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IMPACT OF EDIBLE COATINGS ON CHEMICAL COMPOSITION, QUALITY CRITERIA AND SENSORY PROPERTIES OF SOME COMMON CARP FISH PRODUCTS

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ABSTRACT

This study was planned to study impact of edible coatings on chemical composition, quality criteria and sensory properties of some common carp fish products. Carp fish samples (the average weight was 4.132±1.132 kg) were obtained from Benha fish market Qalyubia Governorate, during october, (2014). Fish fillets were soaked in saturated brine solution contained 0.02% glacial acetic acid for 1-2 min at room temperature (25±2°C), then washed with tap water and drained. Fillets and nuggets were prepared from dorsal muscles, while the remaining part was minced and used in cake production. These products were immersed in milled fresh whole eggs, coated by wheat flour, bread crumb and vegetar, and then fried in deep oil. Chemical composition, physical properties, quality criteria, microbial aspects, colour measurement, and sensory evaluation were determined. The obtained results showed that the major constituents (wet wt.) of raw carp flesh were 73.4% moisture, 16.26% crude protein, 7.98% lipid, 0.71% ash contents. In addition, quality criteria of carp flesh were 5.98 pH, 23.8 mg/100g total volatile basic nitrogen (TVB-N), 1.17mg/100g trimethylamine nitrogen (TMA-N) and 0.29 mg Malonaldhyed/kg as thiobarbituic acid (TBA) value. Total plate count (TPC) and psychrophilic bacterial count (PBC) were 5.32 and 4.77 $\log_{10}$ cfu/g; respectively. Concerning the effect of frying, cooking losses were 9.90%, 10.84% and 14.88% in coated fillets, nuggets and cake products; respectively. Edible coatings improved colour characteristics (L*a* and b*) in particular lightness in wheat flour and vegetar coated, redness in wheat flour, bread crumb, and vegetar coated and yellowness in vegetar coated products. Also, they improved sensory tests *i.e.* odour, taste, texture, and overall acceptability in particularly products coated vegetar followed by wheat flour and bread crumb. In conclusion, this study recommend utilization of common carp to get highly nutritious products, especially these fish as fresh form are not acceptable for the consumer.

Key words: Common carp fish, edible coatings, quality characteristics, cooking method.

INTRODUCTION

Carp fish species are the most widely cultured species in Egypt. Three carp species; common, silver and grass carp are extensively cultured in Egypt. Total production of carp fish in Egypt during 2013 was 311.713 tons (21.43% of total catch 1. 454.401 tons) as set by GAFRD (2013). Although common carp (*Cyprinus carpio*) is one of the most cultured fish in the world but it has low consumer preference and hence limited market due to the presence of intramuscular bones. Hence, there is a need to develop some convenience products from the meat of carps to enhance their consumer acceptability (Gopakumar, 1997; FAO, 2011; Sehgal *et al.* 2011 ; Vanitha *et al.*, 2013). Concerning edible films and coatings materials, polysaccharides, proteins, and lipids can extend the shelf life of foods by functioning as solute, gas, and vapour barriers (Kanatt *et al.*, 2008). In addition, edible film is generally defined as a

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thin layer of edible material formed on a food as a coating or placed on or between food components. This film can be applied by immersion, spraying and or panning (Regalado *et al*., 2006). With regard to the effect of cooking method, deep fat frying is one of the cooking methods and fried foods have a good flavour, appearance and crispy texture. Besides, the properties of fried foods can be affected by the frying medium (Mallika *et al*. 2008). Therefore, the objective of this study was to evaluate the impact of some edible coatings on chemical composition of common carp fillets, nuggets and cake, and also study the characteristics of cooking quality of the products.

MATERIALS AND METHODS

Fish Samples

About 20 kg of common carp (*Cyprinus carpio*) were obtained from Benha fish market, Qalyubia Governorate, Egypt during October, 2014. They were transported immediately using ice box within one hour to Fish Processing and Technology Laboratory, Elqanater Elkhairia Fish Research Station, National Institute of Oceanography and Fisheries. The average weight (Mean ± SD) of common carp fish samples was 4.63 ± 1.60 kg. After that, they were tap water-washed, beheaded, gutted, filleted and rewashed carefully and drained. In addition, scales, fins, skin, viscera and large bones were removed. The yield of flesh achieved by hand-filleting was 44.09%.

