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Effect of different cooking techniques on quality characteristics of some fish species

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ABSTRACT

This work was performed to study the effect of cooking techniques on the quality characteristics of some fishes. Four samples; *Mugil cephalus*, *Liza ramada*, *Tilapia zilli*, and *Solea vulgaris* were obtained from Qarun Lake as the most important and abundant fish. All samples were manually filleted, brined, and then cooked using frying, microwave, and halogen techniques. Sensory, physicochemical, and microbial properties of raw and cooked fillets were determined. The results indicated that fried fish products were the best in texture and acceptability compared with microwave and halogen-cooked products. Cooking methods led to changes markedly in the values of moisture, pH value, total volatile basic nitrogen (TVBN), trimethylamine (TMA), thiobarbituric acid value (TBA) and total plate count (TPC), while increased levels of protein, fat, and ash contents. In conclusion, the quality properties of different cooked fishery products are dependent mainly on fish species and the cooking method used.

INTRODUCTION

Fish is known to be a source of protein, rich in essential amino and it contains micro- and macro elements and fat-soluble vitamins (**Larsen *et al.*, 2007**). With regard to muscles foods, consumers look for high quality and convenient meat and fish products containing natural flavor, fresh appearance and nutrients. Additionally, safe and natural products without additives such as preservatives and humectants are being demanded (**Hugas *et al.*, 2002**). Chemical and physical reactions are take place during cooking process (e.g. boiling, baking, roasting, frying and grilling) which both improve the food nutritional quality and enhances digestibility and bio-availability of nutrient in the digestive tract (**Bognar, 1998** and **Kocatepe *et al.*, 2011**). Also, several authors (**Oğuzhan & Angis, 2013** and **Talab, 2014)** have been reported that cooking methods had the effect on the major constituents and quality criteria of fish products however; others mentioned that cooking methods had little influence (**Koubaa *et al.*, 2012)** or did not affect chemical composition but influenced the texture and color parameters **(Bainy *et al.*, 2015**). Therefore, this work was designed to study the effect of different cooking techniques (frying, microwave and halogen) on quality characteristics of the most

important and abundant fishes; *Mugil cephalus*, *Liza ramad*, *Tilapia zilli* and *Solea vulgaris* obtained from Qarun Lake.

MATERIALS AND METHODS

Materials

Four fish samples; grey mullet (*Mugil cephalus*), thin lip mullet (*Liza ramad*), tilapia (*Tilapia zilli*) and sole fish (*Solea solea*) were obtained from Qarun Lake. Total weight of fish samples were 250, 150, 80 and 60 g, respectively. Fish samples were transferred using ice box to Fish Processing Technology Lab., El-Kanater El-Khairia Branch, National Institute of Oceanography and Fisheries (NIOF) within 3 hrs. Sunflower oil, table salt, wheat flour were obtained from local market.

Cooking techniques

Fish samples were washed with tap water, eviscerated and filleted and washed again. Skins off fillets of each species were randomly divided to 4 batches. The first batch was raw and remaining three batches were brined (saturated for 2 min at 26 °C), washed, drained, rubbed in wheat flour, left for 3-4 min and cooked by frying, microwave and halogen techniques as follows: Deep-oil frying was done at 180 °C for 10 min. (5 min of each side) using a domestic pan (2 liter capacity), then drained in basket to remove excess oil. Microwaving was performed for 6 min in a Microwave oven (Zipel DG 68-00216B-01, Samsung, Gwangin, Korea) and Halogen cooking was performed using electric Halogen oven (Lentel, model KYR-912A, 1300C watt) at 180°C for 20 min (10 min of each side).

