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Chemical and microbial changes of fish fingers made from mince and surimi of common Carp *(Cyprinus carpio* L., 1758)

[1]Elyasi, A., [1,*]Zakipour Rahim Abadi, E., [2]Sahari, M. A. and [1]Zare, P.

[1]*Department of Fisheries, Faculty of Natural Resources, University of Zabol, P.O. Box 98615-538 Zabol, Iran*
[2]*Department of Food Technology, College of Agriculture, Tarbiat Modares University, P.O. Box 14115-336 Tehran, Iran*

Abstract: The fish finger produced from mince and surimi of common carp (*Cyprinus carpio* L., 1758) as well as the changes in chemical, microbial and sensory quality of the during product process were examined. The moisture content in the fish fingers produced from mince (FFm) and surimi (FFs) was reduced from 76.65 to 66.10 % and from 83.76 to 70.08 %, respectively ($p<0.05$). The Ash and fat content increased significantly in both kinds of fish finger. The increase in the protein content was only significant in fish finger produced by surimi. The protein content in surimi-based fish finger increased from 10.85% to 12.09%. There was also a significant decrease in TBC, TC and *E. coli* during the production process of both fish fingers ($p<0.05$). There were no significant difference in sensory parameters of odor, taste and texture, but the difference in color and general acceptability of both groups was significant ($p<0.05$). The Overall mean score of sensory evaluation of fish fingers produced from surimi was higher than fish fingers produced from mince.

Key words: fish finger, mince, surimi, common carp, *Cyprinus carpio*

Introduction

The consumption of fish and seafood and their popularity has consistently increased during recent years (Bochi *et al.*, 2008) and demand for aquatic products is increasing due to population growth, increase in the disposable incomes and increase in the relative preference for fish comparing with other foods (Taşkaya *et al*., 2003). Fish constitutes the fastest growing sources of food in the developing world. Aquaculture is currently one of the fastest growing food production systems in the world and contributes both to the economics and food security of many producing countries (James, 1998).

The growth of this industrial production has been equal to 16.5 percent in Iran during 2002 to 2004, which won the 6th place in terms of production growth (FAO, 2006). Common carp (*Cyprinus carpio*) with three Chinese carps (*Ctenopharyngodon idella*, *Hypophtalmichthys molitrix*, *Aristichthys nobilis*) production in Iranian polyculture system was around 77463 million metric tons in 2006 (Fisheries Statistical of Iran, 2006). The total production of common carp was around 20 million metric tons in 2006 (Fisheries Statistical of Iran, 2006). This fish has high feed efficiency ratio (Tokur *et al*., 2006), but due to its feeding behavior has a bad smell (Shabanpour *et al*., 2007) that cause to sell with a lower price.

The annual fish consumption in Iran, is about 7.7 kg, which is lower than average global consumption (Fisheries of Iran, 2006). Seafood products, such as fish fingers, sausage and fish burger could supply a variety of healthy food to increase the aforementioned ratio. The aim of present study was to process of fish fingers from minced and surimi of common carp meat and evaluation of chemical, microbial changes during production process.

Materials and Methods

Raw material

Thirty whole fresh Common carp weighing approximately 650±1.32 g were purchased from a local market in Zabol (Sistan and Bloachestan province, Iran) in January 2008. The purchased fish were kept in powder ice with fish/ice ratio 1:3 (w/w) and transferred to fisheries laboratory at Zabol University.

Sample preparation

Upon arrival, fish were washed, de-headed, gutted, re-washed and filleted by hand. The yield

*Corresponding author
E-mail: *e_zakipour@yahoo.com*
Tel: +98-542-2232600, Fax: +98-542-2232600

of flesh achieved by hand-filleting was 35.97%.The prepared fillet skinned and then fish meat, minced by a kitchen meat mincer (Pars Khazar, model Samira, Iran) using 4 mm diameter holes plate. The yield of mince achieved by meat mincer was 80.62%. The minced meats were mixed; some part was analyzed immediately as raw fish and 6252g of meat were divided to two groups. One group used as minced to produce the fish finger and other group used to produce surimi and then fish finger. The produced fish finger weighing 30.15±1.07 g was analyzed before and after flash frying. For sensory analysis, samples were deep fried. Surimi was processed according to Shabanpour *et al*. (2007) method. The minced meat was washed two times in cold water (8°C) with a ratio 3:1 (water to meat) for 10 min and in the final step; it was washed in salt solution (0.2 percent). After each washing step, meat was dewatered by being squeezing manually. Fish fingers made from 93.50 % of minced and also surimi with 1.50 % salt, 1.00 % sugar, 3.00 % wheat flour, 0.24 % cumin, 0.24 % onion, 0.24 % garlic powder, 0.24 % pepper and 0.02 % thyme according to Tokur *et al*. (2006). The ingredients were mixed and homogenized by a kitchen blender (Panasonic, MJ. W176P, Japan). The fish fingers formed manually. After that, fish fingers were battered (30 % wheat flour, 10 % corn flour and 60 % cold water) and breaded with conventional breading crumbs (Solar Company, Iran) (Bakar, 2005). Prepared fish fingers were kept in refrigerator chill-room (Negin, Model DR110, Iran) for 8 hr at 2°C.

