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Effects of cooking methods on the proximate composition and mineral contents of rainbow trout (*Oncorhynchus mykiss*)

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Abstract

The effects of different cooking methods (frying, boiling, baking, grilling, microwave cooking) on proximate composition and mineral contents of rainbow trout (*Oncorhynchus mykiss* Walbaum 1792) were determined. Mean moisture, protein, ash and fat contents of raw fish were 73.38±0.015, 19.8±0.035, 1.35±0.012 and 3.44±0.013%, respectively. The changes in dry matter, protein and ash contents were found to be significant for all cooking methods. The increase in fat content of fried samples was found to be significant but not those samples cooked by other methods. The Mg, P, Zn and Mn contents of fish cooked by almost all methods significantly decreased. The Na and K contents in microwave cooked samples increased, the Cu content increased in fried samples. Losses of mineral content in boiled fish were higher than those of fish cooked by other methods. On comparing the raw and cooked fish, the results indicated that cooking had considerable affect on the proximate composition and mineral contents. Baking and grilling were found to be the best cooking methods for healthy eating.

Keywords: Trout; Cooking methods; Proximate composition; Minerals

1. Introduction

Rainbow trout (*Oncorhynchus mykiss*) is an extensivelly cultured species in Turkey. Total production was 263 tons in 1999 (Anonymous 2001a, 2001b). As it can be easily provided alive or very fresh, from pond to table, the consumer considers it as safe for consumption. In this connection, the consumption of this species has recently increased. It is generally marketed as fresh, chilled, frozen or smoked. Although the fish are commonly consumed as pan-fried by Turkish people, preferences of the consumers for cooking methods are increasingly changing. The Turkish consumer, however, has minimal knowledge about nutritive values of raw and cooked fish.

Fish is a major source of animal protein and it also contains vitamins and minerals. The nutritive value of fish can be affected by processing or cooking methods. The effects of different processing and cooking methods on nutritive values of different fish species have been previously studied (Agreen & Hänninen 1993; Candela, Astiasasran & Bello, 1996; Gall, Otwell, Koburger, & Appledorf, 1983; Mai, Shimp, Weilhrauch, & Kinsella, 1978; Matilla, Ronkainen, Lehikoinen, & Piironent, 1999; Puwastien et al., 1998; Rodrigo, Ros, Priago, Lopez, & Ortuno, 1998; Sánches-Muñiz, Viejo, & Medina, 1992; Scott & Latshaw, 1991; Suzuki, Hayakawa, Wada, Okazzaki, & Yamazawa, 1988; Steiner-Asiedu, Juslhamn, & Lie, 1991; Toth-Markus & Sass-Kiss 1993; Unlusayin et al., 2001). The aim of the present study was to determine the effects of different methods of cooking (frying, boiling, grilling, baking and microwave cooking) on the proximate composition and mineral contents of rainbow trout.

2. Materials and methods

2.1. Sample preparation and cooking

The fish, rainbow trout (*Oncorhynchus mykiss* Walbaum, 1792), were obtained from a trout farm in Antalya, Turkey. The fish were harvested from the ponds by a dip net and transferred to the laboratory alive. A total of 24 fish was provided and four fish were incorporated

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into a lot. The mean weight and length of fish were 195.67±4.64 g and 22.2±1.91cm respectively. On arrival at the laboratory, the fish were killed and allowed to pass into rigor. Then fresh fish were prepared using a handling process, i.e. eviscerating, beheading and washing, and then cooked by frying, boiling, grilling, baking and microwave cooking. Sunflower oil was used for pan-frying. The temperature of oil during the frying process was 180 °C. For the boiling process, the fish were dipped into boiling water for 5 min. The grilling process was carried out with an electrically operated grill at 180 °C for 30 min. The fish were baked in an electrically operated oven at 180 °C for 30 min. Microwave cooking processes were carried out in a microwave oven at 2450 MHz for 13 min. After the cooking process, for all methods, the bones and skins of fish were removed. All fish in each lot were homogenised using a kitchen blender and analyzed to determine proximate composition and mineral contents. All assays were conducted on duplicate samples of the homogenates.

2.2. Analyses

2.2.1. Proximate composition

The moisture content of trout was determined by drying the meat in an oven at 105 °C until a constant weight was obtained (AOAC, 1990). Crude protein content was calculated by converting the nitrogen content determined by Kjeldahl's method (6.2×N). Fat was determined by the method described by the AOAC (1990) using the Soxhlet system. Ash content was determined by dry-ashing in a furnace at 525 °C for 24 h (AOAC, 1990).