Analytical methods

Sensory characteristics (color, taste, odor, texture and overall acceptability) of cooked fish samples were evaluated by ten panelists and hedonic rating scale, where 9 point means "like extremely" and 1.0 means "disliked extremely" **(Karamer & Twigg, 1970)**. The data "judge's results" were analyzed statistical using Duncan test as outlined by **Steel & Torri (1980)**. Proximate composition; moisture, protein (N×6.25), fat and ash content were determined as described by **AOAC (2002)**. Quality indices; total volatile basic nitrogen (TVB-N), Thiobarbituic acid (TBA) and pH value were determined as described by **Pearson (1991)**. Trimethylamine nitrogen (TMA-N) was determined according to **AOAC (2002)**. Total plate count (TPC) as follows: 10 g of sample were taken aseptically from different places of fish flesh and were homogenized with 90 ml of sterilized buffer peptone water (1 g peptone in one liter distilled water). 1ml of appropriate dilutions was poured on the plate count agar (PCA, Oxide) as described by **(FAO, 1979)**. The plates were incubated at 37 ºC for 48h and the results obtained were expressed as $\log_{10}$cfu/g sample.

RESULTS AND DISCUSSION

Sensory evaluation of cooked fish fillets

Results of sensory tests (appearance, odor, texture, taste and overall acceptability) of different cooked fish fillets are shown in **Figs. (1- a, b, c, & d)**.