Technological Process

Fish fillets were soaked in saturated brine solution (26% Sodium chloride) contained 0.02% acetic acid for 1-2 min at room temperature (25±2°C), washed with tap water and drained. Treated fillets were trimmed to obtain three forms; (a) small fillets for coated fillets. Fish fillets manufactured as described by Ibrahim (2004a), (b) cubic shape for coated nuggets which were prepared from dorsal muscles. Fish nuggets manufactured as described by Abdel Aziz (2013), and (c) the remaining part was minced using electrical mincer (Braun, power plus 1300W) for coated cake production. Fish cake manufactured as described by Ibrahim (2004b). Fillets were immersed into batter solution contained 1% fresh whole egg, 3.04% onion, 1.01% garlic, 2.03% sunflower oil, 0.71% edible salt, 0.20% black pepper, 1.11% red pepper, 0.10% cumin, 0.02% thyme, 0.02% curry and 2.40% starch. Concerning fish nuggets, equal cubic pieces were immersed into batter solution contained 1.5% fresh whole egg, 4.5% chopped onion, 0.28% edible salt, 0.22% black pepper, 0.33% cumin, 0.22% thyme, 0.22% ginger, 0.22% cardamom, 0.22% cubeb, 3.10% bread crumb and 5.62% starch. In addition, fish mince were manually good mixed with other ingredients; 1% fresh whole egg, 3.37% onion, 1.12% garlic, 2.25% sunflower oil, 0.78% edible salt, 0.78% black pepper, 1.12% red pepper, 0.11% cumin, 0.02% thyme, 0.02% curry and 3.87% starch. All ingredients were purchased from local market Qalyubia Governorate. Then, all batch was cake shaped (50g unit) using manually cake machine. Finally, semi processed products; fillets, nuggets and cake samples were coated with wheat flour, bread crumb and vegetar. Prepared fillets, nuggets and cake samples were deep-oil fried using electrical fryer pan (Moulinex brand) in sunflower oil preheated at 170^{o}C for 5 – 10 min, cooled to room temperature and analyzed.

Analytical Methods

Chemical composition (moisture, crude protein (N×6.25), lipid, and ash contents) and trimethylamine nitrogen (TMA-N) content were determined according to the methods recommended in AOAC (1995).Total volatile basic nitrogen (TVB-N) content and thiobarbituic acid (TBA) value were determined as mentioned by Pearson (1976). The pH value was measured as described by Zaika *et al.* (1976). Total plate count (TPC) and psychrophilic bacterial count (PBC) were examined according to Oxoid (1979). Cooking yield and loss were estimated according to Roland *et al.*, (1981). Colour test was measured using a Hunter lab colour flex EZ, USA. Sensory evaluation was assessed according to the procedure of Ibrahim (2004a) and Abdel Aziz (2013). The obtained data (n=3) was statistically analysed and expressed as mean±SD according to Snedecor and Cochran (1969).

RESULTS AND DISCUSSION

Proximate Analysis and Quality Criteria of Raw Common Carp Fish Flesh

Large fish species are played an important role to some fancy fishery products. Table 1 shows the proximate analysis and quality criteria of raw common carp fish flesh. The chemical composition (wet wt) of raw fish flesh was 73.4% moisture, 16.26% crude protein, 7.98% lipid, 0.71% ash and 1.65% carbohydrate contents. Concerning quality criteria; the pH value, TVB-N, TMA-N contents and TBA value of carp flesh were 5.98, 23.8mg/100g, 1.17mg/100g and 0.29 mg malonaldhyed/kg sample; respectively. Moreover, TPC and PBC were 5.32 and 4.77l og10 cfu/g; respectively. These results confirm that common carp fish is a fatty fish based on fat content and are in agreement with those findings by Ibrahim (2004a), Živković *et al.* (2004), Khidhir (2011), Ćirković *et al.* (2012) and Khanipour *et al.* (2014). Crude protein and lipid content are higher than those reported by Afkhami *et al.* (2011) and Ćirković *et al.* (2012) who found that the chemical composition of carp fish were ranged between 75.48%-75.02% moisture, 15.02% -15.59% crude protein, 3.53%-6.85% lipid and 0.89% - 1.5% ash contents. However, crude protein and lipid contents are lower than those reported by Ibrahim (2004a) and Živković *et al.* (2004) who found that the chemical composition of carp fish were 72.07% and 73.22% moisture, 17.46% and 16.6% crude protein, 9.26% and 8.97% lipid and 1.03% as well as 1.20% ash contents.

Cooking Loss of Deep-Fried Carp Products

Cooking loss of cooked coated carp fillets, nuggets and cake by deep-fried were14.36, 15.49 and 13.76% with wheat flour, 15.45, 16.19 and 14.86% with bread crumb and 13.21, 14.36 and 12.91% with vegetar; respectively. Cooking loss is due to the water evaporation and it is known that the presence of steam in the chamber of the oven slows down the rate of water evaporation from the product (Clausen and Ovesen 2005). Also, cooking loss are lower than those reported by Hakimeh *et al.* (2010) and Abdel Aziz (2013) who reported that the cooking loss of carp fillets and cuttlefish nuggets was 31.95% and 17.6%; respectively. Also, Ibrahim (2004a) found that cooking loss of carp cake with flour was 36.5%. The main causes of the loss of weight are loss of water by evaporation and dripping throughout deep-frying process. Also, vegetar coating led to reduce slightly in loss of cooked coated carp fillets, nuggets and fish cake.