Pre-frying the samples

The fish fingers were deep fried for 30s at 180ºC in sunflower oil which was preheated to 180ºC for 3 min in a deep-fryer (Tefal- Azura, Iran). The internal pan of the fryer was washed, cleaned and dried after each batch of frying. After frying, the slices were drained on stainless steel grills and allowed to be air cooled.

Chemical analysis

The moisture content was determined by using oven at 103°C (AOAC, 2000). The amount of ash was also measured by drying the sample in an electrical kiln at 550 °C (AOAC, 2000). The amount of crude protein was determined by Micro-kjeldahl method (AOAC, 2000) and crude fat was measured using Bligh and Dyer Method (1959).

Microbial analysis

For all microbiological counts, 10 g of sample were taken and transferred in 90 ml 0.1% peptone water (Difco, 0118-17-0). From the 10-1 dilution, other decimal dilutions were prepared (10^{-2}, 10^{-3}, 10^{-4} and 10^{-5}). Total viable count was determined by using pour plate method. Plate Count Agar (Difco, 0479-17) was used as medium (Harrigan and McCance, 1976). Plates were incubated at 30°C for 24-48 h. For coliform bacteria count Most Probable Number method was used. Lauryl Tryptose Broth (Difco, 0241-17-0) was used as medium and confirmation test was made in Brilliant Green Bile 2% (Difco, 0007-17-4). Tubes were incubated at 37°C for 24-48 h (Harrigan and McCance, 1976). For *Escherichia coli* count Most Probable Number method and Lauryl Tryptose Broth was used as medium. All Lauryl Tryptose Broth tubes that demonstrated gas production within the 48-h incubation period were subcultured into *E. coli* (EC) broth. The EC tubes were incubated at 45.5°C for 48 h. All positive EC broth tubes were streaked onto Levine's Eosin Methylene Blue agar and incubated at 35°C for 24 h. Thus, if typical *E. coli* colonies (i.e. mauve in colour, darkly nucleated and possibly displaying a metallic green sheen) were present, the EC broth tube was considered positive for the presence of E. coli. (Unlütürk and Turantas, 1996)

Sensory analysis

The Sensory quality of fish finger made from mince (FFm) and made from surimi (FFs) was assessed by 30 trained persons. The fish fingers were deep–fried with sunflower oil until they were cooked before being presented to the panelists. Panelists scored the product for color, taste, texture and general acceptability, using a hedonic scale (ASTM, 1969).

Statistical analysis

The obtained Data were analyzed by ANOVA one way test, using the SPSS 15.0. Duncan's multiple range tests for chemical and microbial quality and Mann-Whitney U for sensory quality were used; also they employed to find whether there is any significant difference between both fish fingers.

Results and Discussion

Proximate analysis

The proximate composition of Fish finger made from mince and surimi during processing are as in Table 1.

There were significant ($p<0.05$) differences in proximate composition between mince and surimi of common carp. Significantly higher protein, lipid and ash content were observed in the mince of common carp.

Significant decreases (P<0.05) was observed in the moisture content of fish fingers during production. The initial moisture content of mince and surimi were 76.65 and 83.76%, respectively. Process of fish finger production which followed by flash frying caused to decrease of 8 and 14 % in the moisture content for mince based product and 11 and 17 % for surimi based product. The ash content was increased after adding the ingredients for making the fish fingers and subsequently decreased after deep frying.

The fat content showed a reduction after the adding of ingredients for making the fish fingers. About 2.46 and 2.31 times iFncrease was observed in the fat content of mince and surimi based fish finger after flash frying.

Changes in protein content during the fish finger production and subsequent frying was similar to ash content changes. The ingredient adding caused to increase in the protein content from 17.38 to 18.71 % for mince and from 10.85 to 12.22 % for surimi based product, respectively. The fish fingers gained about 0.08 and 0.13 times protein after adding the ingredients, respectively. The protein content decreased after deep frying in both kinds of fish fingers.