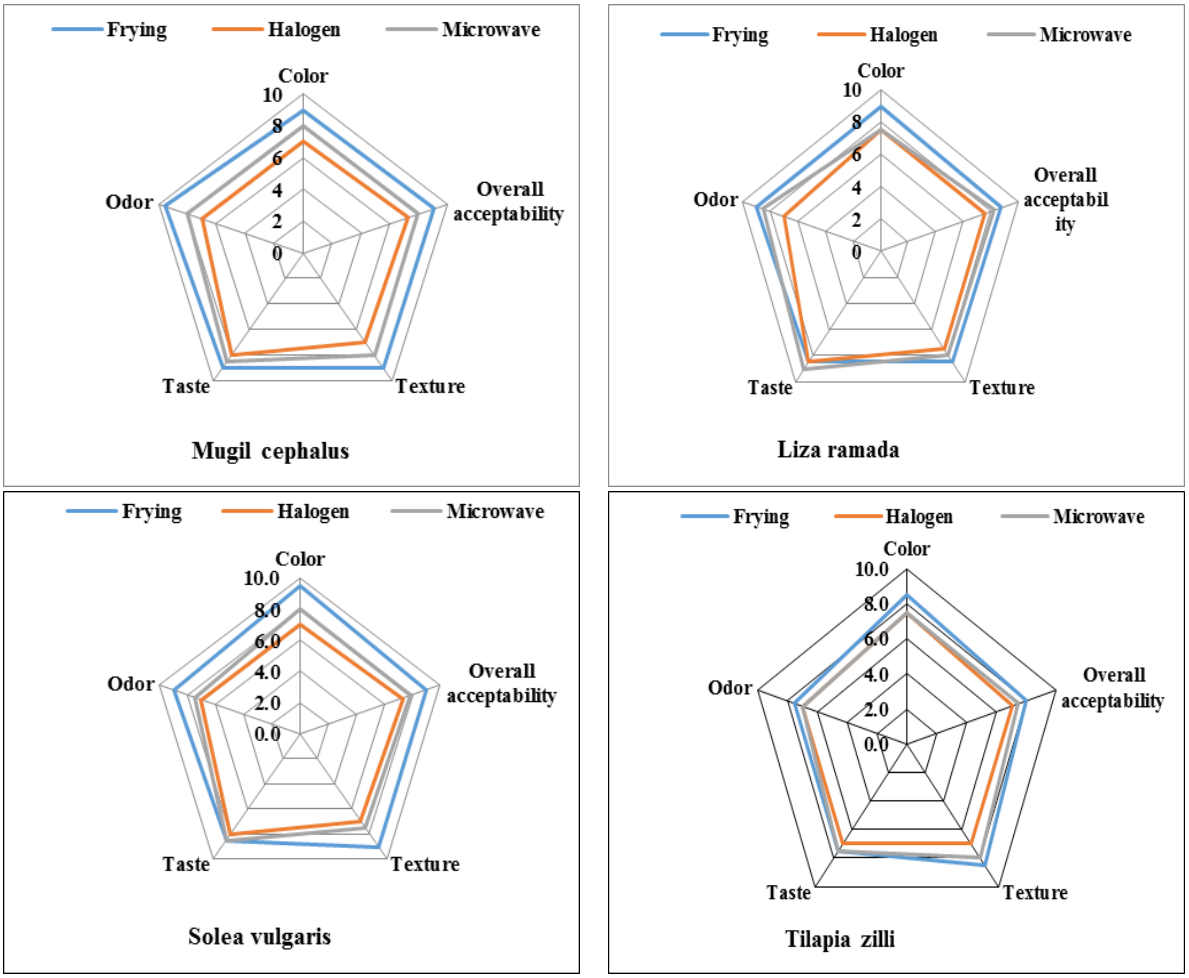

Fig. (1). Sensory tests of cooked fish fillets: (a) *M. cephalus*, (b) *L. ramada*, (c) *S. vulgaris*, (d) *T. zilli*.

There is no doubt that cooking methods improved acceptability of fish products, therefore all fried fish products had been given high scores and followed by microwave and halogen cooked products. Also, fried tilapia, *T. zilli* product was more preferred than other ones. On the other side, all cooked sole fish, *S. vulgaris* products had been given low scores of appearance. Besides, the scores of odor, texture, taste and overall acceptability of different cooked fish products were taken the same trends with exception fried grey mullet, *M. cephalus* product has the best odor and taste than others. Besides, all fried fish products were the best in texture and acceptability compared with microwave and halogen- cooked products.

Proximate composition of raw and cooked fish fillets

Proximate composition of fish is often necessary to meet the requirements of food regulations and commercial specifications (**Waterman, 2000**). The proximate composition of raw and different cooked fish fillets are presented in **Table (1)**. Moisture content ranged from 73.90 % (*M. cephalus*) to 78.65% (*S. vulgaris*) in raw fish fillets. Concerning the effect of cooking techniques on moisture content, moisture reduced to59.26– 61.60 %, 61.50–65.30 % and 65.88 –70.45 % of fried, microwave and halogen cooked fillets, respectively. Reduction in moisture in cooked products is due to partially loss of water by evaporation, dripping of moisture and some components during cooking. Initial crude protein (ww) of raw fish fillets ranged from 18.36 to 19.51%, increased apparently to 27.82 - 29.06%, 25.45 - 28.10% and 23.53 - 26.21 % in fried, microwave and halogen cooked fish fillets, respectively.

Table (1). Proximate composition of raw and different cooked fish fillets.

Item	Moisture (%)	Crude Protein (%)	Fat (%)	Ash (%)	Energy (K Cal.)
Mugil cephalus					
Raw	73.90±0.44	19.51±1.38	5.12±0.16	1.47±0.36	124.12
Frying	59.26±2.12	29.06±0.95	9.51±0.22	2.17±0.15	201.83
Microwave	61.50±1.18	28.10±2.37	8.50±0.89	1.90±0.28	188.90
Halogen	66.18±0.35	26.20±0.86	5.62±0.72	2.00±0.27	155.38
Liza ramada					
Raw	75.70±2.29	18.71±1.09	4.01±0.35	1.58±0.54	110.93
Frying	61.60±1.54	28.20±1.07	7.30±0.72	2.90±0.33	178.50
Microwave	65.30±1.95	26.95±1.37	5.80±0.10	1.95±0.37	160.00
Halogen	70.45±2.06	23.53±0.57	4.47±0.41	1.50±0.005	134.35
Solea vulgaris					
Raw	77.60±2.04	18.36±0.87	2.22±0.81	1.80±0.36	84.66
Frying	60.18±0.50	27.82±0.92	8.90±0.56	3.10±0.27	191.38
Microwave	63.22±2.03	25.45±1.05	7.50±0.64	3.83±0.25	169.30
Halogen	65.88±1.01	25.08±1.22	5.30±0.68	3.74±0.10	148.02
Tilapia zilli					
Raw	78.65±0.73	19.01±1.17	1.11±0.73	1.20±0.66	86.03
Frying	61.46±1.11	28.33±2.43	7.20±0.83	3.01±0.93	178.12
Microwave	64.70±3.41	27.00±1.71	4.79±0.32	3.49±0.79	151.11
Halogen	68.38±2.12	26.21±1.59	2.96±0.61	2.45±0.29	131.48