Colour Measurement of Deep-Fried Carp Products

Colour is an important indicator of food quality. Although seafood colour is a parameter normally not used by many consumers in their buying decision, it is very important when seafood is consumed (Moradi *et al.* 2009). The colour results were expressed by CIE (L*a*b*). L*, a* and b* indicate lightness, redness, and yellowness; respectively. From the obtained data in Table 2, it could be observed that L* values of cooked coated carp fillets, nuggets and fish cake products were 41.33, 49.61 and 34.22 with wheat flour, 29.05, 41.23 and 31.84 with bread crumb and 30.07, 49.43 and 39.64 with vegetar; respectively. a* values of cooked coated carp fillets, nuggets and fish cake were 6.64, 0.69 and 8.13 with flour , 3.01, 3.43 and 7.82 with bread crumb and 4.68, 1.86 and 8.28 with vegetar; respectively. b* values of cooked coated carp fillets, nuggets and cake were 10.60, 13.53 and 14.71 with wheat flour, 9.90, 14.15 and 13.51 with bread crumb and 16.88,14.32 and 17.23 with vegetar; respectively. In general, cooking increased L*and b* values, but reduced a* value (Min and Green, 2008). Lightness, and yellowness values are lower than those reported by Hakimeh *et al.* (2010) who found that L*,a* and b* values of silver carp fillets with wheat flour were 42.46, 9.80 and 15.03; respectively.

Sensory Evaluation of Deep-Fried Carp Products

Fish frying is one of the oldest methods of food preparation. It improves the sensory quality of food by formation of aroma compounds, attractive colour, crust and texture (Garcia-Arias *et al.*, 2003 ; Venugopal, 2006). The means of sensory scores of deep-fried carp fillets, nuggets, and fish cakes with edible coatings are presented in Table 3. Odour, taste, texture, and overall acceptability were judged to assess the quality of investigated products. Odor scores of cooked coated carp fillets, nuggets and cake were 7.57, 7.57 and 7.85 with wheat flour, 7.57,

Table 1. Proximate analysis, quality criteria and microbial aspects of raw common carp fish flesh

Constituent (%)	Wet weight	Quality criteria	Wet weight	Bacterial aspects	log_{10} cfu/g
Moisture	73.40±0.13	pH value	5.98±0.07	[d]TPC	5.32
Crude protein	16.26±0.14	[a]TVB-N mg/100g	23.8±0.7		
Lipid	7.98±0.01	[b]TMA-N mg/100g	1.17±0.00	[e]PBC	4.77
Ash	0.71±0.01	[c]TBA mgMA/ kg	0.29±0.01		
Carbohydrate	1.65±0.28				

[a]TVB-N: total volatile bases nitrogen; [b]TMA-N: trimethylamine nitrogen; [c]TBA: thiobarbituric acid; [d]TPC: total plate count; [e]PBC: Psychrophilic bacterial count.

Table 2. Colour measurement of cooked coated carp products

Colour	Cooked carp products								
	Coated fillets with			Coated nuggets with			Coated cake with		
	**W.F.	*B.C.	Vegetar	**W.F.	*B.C.	Vegetar	**W.F.	*B.C.	Vegetar
L*	41.33	29.05	30.07	49.61	41.23	49.43	34.22	31.84	39.64
a*	6.64	3.01	4.68	0.69	3.43	1.86	8.13	7.82	8.28
b*	10.60	9.90	16.88	13.53	14.15	14.32	14.71	13.51	17.23

*B.C: (bread crumb). **W.F : (wheat flour).

Table 3. Sensory tests(mean ± SD) of cooked coated carp products

Sensory attributes	Cooked carp								
	Fillets coated with			Nuggets coated with			Cake coated with		
	**W.F.	*B.C.	Vegetar	**W.F.	*B.C.	Vegetar	**W.F.	*B.C.	Vegetar
Odour *	7.57±0.29	7.57±0.45	7.85±0.29	7.57±0.36	8.00±0.60	7.28±0.30	7.85±0.40	7.57±0.47	9.71±0.48
Taste *	7.71±0.42	7.28±0.40	9.00±0.64	7.42±0.52	8.28±0.55	7.85±0.42	9.42±0.61	9.00±0.43	9.00±0.57
Texture *	8.00±0.42	7.14±0.37	7.57±0.50	7.85±0.26	9.00±0.57	8.00±0.45	9.42±0.48	8.57±0.42	10.00±0.57
Overall acceptability*	7.76±0.42	7.33±0.42	8.14±0.45	7.61±0.50	8.42±0.56	7.60±0.59	8.89±0.56	8.38±0.40	8.57±0.71

*:1-4 rejected, 5-6 accepted, 6-7: good, 7--8: very good, 9-10: excellent.

*:B.C: (bread crumb); ** W.F:(wheat flour).

