20ºC until analysis.

Proximate composition analysis

Proximate composition analysis for homogenized samples of cooked and raw fish fillets were done in triplicate for protein, moisture, lipid, and ash contents. The crude protein was determined by the Lowry method (Lowry et al., 1951). Protein concentration was extrapolated from standard curve using bovine serum albumin (BSA) as standard. Moisture content was determined by oven drying at 105ºC to constant weight. Total lipid was extracted from the muscle tissues using the Folch method using chloroform: methanol (2:1, v/v) solvent system (Folch et al., 1957). The lipid content was gravimetrically determined. Ash content was determined gravimetrically in a muffle furnace by heating at 550ºC to constant weight (AOAC, 1990).

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Mineral analysis

For mineral determination, 5 g of respective cooked and raw fish samples were digested in concentrated nitric acid (HNO_3; AOAC, 1995). The digest was quantitatively transferred to a 50 ml volumetric flask with distilled water and made up to volume with distilled water. A blank digest was prepared in the same way. All minerals were determined using atomic absorption spectrometry (AAnalyst 700, Perkin-Elmer, Waltham, MA, USA) against aqueous standards. Standard solution of sodium (Na), potassium (K), Ca, magnesium (Mg), Fe, Zn, manganese (Mn), copper (Cu), and P (1000 ± 3µg/ml in 1% HNO_3) were purchased from Merck Chemicals Ltd (Whitehouse Station, NJ, USA). Each solution was diluted to the desired concentration, and the standard calibration curve for each mineral was prepared according to the procedures described in Analytical Methods for Atomic Absorption Spectroscopy (Perkin Elmer Instruments, 2000). The mineral concentration was expressed as mg mineral/kg fish dry weight.

Statistical analysis

The proximate and mineral composition of sea bass was analyzed using one-way analysis of variance (ANOVA), and the significant differences between means were determined by post hoc Duncan's multiple range test. Differences were considered to be significant when $P< 0.05$. Data were analyzed using SPSS (version 11, Chicago, IL, USA).

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Results and Discussion

The proximate composition of raw fish and fish fillets after various cooking methods of sea bass (*L. calcarifer*) are presented in Table 1. The mean moisture, protein, fat, and ash contents of raw fish were 67.87±0.68, 18.2±0.05, 5.13±0.14, and 0.88±0.07 %, respectively. The proximate composition of raw fillets is in accordance with the earlier reports of sea bass (Sayam and Trevor, 2003). Proximate composition (moisture, protein, fat, and ash) of sea bass changed in all the cooking methods. Significantly higher protein content (23.07±0.08%) was recorded in fried fillets, followed by baked fish (21.07±0.09%; $P< 0.05$). The protein and ash contents increased after cooking in all the evaluated methods, and the lipid content increased only in fried fillets (Table 1). No significant difference was noticed in fat content among boiled, baked, and raw fish fillets ($P> 0.05$). These results are in agreement with those of Puwastien et al. (1989) and Marimuthu et al. (2011). The moisture content of the fish fillets ranged from 58% to 68%, decreasing in fried and baked fish and increasing in boiled fish. The increases in protein, fat, and ash contents observed in cooked fish fillets are explained by the reduction in moisture. However, the decrease in the moisture content has been described as the change that makes the protein, fat, and ash contents increase significantly in cooked fish fillets (Arias et al., 2003). The increase in fat content of the fried fish fillets is also related to oil absorption during the cooking process. Further, the increase of fat content can be attributed to the oil penetration on the fish fillet after water is partially lost by evaporation during cooking (Saguy and Dana, 2003). Similar results were reported for sardine, African catfish, and rainbow trout fried in vegetable oils (Candela et

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al., 1998; Ersoy and Ozeren, 2009; Gokoglu et al., 2004). Water loss was also recorded in baked fillets of sea bass. However, the dehydration rate was comparatively lower than in the frying method of cooking. These changes were similar to those reported by Gokoglu et al. (2004) in rainbow trout and Arias et al. (2003) in sardines.