Moisture content of fish fingers decreased during processing. This deduction was due to the addition of some ingredients like wheat flour and also effect of frying. Similar results have also been reported by Taşkaya *et al*. (2003) for fish burgers produced from rainbow trout (*Oncorhynchius mykiss*), by Ihm *et al*. (1992) for fish burgers produced from sardine and by Bochi *et al*. (2008) for fish burgers produced from silver catfish (*Rhamdia quelen*). Washing process during the production of surimi increased the moisture in mince that caused to change in the moisture content from 76.65 to 83.76%. Similar results have been reported by Lee (1986), Sultanbawa and Li-chan (1998) and Shabanpour *et al*. (2007). The moisture content of surimi in this project was higher than commercial surimi and this is because of hand dehydration. The Washing process also decreased the ash amount in surimi. After the production of carp fingers, the amount of ash increased because there were additives like wheat flour, corn flour, *etc*. The Fat content in mince and surimi products was 4.58% and 1.95%, respectively. The process of washing also extracted fat and therefore its amount decreased in the product (Haard *et al*., 1994; Lin and Park, 1996; Shabanpour *et al*., 2007). The decrease in fat content was clearly shown in this study, i.e., from 4.58% to 2.27% after adding some ingredients in FFs. Absorbing the frying oil during deep frying increased the fat content. Similar results have also been reported by Tokur *et al*. (2006) for fish fingers produced from washed and unwashed mince of mirror carp, by Bochi *et al*. (2008) for fish burgers produced from silver catfish.

Washing can cause Sarcoplasmic protein, which makes up to 20% to 25% of total protein of fish muscles, to exit; hence, the amount of protein in surimi is less than that of mince (Negbenebor *et al*., 1999; Taşkaya *et al*. 2003). The crude protein, fat, and ash contents of FFs decreased as a result of the washing process. Similarly, a decline impact of washing treatment on proximate analyses parameters was established by Lin *et al*. (1996) and Adu, Babbitt and Crawford (1983).

In this study, the sum of the moisture, crude protein, fat and crude ash content were determined to

Table 1. Proximate composition (%) of Fish finger made from mince and surimi during prosessing product

Treatment	Crude protein	Crude fat	Moisture	Crude ash
Mince	17.38 ± 0.45 b	4.58 ± 0.42 b	76.65 ± 0.43 a	4.33 ± 0.57 b
FFm (raw)	18.71 ± 0.50 a	2.27 ± 0.33 c	70.95 ± 0.22 b	6.66 ± 0.28 a
FFm (flash fried)	17.70 ± 0.79 ab	5.58 ± 0.44 a	66.10 ± 0.73 c	6.50 ± 0.00 a
Surimi	10.85 ± 0.27 b	1.98 ± 0.05 b	83.76 ± 0.35 a	1.82 ± 0.29 c
FFs (raw)	12.22 ± 0.61 a	1.73 ± 0.34 b	75.17 ± 0.32 b	5.63 ± 0.23 a
FFs (flash fried)	12.09 ± 0.45 a	4.01 ± 0.38 a	70.08 ± 0.70 c	4.47 ± 0.25 b

Data is expressed as mean ± SD (n=3).
a-c Value in the same columns with different superscript letters within a same strain are significantly different (P<0.05)

be 98.52% in fish fingers produced from mince and 94.75% in fish fingers produced from surimi. The remaining percentage of the total proximate analyses may be due to carbohydrate (Tukor *et al*., 2006). In general, fish are considered to have low amounts of carbohydrate in their muscles. However, the higher amounts of carbohydrate in fish fingers produced from mince and surimi might be due to the coating materials such as flour, starch and bread crumbs. Similar results have also been confirmed by Sayar (2001) who found 15.2% carbohydrate in fish finger.

Microbial analysis

Figure 1 shows the microbial content of fish fingers. Microbial content of fish fingers decreased during the production process and it reached a minimum after frying. There was no significant difference of TBC in mince and surimi. Adding garlic and pepper powder caused to reduce the bacterial count in fish fingers due to their antibacterial role. Total bacterial count was 3.33 and 26.66 CFU/g in deep fried fish finger made from mince and surimi, respectively. Changes in coliform bacteria and *E. coli* were similar to TBC. All fish fingers were healthy according to microbial count.

After flash frying, the content of coliform decreased to zero. The content of *E. coli* in raw and flash fried of both fish fingers are zero (Figure 1).

The Total Bacteria count is an important criterion for quality evaluation. According to the Institute of Standards and Industrial Research of Iran (ISIRI, 2006) suggestion, the maximum level of total viable count for raw and flash fried fish fingers was in a proper limitation. After adding some ingredients like salt powder, pepper and garlic during the production process, the TBC count decreased and this fact shows the antibacterial role of these things. The Maximum level of coliform bacteria in raw fish fingers has been 4×10^2 CFU/g and for flash fried fish fingers has been 10^2 CFU/g by ISIRI (2006). According to Figure 1, it is confirmed that the produced fish fingers were proper from the hygienic view point. The amount of *E. coli* by ISIRI was reported zero for raw and flash fried fish fingers.