8.00 and 7.57 with bread crumb and 7.85, 7.28 and 9.71 by vegetar, respectively. Taste scores of cooked coated carp fillets, nuggets and fish cakes were 7.71, 7.42 and 9.42 with wheat flour, 7.28, 8.28 and 9.00 with bread crumb and 9.00, 7.85 and 9.00 with vegetar, respectively. Texture scores of cooked coated carp fillets, nuggets and cake were 8.00, 7.85 and 9.42 with wheat flour, 7.14, 10.00 and 8.57 with bread crumb and 7.57, 8.00 and 10.0 with vegetar; respectively. Overall acceptability values of cooked coated carp fillets, nuggets and cake were 7.76, 7.61 and 8.89 with wheat flour, 7.33, 8.42 and 8.38 with bread crumb and 8.14, 7.60 and 8.57 with vegetar; respectively. Meanwhile, edible coatings especially vegetar enhanced the odour, taste, texture and overall acceptability of fried products, due to Millard reaction that can play a pivotal role in food acceptance through the ways they influenced quality factors such as flavour, colour, texture and nutritional value (Rizzi, 1993). Values of odour, taste, texture and overall acceptability are higher than those reported by Hakimeh *et al.* (2010) who found that odour, taste, and overall acceptability values of silver carp fillets with wheat flour were 3.8,4.80 and 4.7; respectively. While odour, taste, texture and overall acceptability values are lower than those reported by Ibrahim (2004a) who reported that texture, flavour, taste and overall acceptability of carp cake with flour were 8.6, 8.4, 8.6 and 8.2; respectively. Ebeed *et al*. (2011) reported that aroma, taste and overall acceptability of fried burger for Elqanater and Manzala were 9.4, 9.8 and 9.2 and 9.4, 9.6 and 9.1, respectively.

Coated Fish Fillets

Proximate analyses

Data in Table 4 shows the proximate analyses of raw and fried coated fillets with edible coatings. It could be observed that the values of moisture, protein, lipid, ash and carbohydrate contents were 64.17, 17.01, 7.27, 1.30 and 10.25% of coated fillets with wheat flour; 60.44, 19.74, 9.50, 1.89 and 8.43% with bread crumb and 62.01, 14.96, 8.61, 1.89 and 12.53% with vegetar, respectively.

Concerning the effect of frying process; frying led to apparent increase in the values of protein, lipid and ash contents and decrease in moisture content in all products. Loss rates in moisture were 15.14, 9.8 and 10.49% of fried fillets coated with wheat flour, bread crumb and vegetar; respectively. These results are in accordance with several authors; Garcia-Arias *et al*. (2003), Gokoglu *et al*. (2004) and Weber *et al.* (2008). They reported that the decrease in the moisture content has been described as the most prominent change that makes the protein, fat and ash contents increase significantly in cooked fish fillets. In general, this data confirms edible coatings affect chemical composition of fish fillets and indicated that the increase in fat content of the fried fish fillets was also related to oil absorption during the cooking process. Similar results were found for sardines fried in sunflower oil (Garcia-Arias *et al*. 2003). Protein and lipid contents are lower than those reported by Gokoglu *et al.* (2004), Weber *et al.* (2008) and Ghelichpour and Shabanpour (2011). They found that the chemical composition (wet wt) of cooked rainbow trout and silver catfish and golden grey mullet fillets were 62.69, 46.9 and 51.58% moisture; 26.34, 32.2 and 31.96% protein; 12.74, 14.1 and 11.53% lipid and 1.66, 2.50 and 2.50% ash. Moisture and lipid (wet wt) of African catfish and striped catfish fillet with flour were 70.7%-63.28% and 8.2%-9.65%; respectively (Ersoy and Ozeren, 2009 ; Domiszewski *et al.*, 2011). While protein and lipid contents in the current study are higher than those reported by Abu Elenien *et al*. (2009) who showed that protein and lipid contents (wet wt) of catfish fillets were 17.5% and 1.45%; respectively. Also, Ersoy and Ozeren (2009) demonstrated that protein of African catfish was 20.00%.

Quality criteria

Table 5 shows the quality criteria of raw and fried coated fillets with edible coatings. The pH values were 6.04, 6.06 and 6.43 in raw coated fillets with flour, bread crumb, and vegetar, while in fried products; they increased to be 6.63, 6.28 and 6.66; respectively. This increasing might be referring to the formation of some basic compounds because of amino acids degradation. The pH values in this study are higher than those reported by Ibrahim (2004b)

Table 4. Proximate analyses (wet wt) of raw and fried coated fillets with edible coating

Constituent (%)	Coated fish fillets with					
	Wheat flour		Bread crumb		Vegetar	
	Raw	Fried	Raw	Fried	Raw	Fried
Moisture	64.17±1.19	49.03±1.07	60.44±1.42	50.64±2.19	62.01±0.3	51.52±2.08
Protein	17.01±1.45	26.29±0.86	19.74±0.37	23.32±2.78	14.96±1.07	20.57±0.07
Lipid	7.27±0.84	11.30±0.73	9.50±2.79	13.39±0.96	8.61±4.74	12.01±0.05
Ash	1.30±0.19	1.84±0.2	1.89±0.13	2.69±0.06	1.89±0.25	2.20±0.03
Carbohydrate	10.25±0.005	11.54±0.03	8.43±0.09	10.36±0.09	12.53±0.7	13.7±0.005

Table 5. Quality criteria and microbial aspects of raw and fried coated fillets with edible coating

