Determination of nutritional value of snacks containing grass carp powder

تقدير القيمة الغذائية للمقرمشات المحتوية على بودرة سمك مبروك الحشائش

By

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Abstract

Although carp fish species have a successfully cultured in Egypt, but they have intramuscular bones and it has a muddy odor, this is leads to their limited marketing. So, this study was designed to evaluate the nutritional value and safety of snacks incorporated with different levels (0.0, 5, 10, 15 and 20% w/w) grass carp (*Ctenopharyngodon idella*) powder. The results showed that fish powder contained 9.66% moisture, 69.56% protein, 16.26% fat and 3.88% ash content. The total essential amino acids (TEAAs) of raw grass carp and its powder were29.81 and 27.90 g/100g and biological value (BV) were 83.64 and 77.07%, respectively. Both fish and its powder have lower content of Ca, Mg, Na and K than the maximum permissible levels (MPLs) (800, 350, 2400, and 3500mg/100g sample, respectively). Concerning safety of raw fish and fish powder, it was found that total plate counts were under the MPLs (10^3-10^6cfu/g). Based on sensory tests, fried and baked snacks contained 10% fish powder has got higher scores than others. TEAAs of fried and baked fish snacks recorded 3.85

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and 4.09mg/100g and BV values were 45.86 and 46.40%, respectively. Also, gram daily requirements (GDR) of EAAs in fried snacks were higher than baked snacks. GDR of Mg and Na content in fried snacks were higher than baked while Ca was equaled. In conclusion, this study recommends that grass carp fish is a good source of fish powder for fortification some bakery products which preferred by many consumers.

Key words: Grass carp, ready to eat products, cooking methods, quality indices.

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Introduction

Nowadays, the demand for fish manufactured fishery products (snacks) is increased; this is due to increase in population, urbanization, working women, changing lifestyle, disposable incomes, relative preference and media penetrations (**Venugopal, 2006** and **Bochi*et al.*, 2008**). Snack foods are smaller than a regular meal, generally eaten between meals or during the night. Also, these products have many benefits such as less perishable, more durable and portable than prepared foods, meet nutrients needs for the day and make a feel of satiation. However, snacks are contributing to weight gain, obesity, chronic cardiac disease, hypertension and diabetes mellitus **(Thakur and Saxena, 2000).**

Fish based snacks have a relevant nutritional value; due to their high protein, lipid (omega-3) and minerals (such as calcium, phosphorus and iron), and vitamins. Fish powder increases the nutritional value and decreases the oil uptake in fried product **(Goday *et al.*, 2010)**. Several researchers (**Cortez Netto *et al.*, 2014; Pianjing *et al.*, 2016; Ganesan *et al.*, 2017 and Abd-Allah (2019)**have been demonstrated that the inclusion of

minced fish and fish powder could be improved nutritional quality of products while addition of more than 10% of blanched dried fish powder reduced the acceptability .Carp fish species are the most widely cultured all over the world; due to its fast growth rate, easy cultivation and high feed efficiency ratio but its feeding behavior has a bad smell. However, carp have intramuscular bones have low consumer preference and hence limited market (**Shabanpour *et al.*, 2007 and Abdelaal *et al*., 2014**). Therefore, this study was designed to evaluate the nutritional value and safety of snacks incorporated with different levels (0.0, 5, 10, 15 and 20% w/w) grass carp (*Ctenopharyngodon idella*) powder.

Materials and Methods

Materials

Fish samples

Grass carp (*Ctenopharyngodon idella*, Valenciennes in Cuvier &Valenciennes, 1844) samples (Fig. 1) were obtained from fish market, Alobour city, Cairo during May 2021. They transported in ice box to Fish Processing and Technology laboratory, Fish Research Station, El-Kanater El-Khairia, National Institute of Oceanography and Fisheries (NIOF). The average weight and length were 3.70±50 kg and 57±40 cm, respectively).