Sensory analysis

Colour, Odour, taste, texture and general appeal in the two kinds of fish fingers were as shown in

Figure 1. Microbial content of fish finger made from mince and surimi during processing product

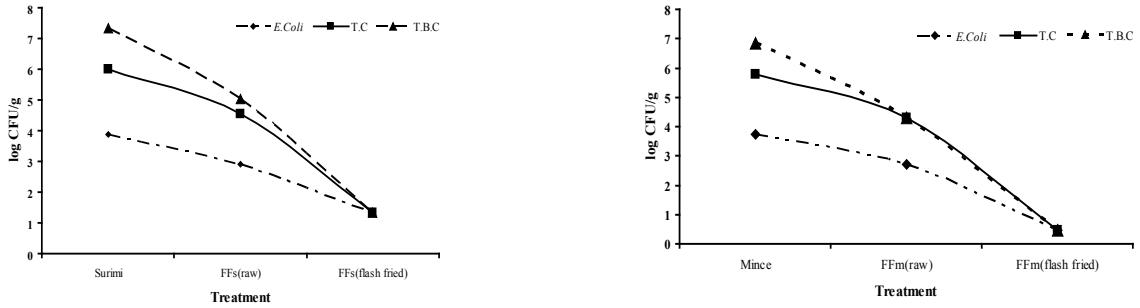

Table 2. Scores of sensory evalution of Fish finger produced from mince and surimi

Formulation	Color	Odor	Taste	Texture	General Acceptability
FFm	3.35 ± 0.74 [a]	4.20 ± 0.76 [a]	4.70 ± 0.73 [a]	4.45 ± 0.94 [a]	4.17 ± 0.58 [a]
FFs	4.45 ± 0.60 [b]	4.55 ± 0.60 [a]	4.55 ± 0.51 [a]	4.70 ± 0.57 [a]	4.48 ± 0.10 [b]

Data is expressed as mean ± SD (n=30).
a-e Value in the same columns with different superscript letters within a same strain are significantly different ($p<0.05$)

Table 2. There was no significant difference of odor in both fish fingers, although the sensory scores of fish fingers produced from surimi were higher than those of mince. Significant difference ($p<0.05$) was found in the two kinds of carp fingers. The average color scores in FFs were higher than those in FFm. The sensory score of taste in FFm also turned out to be higher than FFs, but there was no significant difference between them. In addition, there was no significant difference of texture between the two groups. The sensory scores of texture in FFs were higher than those in FFm. Significant difference ($p<0.05$) was found in general acceptability between FFm and FFs. The sensory scores of FFs were higher than those of FFm. Generally, the average of sensory scores of FFs was higher than FFm.

One of the aims of washing fish mince in the production of surimi is to decrease its bad smell. Washing process caused to decline in bad smell of FFs, and as a result this production obtained higher scores from panelists. In fresh water fishes, the 15-Lipoxygenize enzyme influences the omega-3 and omega-6 fatty acid and cause to produce the carbonate combinations like trans-2-hexanal and cis-3-hexanal. The deduction of bad smell, during washing process, has probably relationship with the mentioned combinations (Shabanpour *et al*., 2007). The taste of sea food under the effect of cooking is due to the combinations produced from the Millard reaction. This, in turn, is because of the demolition of sistein and sisten protein and different combinations with lower molecular weight to necessary nitrogen materials which make taste of meat as follows: Sarcoplasmic protein combinations, such as: Amino acids, peptide, Glico lipids, Nocleosids, Purins, Pirimidins, and Vitamins (Shabanpour *et al*., 2007). These combinations cause formation of some other combinations with low weight. New combinations affect taste (Moini *et al*., 2000) either by themselves or in later reactions, especially in combinations arising from fats, carbohydrates, and combinations produced from milard reaction. Therefore, it seems that washing and taking these combinations out is responsible for the bad taste of fish fingers produced from surimi. Colour is one of the most important indicators of appeal. The washing process on fish fingers causes Mioglobine to exit which is the most important source of producing muscle color (Chen and Chow, 2001). FFs had more appeal because of its lighter colour. The Produced fish fingers, in spite of differences in proximate composition, are similar from nutritive composition point of view. Yet FFs are better from FFm in terms of their quality. FFs are brighter in color, and have better odor and are more attractive, because they can be washed. However, due to the wasting factor in the production process, producers are not eager enough to produce them.

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