Criterion	Coated fish fillets with					
	Wheat flour		Bread crumb		Vegetar	
	Raw	Fried	Raw	Fried	Raw	Fried
pH value	6.04±0.01	6.63±0.02	6.06±0.09	6.28±0.04	6.43±0.01	6.66±0.02
[a]TVB-Nmg/100g	22.4±1.4	24.5±0.70	23.7±0.7	28.0±0.00	18.2±2.1	25.7±4.2
[b]TMA-Nmg/100g	0.56±0.01	0.28±0.01	0.46±001	0.23±0.01	0.60±0.06	0.23±0.01
[c]TBAmg MA / kg	0.35±0.01	0.45±0.05	0.37±0.03	0.46±0.09	0.30±0.06	0.48±0.00
[d]TPC $\log_{10}$ cfu/g	5.33	4.74	5.65	5.00	5.60	4.25
[e]PBC $\log_{10}$ cfu/g	5.87	[*]ND	5.66	[*]ND	5.85	[*]ND

[a]TVB-N: total volatile bases nitrogen; [b]TMA-N: trimethylamine nitrogen; [c]TBA: thiobarbituric acid; [d]TPC: total plate count; [e]PBC: Psychrophilic bacterial count; [*]ND: Not determind

who found that the pH value of carp fillets with flour and vegetar was 6.35 and 6.46; respectively. While the pH values are lower than those recorded by Shirine and Maryame (2014), they showed that pH of carp fillets with wheat flour was 6.79. Ibrahim (2004b) found that pH value of carp fillets with bread crumb was 6.39. In addition, TVB-N and TMA-N contents are considered as good indices to assess quality of fish and its products as affected by microbial activity. Values of TVB-N in raw coated fillets with wheat flour, bread crumb and vegetar were 22.4, 23.7 and 18.2 mg/100g; respectively. After cooking, they were 24.5, 28.0 and 25.7 mg/100g of fried coated fillets with wheat flour, bread crumb, and vegetar; respectively. Deep-frying process caused increase in TVB-N content of all products. Zaitsev *et al*. (1969) mentioned that during frying, the proteins coagulate and moisture is released, but with a further rise in temperature, protein hydrolyze and become denaturized with a tendency of increasing the content of nitrogenous extractive, ammonia, and hydrogen sulfide in fish flesh. Moreover, it was observed that TVB-N level was higher in fillets coated with bread crumb than other coatings. TVB-N content in this study are higher than those reported by Shirine and Maryame (2014)

who found that TVB-N content of carp fillets with wheat flour was 4.90mg/100g; respectively. In addition, values of TMA-N in raw coated fillets with wheat flour, bread crumb, and vegetar were 0.56, 0.46 and 0.60mg/100g sample and in fried products they were 0.28, 0.23 and 0.23mg/100g; respectively. The TMA-N content was variably reduced after frying processes (Ebeed *et al.*, 2011). TMA-N content are lower than those reported by Ibrahim (2004b), who found that TMA-N content of carp fillets with wheat flour, bread crumb and vegetar were 1.54, 1.45 and 1.55, respectively.

Concerning TBA value, MDA was used to determine a secondary products formed lipid oxidation in processed carp fillets. TBA values were 0.35, 0.37 and 0.30mg MDA/kg sample in raw coated fillets with flour, bread crumb and vegetar; respectively. While, it was reached to 0.45, 0.46 and 0.48mg MDA /kg sample in fried products; respectively. This increment in MDA may be due to the oxidation of polyunsaturated fatty acids coming from the used oil (Saghir *et al*., 2005 ; Serrano *et al*., 2006). These results are in agreement with those found by Ebeed *et al*. (2011) who reported that TBA value in raw catfish burgers for Elqanater and Manzala was 0.28 and 0.19mg MDA/kg sample, and it was increased to 0.56 and 0.40mg MDA/kg sample; respectively. TBA value is higher than those reported by Ibrahim (2004b), who found that TBA values of carp fillets with wheat flour, bread crumb and vegetar were 0.02, 0.04 and 0.04mg MDA/kg sample; respectively. On the other hand, TPC were 5.33, 5.65 and 5.60 log10 cfu/g of raw and 4.74, 5.00 and 4.25 log10 cfu/g in fried coated fillets with wheat flour, bread crumb and vegetar; respectively. PBC were 5.87, 5.66 and 5.85 log10 cfu/g in raw coated fillets with wheat flour, bread crumb and vegetar; respectively. Decrease in TPC of fried coated fillets with edible coatings is due to deep frying (Ammar and Korish, 2009 ; Khanipour *et al*., 2014). These results are in agreement with findings of Kilinc *et al*. (2006). In this study, TPC is higher than those reported by Shirine and Maryame (2014), they noticed that TPC in carp fillets with wheat flour was 4.5 log10 cfu/g.

