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Effect of Ginger oil on the sensory and chemical changes of fish finger (*Sarda sarda*, Heckel 1843) during refrigerated storage

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Abstract

This study was examined the effect of ginger oil (0.5% and 1%) on chemical and sensorial quality and production of fingers from *Sarda sarda.* The amounts of moisture, crude ash, salt, pH, TVB-N and TBA in fillet were 77.16%,1.02% 0.59%, 6.43, 8 mg/100 g, 0.72 mgMDA/kg, respectively, while fish finger paste was found to be 56.6%, 2.97%, 2.95%, 6.10, 7.76 mg/100 g, 0.69 mgMDA/kg, respectively. There was no significant difference between groups in terms of moisture, crude ash, and salt amount ($p > 0.05$). However, significant differences were found between groups in terms of pH, TVB-N and TBA values ($p < 0.05$) during storage. It was observed that the addition of ginger oil at 1% to fish fingers increased the shelf life of the products while the addition of ginger oil made a positive effect on sensory quality. In conclusion, the addition of 1% ginger oil to fish fingers allowed for an acceptable shelf life for up to 17 days at 4°C.

Introduction

In recent years, the increase of the world's population as well as various socioeconomic changes, has caused to an increase of the consumer's preference for ready-to-eat foods. Cakes, crackers, burgers, fish fingers, marinated products made from fish or other seafood products are of the most preferred ready-to-eat foods by consumers around the world and many studies have been conducted on the production, quality, and stability of these foods (Çakli *et al.*, 2005; Çakli *et al*., 2008).

Fish fingers, produced from minced fish flesh as a battered and breaded product, are commonly stored and marketed in their frozen state. However, fish and fish products can undergo undesirable changes during frozen storage and deterioration may limit their storage time. These undesirable changes result from protein denaturation and lipid oxidation (Siddaiah *et al*., 2001; Benjakul *et al*., 2005; Tokur *et al.*, 2006).

Oxidation of lipids in fish and fish products can be prevented by storage at low temperatures or with the addition of antioxidants to the recipe. Various chemical antioxidants have been used in order to prevent oxidation of lipids in fish subjected to long-term storage. In recent years there has been increasing concern shown over the safety of synthetic food additives, including the possible toxicity of those synthetic chemicals that are used as antioxidants (Çoban and Patır, 2010; Emir Coban *et al.*, 2012). As a result of these health concerns, food engineers have focused on the use of natural antioxidants to stabilize fat-containing foods. Ginger (*Zingiber officinale*) has been used as a spice for over 2000 years (Bartley and Jacobs, 2000). Its roots and the obtained extracts contain polyphenol compounds (6-gingerol and its derivatives), which have a high antioxidant activity (Chen *et al*., 1986; Herrmann, 1994).

The objective of this study is to (a) determine whether *Sarda sarda* can be used in the production of fish fingers and (b) the effect of ginger oil on the chemical and sensorial quality of fish fingers.

Material and Method

Raw material and the production of fish fingers

Sarda sarda was obtained from the local fish market in Elazığ, Turkey. The fish samples were transferred to the laboratory where they were beheaded, gutted and washed to obtain their fillets. The fillets were cooked in boiled water for 10 minutes. The finger paste included Sarda sarda mince, salt, potatoes, onion, egg, allspice, black pepper, parsley, sugar, flour, currants, and pine kernel. The ingredients were then manually homogenized. After the batter application, it was separated three different groups: Group (C): control group, no oil; Group (A): 0.5% of ginger oil was added in finger paste; Group (B): 1% of ginger oil was added in finger paste

All groups were shaped and covered with corn flour. The samples were placed on polystyrene plates, wrapped in stretched plastic film and stored at 4°C.

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The produced fish fingers contained 20% of additive substances and 80% of minced fish.

Ginger oil

Ginger oil was acquired from Kalsec® (Kalsec®, Inc, Kalamazoo).