The mineral contents of raw and cooked sea bass are presented in Table 2. The main functions of essential minerals include skeletal structure, maintenance of colloidal system, and regulation of acid–base equilibrium. Minerals also constitute important components of hormones, enzymes, and enzyme activators (Belitz and Grosch, 2001). The Na content of raw fish was found to be 232 mg/kg. A Na content of 773 mg/kg in raw European sea bass was reported by Erkan and Ozden (2007). Na content of baked and fried fish significantly increased. A Na content ranging from 380-3200 mg/kg was reported by Wheaton and Lawson (1985) and 335-607 mg/kg by Gokoglu et al. (2004) in trout. A similar observation was reported by Rosa et al. (2007) indicating significantly increased Na content in fried and baked catfish compared to raw fish. The significantly highest amount of K content (3349±245mg/kg) was found in fried fish fillets, and the lowest (2858±65.34mg/kg) was in boiled fish. The K content in baked and raw fish fillets was insignificant ($P>0.05$). This result is similar to K contents in other fish species, such as trout (2800–3580 mg/kg) (Wheaton and Lawson, 1985) and African catfish (1871-2770 mg/kg) (Ersoy and Ozeren, 2009). The Ca content of raw fish was found to be 577 mg/kg. This value is higher than that reported by Rosa et al. (2007) and Ersoy and Ozeren (2009) in African catfish and lower than that reported by Gokoglu et al. (2004) in rainbow trout. The Ca content of fried fish

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decreased significantly (P>0.05) in all cooking methods, whereas no significant difference of Ca content was noticed in baked, boiled, or raw fish (P > 0.05).

The mean Mg content ranged from 246-352 mg/kg in all fish fillets. This value is higher than that reported by Wheaton and Lawson (1985) (a mean value of 170 mg/kg) and similar to that found by Ersoy and Ozeren (2009) (184–265 mg/kg) in African catfish. The Mg content significantly (P<0.05) decreased after frying and boiling but not in the baked fish fillet. Significantly, no difference was noticed in the baked and raw fish fillets (P>0.05). The Fe content of raw fish fillet was 2.38 mg/kg. This result is in accordance with the reports of Schormuller (1968), Ludorff and Meyer (1973), and Wheaton and Lawson (1985). The value is higher compared to rainbow trout (Gokoglu et al., 2004) and lower than in African catfish (Ersoy and Ozeren, 2009). The Fe content in all the cooking methods ranged from 1.53–2.95 mg/kg. The Fe content of baked fish increased significantly, whereas decreased Fe content was noticed in the fried fish sample. Insignificant difference of Fe content was found in the boiled and raw fish samples (P>0.05).

The Zn content of raw fish was found to be 7.79 mg/kg. The Zn content of cooked fish fillets ranged from 2.98-3.65 mg/kg. Decreased Zn content was observed in all the cooked fish samples. A similar range of Zn content (3.43-5.99 mg/kg) was reported in African catfish by Ersoy and Ozeren (2009), and higher Zn content (9.68 mg/kg) was reported in rainbow trout by Gokoglu et al. (2004). Further, Gokoglu et al. (2004) reported that decreased Zn content in

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rainbow trout was noticed in boiled, baked, and fried fish fillets when compared to raw fish fillets. An increased Zn content was observed in baked or fried African catfish (Ersoy and Ozeren, 2009). The Mn content of raw and cooked fish ranged from 0.34–0.55 mg/kg. However, the Mn content after cooking by different methods was found to be insignificant ($P>0.05$). This value is found to be similar to those reported in African catfish (0.22–0.42 mg/kg) by Ersoy and Ozeren (2009), and higher Mn content (0.78 mg/kg) was reported in rainbow trout by Gokoglu et al. (2004). Conversely, an increased Mn content was reported in fried African catfish by Rosa et al. (2007). The Cu content of raw fish was found to be 0.54 mg/kg. Similar values have been reported by Wheaton and Lawson (1985) and Lall (1995). The Cu content of fried fish ($P<0.05$) increased significantly, but an insignificant decrease was observed in the other fish samples ($P>0.05$). This result is in accordance with the reports of Gokoglu et al. (2004) for baked and fried rainbow trout.