Fish Nuggets

Proximate analyses

Chemical composition (wet wt) of raw coated nuggets with wheat flour, bread crumb and vegetar were 65.01, 12.14, 9.17, 2.25 and 11.43%; 66.13, 12.85, 8.98, 1.63 and 10.41% and 62.42, 15.90, 7.05, 1.96 and 12.67% of moisture, protein, lipid, ash and carbohydrate contents; respectively as shown in Table 6. These values are affected by frying process based on type of edible coatings. Frying led to decrease in moisture and an apparent increase in protein, lipid, ash and carbohydrate contents. The increasing rates in lipid contents of fried nuggets coated with wheat flour, bread crumb and vegetar were 12.25, 15.49 and 11.64%; respectively. These results are in accordance with several authors; Garcia-Arias *et al*. (2003) and Gokoglu *et al*. (2004) and Weber *et al.* (2008). The protein and fat contents are higher than those reported by Abdel Aziz (2013) who found that moisture, protein, lipid, ash and carbohydrate contents (wet wt) of cuttlefish nuggets were 68.27, 18.13, 1.75, 1.88 and 9.97%, respectively.

Quality criteria

The quality criteria and microbial aspects of raw coated nuggets with edible coatings are shown in Table 7. The pH values were 6.19, 5.78 and 5.88 in raw coated nuggets with wheat flour, bread crumb and vegetar, while in fried coated nuggets was 6.29, 6.03 and 6.14; respectively. This increase might be referring to the formation of some basic compounds because of amino acids degradation. The TVB-N values of raw coated nuggets with wheat flour, bread crumb, and vegetar were 23.8, 21.7 and 25.2mg/100g; respectively. After cooking, they were 26.6, 28.7 and 26.6 mg/100g; respectively. Deep-frying process caused increase in TVB-N content of all products. TVB-N level is higher than those reported by Abdel Aziz (2013) who showed that TVB-N content of cuttlefish was 1.4 mg/100g. On the other hand, values of TMA-N content of raw coated nuggets with wheat flour, bread crumb, and vegetar were 1.07, 0.98 and 0.98 mg/100g sample and they were 0.89, 0.79 and 0.84 mg/ 100g sample; respectively.

Table 6. Chemical composition (wet wt) of coated nuggets with edible coating

Constituent (%)	Coated fish nuggets with					
	Wheat flour		Bread crumb		Vegetar	
	Raw	Fried	Raw	Fried	Raw	Fried
Moisture	65.01±0.60	47.18±3.81	66.13±2.02	45.87±0.03	62.42±1.82	49.08±0.09
Protein	12.14±0.01	22.97±2.11	12.85±0.48	23.63±0.49	15.90±3.58	23.87±0.47
Lipid	9.17±0.65	12.25±0.12	8.98±0.56	15.49±2.73	7.05±2.08	11.64±0.27
Ash	2.25±0.21	3.36±0.01	1.63±0.54	2.13±0.13	1.96±0.02	2.03±0.04
Carbohydrate	11.43±0.005	14.24±0.02	10.41±0.005	12.88±0.04	12.67±0.005	13.38±.06

Table 7. Quality criteria and microbial aspects of raw and fried coated nuggets with edible coating

Criterion	Coated nuggets with					
	Wheat flour		Bread crumb		Vegetar	
	Raw	Fried	Raw	Fried	Raw	Fried
pH value	6.19±0.03	6.29±0.01	5.78±0.01	6.03±0.07	5.88±0.02	6.14±0.13
[a]TVB-Nmg/100g	23.8±3.2	26.6±8.4	21.7±0.7	28.7±0.00	25.2±1.4	26.6±4.9
[b]TMA-Nmg/100g	1.07±0.00	0.89±0.01	0.98±0.00	0.79±0.00	0.98±0.01	0.84±0.01
[c]TBAmg MA/kg	0.31±0.05	0.43±0.02	0.22±0.01	0.50±0.08	0.10±0.01	0.23±0.04
[d]TPC $\log_{10}$ cfu/g	4.54	4.30	4.94	4.65	4.86	4.41
[e]PBC $\log_{10}$ cfu/g	5.55	[*]ND	5.38	[*]ND	5.12	[*]ND

[a]TVB-N: total volatile bases nitrogen; [b]TMA-N: trimethylamine nitrogen; [c]TBA: thiobarbituric acid; [d]TPC: total plate count; [e]PBC: Psychrophilic bacterial count; [*]ND: Not determind

Concerning, TBA values were 0.31, 0.22 and 0.10mg MDA\kg sample in raw coated nuggets and they were 0.43, 0.50 and 0.23mg MDA/kg sample in fried coated nuggets with wheat flour, bread crumb and vegetar; respectively. This increment in MDA may be due to the oxidation of polyunsaturated fatty acids coming from the used oil (Saghir *et al*., 2005 ; Serrano *et al*., 2006). TBA value is higher than those reported by Abdel Aziz (2013) who showed that TBA value of cuttlefish was 0.32mg MDA/kg sample. Moreover, microbiological load of TPC and PBC of raw coated nuggets with wheat flour, bread crumb and vegetar were 4.54, 4.94 and 4.86 $\log_{10}$ cfu/g and 5.55, 5.38 and 5.12 $\log_{10}$ cfu/g; respectively, while in fried products were decreased to 4.30, 4.65 and 4.41 $\log_{10}$ cfu/g; respectively. This depression in TPC in fried products is due to deep frying process (Khanipour *et al*., 2014; Ammar and Korish 2009). These results are in agreement with those reported by Kilinc *et al*. (2006).