Chemical analysis

The moisture content, crude ash, salt, and pH of fish samples were measured according to standard methods, (AOAC, 2002). Total volatile basic nitrogen (TVB-N) content was determined according to the method of Lücke and Geidel (İnal, 1992). Thiobarbituric acid value (TBA, mg malonaldehyde/kg) was determined using a spectrophotometric method (Tarladgis *et al.*, 1960). All analyses were performed in triplicate.

Sensory analysis

Ten experienced panellists, all of whom academic staff trained in sensory descriptors for fingers, were used to evaluate the quality of fingers during storage. The fish fingers were deep-fried with sunflower oil until they were cooked before being presented to the panellists. Panellists were asked to evaluate the sample's overall acceptability of appearance, taste, and odour on a 5-point hedonic scale ranging from very poor (1) to very good (5). All samples were stored at 4°C until sensory analysis was performed.

Statistical analysis

The resultant data was analyzed statistically using the ANOVA Two-way test with replication methods. Statistical significance was indicated at 0.05 levels. Comparisons between treatments were made by Duncan tests where appropriate (Özdamar, 2001).

Results and Discussion

According to the results of the analysis, there were statistically significant differences ($p < 0.05$) between fillet and finger paste for moisture and ash. Moisture contents decreased while crude ash increased significantly (Table 1). This can be explained with the addition of substances such as potato and flour in the finger paste. Similar findings were reported by Çaklı *et al.* (2005), Yanar *et al.* (2006), and İzci (2010). Significant statistical differences were not found between C groups with ginger oil groups during storage. These results showed that the addition of ginger oil had no effect on moisture and crude ash content of the fish fingers.

The changes in salt amount and pH values for fillet, finger paste, and fish fingers during storage period under refrigeration at 4°C are shown in Table 1 and Table 2. Significant statistical differences were not found between the groups in terms of salt amount ($p > 0.05$). However, the difference in pH values between the control group with ginger oil added groups was found to be significant ($p < 0.05$) after the 3rd day.

Table 1. Biochemical analyses results of raw fish fillet and fish finger paste

Samples	Moisture %	Crude ash %	Salt %	pH	TVB-N mg/100g	TBA mg MDA/kg
Fillet	77.16±0.40	1.02±0.02	0.59±0.02	6.43±0.05	8.00±0.11	0.72±0.05
Finger paste	56.6±1.73	2.97±0.05	2.95±0.07	6.10±0.18	7.76±0.06	0.69±0.03

The concentration of TVB in freshly caught fish is typically reported to vary between 5 and 20 mg N/100 g, whereas levels of 30–35 mg N/100 g flesh are generally regarded as the limit of acceptability for cold water fish stored on ice (Kyrana *et al*., 1997; Boran and Köse 1997). TVB-N values were determined as 8 mg/100 g for fillet and 7.76 mg/100 g for finger paste (Table 1). TVB-N amount increased in all groups during storage. Similar findings were reported by Gürel Inanlı *et al.* (2006), Izci (2010), and Patır *et al.* (2010) for fish fingers. TVB-N increase in the control group was higher than ginger oil added groups during storage. After the 3rd day, the difference between the control group and groups A and B was found to be significant ($p < 0.05$). At the end of storage time, the TVB-N values of the samples in the present study reached maximum levels of 24.85, 26.23 and 25.78 for C, A and B, respectively (Table 2). The values for the three groups remained within acceptable limits throughout the storage period. Ginger oil was the TVB-N value of samples and provided a longer shelf life for fingers produced from *Sarda sarda*.