Values are shown as mean ± standard deviation of triplicates.

This increment in protein is due to denaturation of protein as resultant of water loss by cooking temperature. On the other side, lipid content (ww) of raw fish fillets

ranged from 1.11% (*T. zilli*) to 5.12% (*S. vulgaris*), increased apparently to 7.20 –9.51%, 4.79 –8.50% and 2.96 – 5.62% in fried, microwave and halogen cooked fish fillets, respectively. This increment is due to denaturation of protein as resultant of water loss by cooking temperature. An increase in fat content of fried fillets is due to water loss throughout cooking processes and oil absorption of deep-oil frying. Besides, ash content (ww) of raw fish fillets ranged from 1.20% (*T. zilli*) to 1.80% (*S. vulgaris*), increased apparently to 2.17 –3.10%, 1.90 – 3.83% and 1.50 – 3.74% in fried, microwave and halogen cooked fish fillets, respectively. An increase is due to water loss as affected by cooking methods. In general, our results are in agreement with those findings by several studies (**García-Arias *et al.*, 2003**; **Gokoglu *et al.*, 2004; Bochi *et al.*, 2008; Weber *et al.*, 2008; Hakimeh, *et al.*, 2010; Mnari-Bhouri *et al.*, 2010; Kocatepe *et al.*, 2011; Oduro *et al.*, 2011; Uran & Gokoglu, 2011; Koubaa, *et al.*, 2012; Marimuthu *et al.*, 2012** and **Talab, 2014).** They showed that the different cooking methods led to decrease in moisture content and increase in total protein, lipid and ash content (i.e. rise in dry matter) in fish fillets compared with raw samples. However, other study **(Oğuzhan & Angis, 2013)** found that protein, fat and moisture contents of hot smoked, cold smoked, grilled and fried rainbow trout fillets were found to be highly significant ($P<0.01$) but ash content was found to be non-significant ($P>0.05$) for all processing methods. **Bainy *et al.* (2015**) reported that cooking method did not affect the chemical composition, but influenced the texture and color parameters of the tilapia fish burgers.

Quality attributes

The pH value of fish muscle is usually a good index for quality assessment. It is important determining of fish quality as texture of fish (**Rathod & Pagarkar, 2013**). **Table (2)** showed some quality attributes of raw and different cooked fish fillets. The pH values of raw fish fillets ranged 6.48-6.60, slightly changed to reach 6.33-6.55, 6.60-6.82 and 6.55-6.65 in fried, microwave and halogen cooked fish fillets, respectively. A negligible change in pH values cooked filets is due to breakage of hydrogen bond and electrostatic interactions as reported by **Dhanapal *et al.* (2012**). Total Volatile Basic Nitrogen (TVB-N) is mainly composed of ammonia, trimethylamine (TMA) and thiobarbituric acid (TBA) are widely used as an indicator of meat deterioration (**Fan *et al.*, 2008**). The TVB-N content (ww) of raw fish fillets ranged from 14.0 (*S. vulgaris*) to 17.5 (*T. zilli*) mg/100 g sample. After cooking processes, all values were slightly decreased to 13.20-17.12, 13.5-17.45 and 13.40-17.30 mg/ 100g sample in fried, microwave and halogen cooked fish fillets, respectively. This slight reduction occurred in TVB-N content may be volatilization of some volatile bases as affected by cooking conditions. The same trend was observed in case of TMA content. Trimethylamine (TMA) is produced by the decomposition of trimethylamine N-oxide caused by bacterial spoilage and enzymatic activity. Values of TMA were ranged from 0.95 (*L. ramada*) to 1.95 (*T. zilli*) mg/100g sample, it reduced slightly to 0.80-1.70, 0.93-1.90 and 0.85-1.80 mg/100 g sample in fried, microwave and halogen fillets, respectively.