Fish Cake

Proximate analyses

Table 8 exhibits the chemical composition of raw and cooked coated cake with edible coatings. Chemical composition (wet wt); moisture, protein, lipid, ash and carbohydrate of raw coated cake samples were 67.78, 14.10, 7.69, 1.47 and 8.96% with flour; 65.07, 14.11, 8.56, 1.84 and 10.42% with bread crumb and 64.87, 16.69, 9.01, 1.79 and 7.64% with vegetar, respectively.

Table 8. Proximate analysis (wet wt) of raw and fried coated cake with edible coatings

Constituent (%)	Coated fish cake with					
	Wheat flour		Bread crumb		Vegetar	
	Raw	Fried	Raw	Fried	Raw	Fried
Moisture	67.78±0.44	47.93±2.52	65.07±1.4	50.58±4.07	64.87±16.10	51.53±4.12
Protein	14.10±0.18	26.93±1.55	14.11±1.65	20.88±2.36	16.69±6.49	21.62±2.02
Lipid	7.69±0.65	11.51±7.23	8.56±7.64	10.98±0.93	9.01±0.12	10.80±9.63
Ash	1.47±0.003	2.49±0.11	1.84±0.50	2.52±0.09	1.79±0.005	2.30±0.10
Carbohydrate	8.96±0.01	11.14±0.005	10.42±0.005	15.04±0.005	7.64±3.82	13.75±0.08

While the corresponding values were 47.93, 26.93, 11.51, 2.49 and 11.14% in cooked coated cake with flour, 50.58, 20.88, 10.98, 2.52 and 15.04% with bread crumb and 51.53, 21.62, 10.80, 2.30 and 13.75% with vegetar; respectively. Our results in accordance with several authors; Garcia-Arias *et al*. (2003); Gokoglu *et al*. (2004) and Weber *et al.* (2008). Crude protein content is higher than those reported by Ebeed *et al*. (2011) who showed that moisture, protein, lipid and ash contents (wet wt) of fried burgers for Elqanater and Manzala were 49.03 and 51.17, 18.16 and 18.83%, 16.95 and 15.15% and 4.43 and 4.18%, respectively.

Quality criteria

Table 9 demonstrates the quality criteria of raw coated cake with edible coatings. The pH values were 6.45, 6.55 and 5.39 in raw coated cake with flour, bread crumb and vegetar while it was increased up to 6.66, 6.68 and 6.71 in fried coated cake products; respectively. pH value is higher than those reported by Ibrahim (2004a), he found that pH value of carp cake with flour was 5.96. TVB-N content of raw coated cake with wheat flour, bread crumb, and vegetar was 19.6, 18.2 and 21.0 mg/100g and it was increased to 21.0, 25.2 and 26.6 mg/100g; respectively. Deep-frying process caused increase in TVB-N content of all products. Our results are in agreement with those found by Ebeed *et al*. (2011). Moreover, it was observed that TVB-N level was higher in fillets coated with bread crumb than other coatings. TMA-N content of raw coated cake with wheat flour, bread crumb and vegetar were 0.93, 0.72 and 0.93mg/100g sample and decreased to 0.18, 0.32 and 0.28mg/100g; respectively. TMA-N values are lower than those recorded by Ibrahim (2004a) who found that TMA-N content of carp cake with wheat flour was 0.86 mg/100g sample. These results are in agreement with those reported by Ebeed *et al*. (2011). Concerning TBA values, they were 0.44, 0.49 and 0.39mg MDA/kg sample in raw coated cake with wheat flour, bread crumb and vegetar and reduced to 0.61, 0.59 and 0.51mg MDA/kg sample in fried products; respectively. TBA value is higher than those reported by Ibrahim (2004a) who found that TBA value of carp cake with wheat flour was 0.04 mg MDA/kg sample. Besides, TPC of raw coated cake samples with flour, bread crumb, and vegetar were 4.62, 4.74 and 4.79 log10 cfu/g; respectively. Values of PBC were 5.35, 5.43 and 5.64 log10 cfu/g; respectively. TPC values reduced in fried coated cakes to reach 3.83, 3.47 and 3.69 log10 cfu/g; respectively. This depression in TPC in fried products is due to deep frying process (Ammar and Korish, 2009; Khanipour *et al*., 2014). The results are in agreement with the findings of Ebeed *et al*. (2011) who reported that total plate count in raw catfish burger for Elqanater and Elmanzala was 3.74 log10 cfu/g and 3.92 log10 cfu/g and then reduced to 3.58 log10 cfu/g and 3.72 log10 cfu/g in fried catfish burger for Elqanater and Elmanzala.