The TBA test is widely used to measure lipid oxidation in food products. The amount of TBA was determined to be 0.72 ± 0.05 mg MDA/kg in the filets and 0.69 ± 0.03 mg MDA/kg in finger paste. TBA amount increased in all groups during storage (Table 1). The increase of the TBA value during storage has been demonstrated by Tokur *et al.* (2006) for fingers (made from *Cyprinus carpio*), by İzci (2010) for fingers (made from *Carassius gibelio*), by Patır *et al.* (2009) for fingers (made from shrimp), by Yanar and Fenercioglu (1999) for fish balls made from carp, by Boran and Köse (2007) for fish balls made *Merlangius merlangus*, by Öksüztepe *et al*. (2010) for fish ball made from *Oncorhynchus mykiss*. The results in all of these studies are almost parallel to the results found in this experiment. On the 7th day when the control group was spoiled in terms of sensory quality, the TBA level was 4.14 mg MDA/kg whereas on the same day, the TBA level was detected to be 2.60 in Group A, 1.44 in Group B. The results showed that the increase in TBA level was higher in

Table 2. Biochemical analyses results of fish fingers during storage at 4°C

	Grups	Storage (days)									
		1	3	5	7	9	11	13	15	17	19
Moisture %	C	56.79±2.35^a	56.93±22.10^a	58.16±2.43^a	58.70±1.70^a	SD	SD	SD	SD	SD	SD
	A	56.78±2.37^a	57.36±2.49^a	57.28±2.37^a	58.00±2.33^a	58.50±2.33^a	58.39±2.14^a	SD	SD	SD	SD
	B	56.63±1.38^a	57.13±2.36^a	57.73±1.59^a	57.82±0.19^a	56.86±1.83^a	57.51±2.59^a	58.82±3.63^a	58.94±2.81^a	58.09±2.90^a	SD
Crude ash %	C	3.06±0.06^a	3.00±0.10^a	2.99±0.00^a	3.00±0.14^a	SD	SD	SD	SD	SD	SD
	A	3.08±0.04^a	3.07±0.01^a	2.99±0.14^a	3.01±0.01^a	2.98±0.02^a	3.04±0.12^a	SD	SD	SD	SD
	B	3.04±0.00^a	2.99±0.01^a	2.96±0.01^a	3.00±0.00^a	3.00±0.00^a	3.10±0.10^a	3.00±0.02^a	2.99±0.01^a	3.00±0.02^a	SD
Salt %	C	2.94±0.08^a	2.90±0.07^a	2.98±0.04^a	2.99±0.02^a	SD	SD	SD	SD	SD	SD
	A	2.92±0.02^a	2.93±0.04^a	2.90±0.05^a	2.93±0.04^a	2.88±0.11^a	2.96±0.01^a	SD	SD	SD	SD
	B	2.91±0.01^a	2.93±0.01^a	2.94±0.02^a	2.93±0.04^a	2.93±0.03^a	2.92±0.02^a	2.98±0.03^a	2.98±0.04^a	2.98±0.04^a	SD
pH	C	6.16±0.02^a	6.36±0.03^a	6.54±0.00^a	6.54±0.08^a	SD	SD	SD	SD	SD	SD
	A	5.89±0.05^a	5.90±0.05^b	5.94±0.01^b	6.02±0.05^b	6.10±0.08^a	6.20±0.03^a	SD	SD	SD	SD
	B	5.78±0.05^a	5.80±0.02^b	5.86±0.01^b	5.87±0.00^b	5.91±0.01^a	5.95±0.04^b	5.95±0.00^a	5.98±0.04^a	6.03±0.04^a	SD
TVB-N mg/100 g	C	8.30±0.14^a	13.86±0.37^a	18.59±0.13^a	24.85±1.00^a	SD	SD	SD	SD	SD	SD
	A	8.13±0.04^a	11.18±0.04^b	12.97±0.17^b	15.75±0.08^b	18.78±0.04^a	26.23±0.13^a	SD	SD	SD	SD
	B	8.01±0.01^a	10.00±0.18^b	11.10±0.76^b	13.75±0.98^b	16.29±0.92^b	16.85±0.86^b	19.36±0.96^a	23.21±0.18^a	25.78±0.06^a	SD
TBA mgMDA/kg	C	0.79±0.05^a	2.04±0.09^a	3.53±0.54^a	4.14±0.02^a	SD	SD	SD	SD	SD	SD
	A	0.65±0.00^a	1.47±0.08^b	1.94±0.06^b	2.60±0.05^b	2.96±0.06^a	3.32±0.14^a	SD	SD	SD	SD
	B	0.63±0.02^a	0.63±0.03^c	1.10±0.12^c	1.44±0.08^c	1.70±0.06^b	2.13±0.11^b	2.90±0.07^a	3.18±0.06^a	3.37±0.02^a	SD