The P content of raw fish was found to be 3154 mg/kg. This value is higher than that reported by Wheaton and Lawson (1985) who found that the P contents ranged from 1520–2600 mg/kg in trout. The P content of cooked fish fillets ranged from 2451-2911 mg/kg. Decreased P content was noticed in boiled and fried fish fillets. The changes in P contents were found to be insignificant in raw and baked fish samples ($P>0.05$). Decreased P content was reported in baked, boiled, and fried fish fillets of rainbow trout when compared to raw fish (Gokoglu et al., 2004). Earlier studies have reported that the cooking methods had little or no effect on the minerals (Ackurt, 1991; Gall et al., 1983; Steiner–Asiedu et al., 1991) but Ackurt (1991) and

Marimuthu et al. (2011) reported that mineral levels in some fish samples were affected by cooking methods. The present study demonstrates the alteration in the mineral composition of fish fillets cooked by different methods.

Conclusion

Increased dry matter, protein, and ash contents were observed in fried and baked fish fillets. Increased Na and K contents were observed in baked and fried fish samples. Increased Cu content and decreased Ca and Fe content was observed in fried fish samples. Comparatively, the loss of mineral content in fried fish was higher than that of fish cooked by baking and boiling. The fat content in fried fish fillet significantly increased due to absorption of oil by the fish during frying. Hence, this method of cooking is not advisable. On comparing the raw and cooked fish fillet, the results indicated that cooking had considerable effect on the proximate composition of sea bass fillets. No loss of minerals, except Zn, was noticed in baked fish when compared to raw fish fillets. Based on the results obtained for proximate and mineral composition, baking was found to be the best among all the cooking methods for healthy living.

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Table 1

Proximate composition of raw and cooked fillets of sea bass, *Lates calcarifer*

Sample	Moisture (%)	Protein (%)	Lipid (%)	Ash (%)
Raw	67.87 ± 0.68^{a}	18.2 ± 0.05^{c}	5.13 ± 0.14^{b}	0.88 ± 0.07^{c}
Boiled	68.15 ± 3.33^{a}	20.18 ± 0.10^{b}	4.76 ± 0.49^{b}	1.15 ± 0.16^{b}
Baked	60.26 ± 2.65^{b}	21.07 ± 0.09^{a}	5.12 ± 0.33^{b}	2.16 ± 0.23^{a}
Fried	58.98 ± 1.25^{b}	23.07 ± 0.08^{a}	13.51 ± 0.90^{a}	1.94 ± 0.22^{a}

Values are shown as mean ± standard deviation of triplicate. Values with different superscripts in the same column are significantly different ($P < 0.05$).

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Table 2

Mineral composition of raw and cooked fillets of sea bass, *Lates calcarifer* (mg/kg)

	Raw	**Boiled**	**Baked**	**Fried**
Sodium (Na)	232 ± 17.32[b]	207 ± 22.73[b]	241± 17.53[a]	276±30.88[a]
Potassium (K)	3052± 96.04[bc]	2858±65.34[c]	3237± 61.61[ab]	3349± 245[a]
Calcium (Ca)	577± 34.59[a]	545±14.32[a]	594± 23.45[a]	168 ± 23.35[b]
Magnesium (Mg)	352± 35.54[a]	246 ±15.15[c]	314± 10.60[a]	274± 13.64[bc]
Iron (Fe)	2.38± 0.42[b]	2.36± 0.33[b]	2.95± 0.07[a]	1.53±0.20[c]
Zinc (Zn)	7.79 ± 1.31[a]	2.98± 0.19[b]	3.08±0.28[b]	3.65± 0.22[b]
Manganese (Mn)	0.553 ± 0.15[a]	0.357± 0.05[a]	0.34± 0.13[a]	0.40 ± 0.14[a]
Copper (Cu)	0.543± 0.22[b]	0.617± 0.08[b]	0.66± 0.14[b]	1.46± 0.31[a]

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Phosphorus (P)	3154± 171.26[a]	2451±207.04[b]	2911± 149.70[a]	2523±153.57[b]

Values are shown as mean ± standard deviation of triplicates. Values with different superscripts in the same row are significantly different ($P < 0.05$).