Conclusion

In conclusion, the results suggested that edible coatings improve colour (L*a*b*) in particular lightness in wheat flour and vegetar coated, redness in wheat flour, bread crumb, and vegetar coated and yellowness in vegetar coated products. Also, it improved sensory tests by odor, taste, texture, and overall acceptability in particularly products coated vegetar followed by wheat flour and bread crumb. Based on the obtained results, the study recommends by utilization of common carp to get value added for fishery products, especially these fish as fresh form are low acceptable for the consumer.

Table 9. Quality criteria and microbial aspects of raw and fried coated cake with edible coating

Criterion	Coated fish cake with					
	Flour		Bread crumb		Vegetar	
	Raw	Fried	Raw	Fried	Raw	Fried
pH value	6.45±0.03	6.66±0.05	6.55±0.01	6.68±0.01	5.39±0.001	6.71±0.01
[a]TVB-Nmg/100g	19.6±0.07	21.00±4.9	18.2±6.0	25.2±1.4	21.00±5.3	26.6±0.7
[b]TMA-Nmg/100g	0.93±0.01	0.18±0.003	0.72±6.49	0.32±0.001	0.93±6.39	0.28±0.01
[c]TBAmg MA / kg	0.44±0.03	0.61±0.08	0.49±6.15	0.59±0.04	0.39±6.22	0.51±0.02
[d]TPC $\log_{10}$ cfu/g	4.62	3.83	4.74	3.47	4.79	3.69
[e]PBC $\log_{10}$ cfu/g	5.35	[*]ND	5.43	[*]ND	5.64	[*]ND

[a]TVB-N: total volatile bases nitrogen; [b]TMA-N: trimethylamine nitrogen; [c]TBA: thiobarbituric acid; [d]TPC: total plate count; [e]PBC: Psychrophilic bacterial count; [*]ND: Not determind

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تأثيـر مــواد التغطيــة علــى التركيب الكيمـــاوى ومعــاييـــر الجــودة والخــواص الحسية لبعض منتجات سمك المبروك

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يهدف هذه البحث إلى دراسة تأثير مواد التغطية على التركيب الكيماوى ومعايير الجودة والخواص الحسية لبعض منتجات سمك المبروك، تم الحصول على عينات السمك (١.١٣٢±٤.١٣٢كجم) من سوق السمك ببنها، محافظة القليوبية فى شهر اكتوبر (٢٠١٤م)، تم تجهيز الشرائح السمكية بعد عمليات الغسيل والتنظيف، تم غمر الشرائح فى محلول ملحى مشبع محتوى على ٠.٠٢% حمض خليك لمدة ١-٢ دقيقة على درجة حرارة الغرفة، ثم الغسيل بماء الصنبور والتصفية، تم تجهيز الشرائح والناجتس من عضلات الظهر بينما تم فرم الجزء المتبقى واستخدامه فى تصنيع الكيك، تم تغطية هذه المنتجات بمادة التغطية والمكونة من دقيق القمح، البقسماط والفيجيتار بعد غمرها فى البيض المخفوق، تم تقدير التركيب الكيميائى، الخواص الفيزيائية، معايير الجودة، الاختبارات الميكروبية، قياس اللون والتقييم الحسى، أوضحت النتائج أن التركيب الكيميائى (على أساس الوزن الرطب) للسمك الخام على النحو التالى: ٧٣.٤% رطوبة، ١٦.٢٠% بروتين، ٧.٩٨% دهن و٠.٧١ % رماد على التوالى، بالإضافة إلى أن معايير الجودة لسمك المبروك الخام كانت كالآتى : القيم للأس الهيدروجينى ٥.٩٨، القواعد النيتروجينية الطيارة ٢٣.٨ مجم/١٠٠جم، الثلاثى ميثيل أمين ١.١٧ مجم/١٠٠جم و رقم حامض الثيوباربتيوريك ٠.٢٩ مجم مالونالدهيد/كجم بينما كان العد الكلى للبكتريا والبكتريا المحبة للبرودة ٥.٣٤ مستعمرة/جم و٤.٧٧مستعمرة/جم على التوالى، كما سجل الفاقد فى الطهى ٩٠.٩%، ١٠.٨٤% ، ١٤.٨٨% فى منتجات الفيلية والناجتس والكيك على التوالى، حسنت مواد التغطية من خواص اللون خاصة فى المنتجات المغطاة بالدقيق والفيجيتار، الاحمرار فى المنتجات المغطاة بالدقيق و دقيق البقسماط والفيجيتار، الإصفرار فى المنتجات المغطاة بالفجيتار، كما حسنت من الخواص الحسية (الرائحة، الطعم، القوام والقبول العام) خاصة فى المنتجات المغطاة بالفيجيتار ثم دقيق القمح ثم دقيق البقسماط، وبناءاً على النتائج المتحصل عليها فان الدراسة توصى بالاستفادة من سمك المبروك العادى فى الحصول على منتجات ذات قيمة غذائية عالية خاصة وأن هذه الأسماك لا تلقى قبولاً على حالتها الطازجة لدى المستهلك.

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