Table (2). Physiochemical and microbial properties of raw and different cooked fish fillets

item	pH value	TVB-N (mg/100g)	TMA-N (mg/100g)	TBA (mg MA/kg)	TPC (Log_{10}cfu/g)
			Mugil cephalus		
Raw	6.48±0.040	16.18±0.385	1.01±0.046	0.75±0.004	2.85±0.029
Frying	6.42±0.041	15.20±0.866	0.80±0.040	0.67±0.012	2.45±0.032
Microwave	6.82±0.020	16.01±0.357	0.93±0.020	0.55±0.029	2.66±0.033
Halogen	6.64±0.036	15.50±0.903	0.85±0.021	0.49±0.021	2.75±0.036
			Liza ramada		
Raw	6.60±0.020	16.55±0.396	0.95±0.023	0.80±0.032	2.78±0.020
Frying	6.55±0.077	15.90±0.892	0.90±0.008	0.76±0.012	2.50±0.023
Microwave	6.72±0.020	16.01±0.133	0.94±0.008	0.75±0.023	2.62±0.020
Halogen	6.65±0.012	16.50±0.860	0.93±0.020	0.70±0.047	2.65±0.032
			Solea vulgaris		
Raw	6.48±0.043	14.00±0.008	1.30±0.047	0.90±0.016	2.92±0.064
Frying	6.33±0.020	13.20±0.793	1.02±0.008	0.85±0.016	2.65±0.032
Microwave	6.66±0.033	13.50±0.554	1.25±0.026	0.80±0.020	2.73±0.020
Halogen	6.60±0.009	13.40±0.453	1.10±0.068	0.45±0.040	2.80±0.040
			Tilapia zilli		
Raw	6.52±0.020	17.50±0.784	1.95±0.023	0.70±0.023	2.80±0.047
Frying	6.49±0.041	17.12±0.186	1.70±0.026	0.65±0.032	2.50±0.081
Microwave	6.60±0.081	17.45±0.312	1.90±0.008	0.68±0.020	2.70±0.040
Halogen	6. 55±0.040	17.30±0.604	1.80±0.077	0.50±0.020	2.75±0.020

Values are shown as mean ± standard deviation of triplicates.

Concerning thiobarbituric acid (TBA), TBA values were ranged from 0.70 (*T. zilli*) -0.90 (*S. vulgaris*) mg MA/kg sample, decreased slightly to 0.65-0.85, 0.55-0.80 and 0.45-0.70 mg MA/kg sample, in fried, microwave and halogen-cooked fish fillets, respectively. This decrement in TBA values of cooked fillets may be attributed to the interaction of decomposition products of protein with malonaldehyde to give tertiary products. Similar findings are reported by many authors **(Tokur *et al*., 2004; Talab, 2014; Bastías, *et al*., 2017** and **Hernández-Sánchez *et al*., 2020).** Total plate count (TPC) of raw fish fillets ranged from 2.78 (*L. ramada*) to 2.92 (*S. vulgaris*) log_{10}cfu/g sample, reduced markedly to 2.45 – 2.65, 2.65 – 2.73 and 2.65 – 2.80log_{10}cfu/g sample of fried, microwave and halogen – cooked fish fillets, respectively. This reduction occurred in cooked fillets is due to effect of cooking conditions in particular vegetative cells.

CONCLUSION

All cooking techniques; frying, microwave and halogen techniques caused significant changes in sensory analysis, chemical composition and quality indices of investigated fishes. Besides, all fried fillets fish products were the best in texture and total acceptability compared with microwave and halogen- cooked products.

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