2.2.2. Mineral analyses

For mineral determination, the samples were digested in $HNO_3/HClO_4$ (Kacar, 1972). The elements, Na, K, Ca, Mg, Fe, Zn, Mn, Cu, were measured by atomic absorption spectrophotometry (AAS) using a Varian Spectra atomic absorption spectrophotometer model A-400. Phosphorus (P) was measured by a spectrophotometer (Shimadzu UV 160 A) after colour development of the samples in Barton solution (Kacar & Kovancı, 1982). The results were expressed as absorbance at 430 nm. Standard curves were used for the determination of the elements in question.

2.2.3. Statistical analysis

Significant differences between means of experiments were determined by least significant difference. A significance level of 0.05 was chosen (Sokal & Rohlf, 1987).

3. Results and discussion

The proximate compositions of fish (in raw and cooked forms) are given Table 1. The compositions of the raw fish are similar to findings of other researchers (Akhtar, 1994; Unlusayin et al., 2001).

Changes in dry matter, protein and ash contents were found to be significant ($P<0.05$) for all cooking methods. The increase of fat content was found to be significant ($P<0.05$) in fried fish but not for other types. In a previous report, differences in water contents between fresh and smoked rainbow trout were found to be significant (Unlusayin et al., 2001).

Fried fish had a higher level of fat than raw or other cooked fish, mainly due to the absorption of fat by the fish. The absorption of fat through frying also caused an increase of dry matter. Steiner-Asiedu et al. (1991) and Unlusayin et al. (2001) have reported similar findings. Puwastien et al. (1998) stated that boiled fish contained the same range of fat content as raw fish.

The greatest increase in dry matter content was observed in fried and microwave cooked samples. Water losses, occuring during frying and microwave cooking resulted in a higher protein content in fried and microwave cooked fish than in raw fish. This is in accordance with the findings of Gall et al. (1983) that deep fried fish fillet had significantly higher protein than raw fillet. An important moisture loss was observed after precooking of sardines (Ruiz-Roso et al., 1998).

Table 1
Proximate composition of raw and cooked rainbow trout[a,b]

	Moisture (%)	Protein (%)	Ash (%)	Fat (%)
Raw	73.38±0.015a	19.80±0.035a	1.35±0.012a	3.44±0.013a
Fried	62.69±0.024b	26.34±0.23b	1.66±0.006b	12.70±0.08b
Boiled	69.16±0.035c	20.66±0.67a	1.61±0.026bc	4.32±0.75a
Baked	65.30±0.074d	23.26±0.0c	1.41±0.00017a	6.21±0.43a
Grilled	65.83±0.051d	25.00±0.41bc	1.54±0.025c	5.95±1.49a
Microwave-cooked	63.52±0.082b	29.04±0.48d	1.53±0.007c	4.52±0.06a

[a] Values are shown as mean±standard error of duplicates.
[b] Within the column values with different letters are significantly different ($P<0.05$). Values without letters are not significantly different ($P>0.05$)

Table 2
Mineral composition of raw and cooked rainbow trout (mg/kg)[a,b]

	Na	K	Ca	Mg	P	Fe	Zn	Mn	Cu
Raw	455±24.5a	3060±56.8a	632±136	409±13.2a	3378.78±117.31a	2.10±0.58	9.68±0.22a	0.78±0.049a	0.33±0.1a
Fried	493±1.09a	3201±95.2a	147±19.0	268±0.58b	2557.99±17.75b	1.76±0.19	3.68±0.26b	0.43±0.10b	0.84±0.04b
Boiled	335.54±7.81b	2417±74.2b	609±111	242±5.99b	2476.4±88.20b	2.10±0.037	3.20±0.017b	0.41±0.032b	0.08±0.001a
Baked	460±13.8a	3127±68.9a	395±6.71	290±0.13c	2695.2±18.71b	2.91±0.52	3.85±0.26b	0.32±0.02b	0.29±0.06a
Grilled	514±29.7a	3808±111c	665±10.1	324±0.18c	3163.54±12.51a	1.78±0.18	3.51±0.21b	0.41±0.06b	0.34±0.01a
Microwave Cooked	607±2.54c	4362±20.5d	344±184	394±15.8a	3424.47±32.18a	1.40±0.07	3.82±0.004b	0.66±0.1b	0.33±0.037a

[a] Values are shown as mean±standard error of duplicates.
[b] Within the column values with different letters are significantly different ($P<0.05$). Values without letters are not significantly different ($P>0.05$).