a,b,c: Different letters in the same column are statistically important ($p < 0.05$). The data are means ± standard errors.
C: Control, **A**: 0.5% Ginger oil added, **B**: 1% Ginger oil added, **SD**: Sensory Deterioration

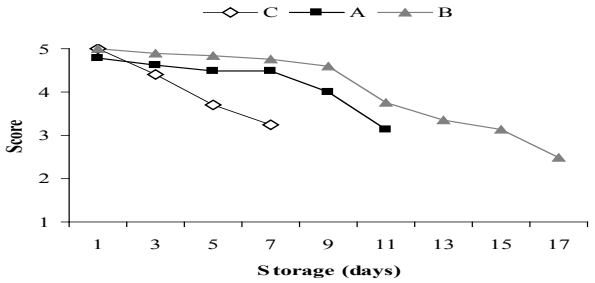

Figure 1. Taste scores of fish fingers during storage at 4°C. **C**: Control, **A**: 0.5% Ginger oil added, **B**: 1% Ginger oil added

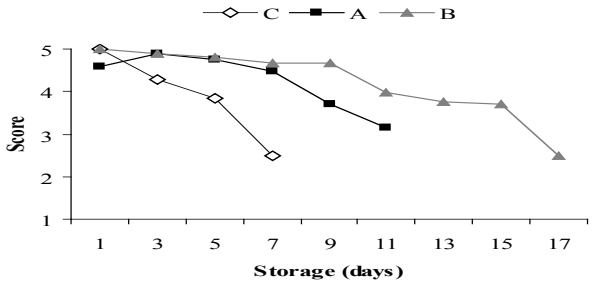

Figure 2. Odour scores of fish fingers during storage at 4°C. **C**: Control, **A**: 0.5% Ginger oil added, **B**: 1% Ginger oil added

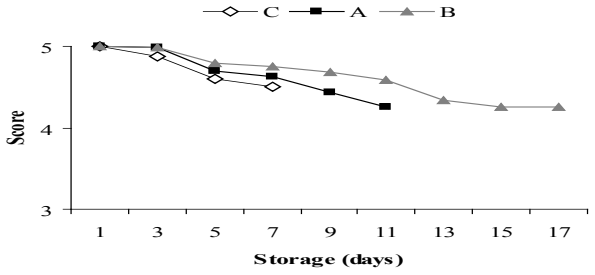

Figure 3. Appearance scores of fish fingers during storage at 4°C. **C**: Control, **A**: 0.5% Ginger oil added, **B**: 1% Ginger oil added

the control group than the ginger oil added groups, and that ginger oil and important effects on storage duration. These results established the antioxidant characteristics of the ginger oil and confirmed the findings of Pizzale *et al.* (2002) and Fasseas *et al.* (2007).

The sensory scores of fish fingers obtained from *Sarda sarda* in the present study revealed that the panellists liked fish fingers in terms of taste, odour, and appearance. The sensorial scores decreased in all groups by increasing duration of storage (fig. 1, 2, 3). It was determined that the impact of ginger oil and storage duration were important for taste and odour scores ($p < 0.05$). The shelf-life of the fingers was determined to be 5, 11 and 17 days for C, A and B, respectively.

Conclusion

According to the results of this study, it was determined that the effect of ginger oil on the sensorial quality, pH, TVB-N, TBA levels are important and significant. The fish fingers that contained 1% ginger oil and produced from Sarda sarda as an alternative product can be stored for 17 days in a 4°C state without undesirable changes of sensory and chemical quality.

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