Table 2 shows the composition of minerals. The Na content of raw fish was found to be 544 mg/kg. A Na content of trout, ranging from 380 to 3200 mg/kg was reported by Wheaton and Lawson (1985). Na content of microwave cooked fish significantly increased, while that of boiled fish significantly decreased.

The K content of raw fish was found to be 3060 mg/kg. This result is similar to K contents of trout described by Wheaton and Lawson (1985) (2800–3580 mg/kg). Although the K contents of grilled and microwave-cooked fish significantly ($P<0.05$) increased, those of boiled fish decreased significantly ($P<0.05$). The changes in K content of fried and baked fish were insignificant ($P>0.05$).

The Ca content of raw fish was found to be 632 mg/kg. However, this value is higher than that reported by other authors (Lall, 1995; Ludorff & Meyer, 1973; Schormüller, 1968; Wheaton & Lawson, 1985). The changes in Ca content of all samples were insignificant ($P>0.05$)

The mean Mg content was found to be 409 mg/kg. This value was higher than that by reported Wheaton and Lawson (1985) (a mean value of 170 mg/kg) and Lall (1995) (a mean value of 250 mg/kg). The Mg content of fish significantly ($P<0.05$) decreased after frying, grilling, baking and boiling but not for the microwave-cooked sample.

The mean *P* content of rainbow trout was found to be 3379 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 contents of fried, baked and boiled samples decreased significantly ($P<0.05$). The changes in P contents were found to be insignificant ($P>0.05$) in grilled and microwave cooked fish.

The Fe content of raw rainbow trout was 2.10 mg/kg. This result is in accordance with the reports of other authors (Schormüller, 1968; Ludorff & Meyer, 1973; Wheaton & Lawson, 1985). The change in Fe content after cooking for all cooking methods was found to be insignificant ($P>0.05$).

The mean Zn content of rainbow trout was found to be 9.68 mg/kg. Wheaton and Lawson (1985) have reported that Zn content of trout ranged from 1.4–26 mg/kg. The decrease in Zn content was significant ($P<0.05$) for all cooking methods.

The Mn content of raw fish was found to be 0.78 mg/kg. Similar Mn values were reported by other authors (Lall, 1995; Wheaton & Lawson, 1985). The decrease in Mn content after cooking by all cooking methods was found to be significant ($P<0.05$).

The Cu content of raw fish was found to be 0.33 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 samples.

In the previous studies it was found that the processing and cooking methods had little or no effect on the elements (Ackurt, 1991; Gall et al., 1983; Steiner-Asiedu et al., 1991), but Ackurt (1991) reported that mineral levels in some fish samples were affected by cooking methods.

4. Conclusion

The increase in dry matter content in microwave-cooked samples was considerably high. The Na and K contents of microwave-cooked fish increased; Zn and Mn contents decreased. This cooking method can be recommended.

The least increases in dry matter and protein were observed in boiled samples. Boiling also caused important losses in mineral contents. In particular, Na, K, P, Mg, Zn and Mn significantly decreased. For these reasons, it was found inappropriate for fish cooking. The changes in mineral contents of baked samples were found to be insignificant with the exception of decreases in Mg, P, Zn and Mn contents. It can be concluded that this method is appropriate for fish cooking, considering that Mg, P, Zn and Mn contents decreased in almost all cooking methods.

The fat content in fried samples significantly increased due to absorption of fat by the fish. Although Mg, P, Zn and Mn contents in fried samples decreased, Cu increased. Fat absorption of fish increases the energy value. Therefore, frying cannot be recommended for people who have an obesity problem.

Water losses in grilled fish are lower than fried, baked and microwave-cooked samples. The Mg, Zn and Mn contents of grilled fish decreased; K content increased. Since Mg, Zn and Mn contents decreased in almost all samples, it can be concluded that mineral contents of grilled samples did not change and that the grilling process is an appropriate method for cooking rainbow trout.

Overall, it can be concluded that baking and grilling are the best cooking methods for rainbow trout as far as healthy eating is concerned

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