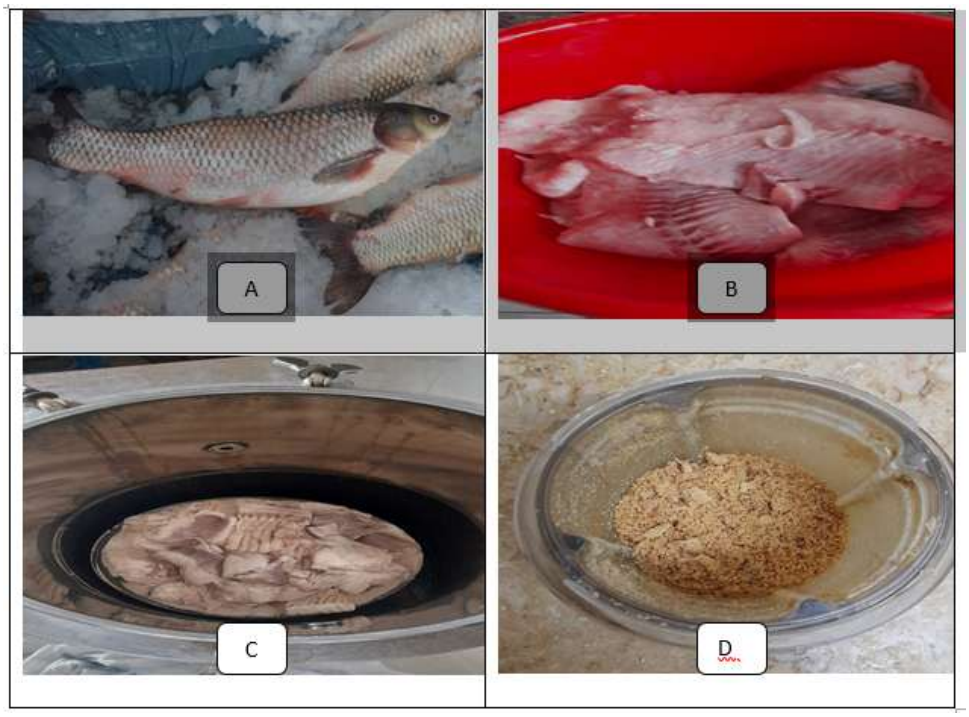

Fig. (1): A: raw Grass carp (*Ctenopharyngodon idella*), B: fillets, C: cooked and D: fish powder.

Ingredients; all ingredient used in this study (corn and wheat flour, edible salt, sunflower oil and chees as flavoring agent) were purchased from local market, El-Kanater El-Khairia city, Qalubya.

Production of fish powder; under laboratory conditions**,** raw grass carp samples were carefully washed using tap water, beheaded, eviscerated, and manually filleted, washed again, drained. After that, they cooked by autoclave for 15 minutes at 100 °C, dried in the oven at 50° for 48h until completely dried (9.66% moisture) and then grinded and sieved (50 mesh) to

obtain a fine powder with excluding small bones and dark parts (Fig. 1).

Treatments

Fish snacks samples were prepared under room conditions according to expermintal recipe modified as presented in Table (1) and Fig. (2). After that, each sample incorporated with levels of 0.0, 5, 10,15 and 20% (w/w) was cut into equal parts with a very thin high in a circular shapes then put it in a pan (one minute for every face), and then divided into two parts; the first part was for frying and the second was for baking. Two cooking methods; deep-oil frying and baking n dry oven were used (**Weber *et al.*, 2008**).

Table (1): Formula used in snacks incorporated with grass carp powder.

Ingredient	Control	Snacks with different levels of fish powder;			
		5%	10%	15%	20%
*Wheat flour	500g	475g	450g	425g	400g
*Corn flour	500g	475g	450g	425g	400g
Fish powder	----	50g	100 g	150g	200g
Salt	20 g	20 g	20 g	20 g	20 g
Water	550ml	550ml	550ml	550ml	550ml
Thyme	1g	1g	1g	1g	1g
Sunflower oil	110 ml	110 ml	110 ml	110 ml	110 ml

*Wheat and corn powder were replaced with different levels of grass carp fish powder.

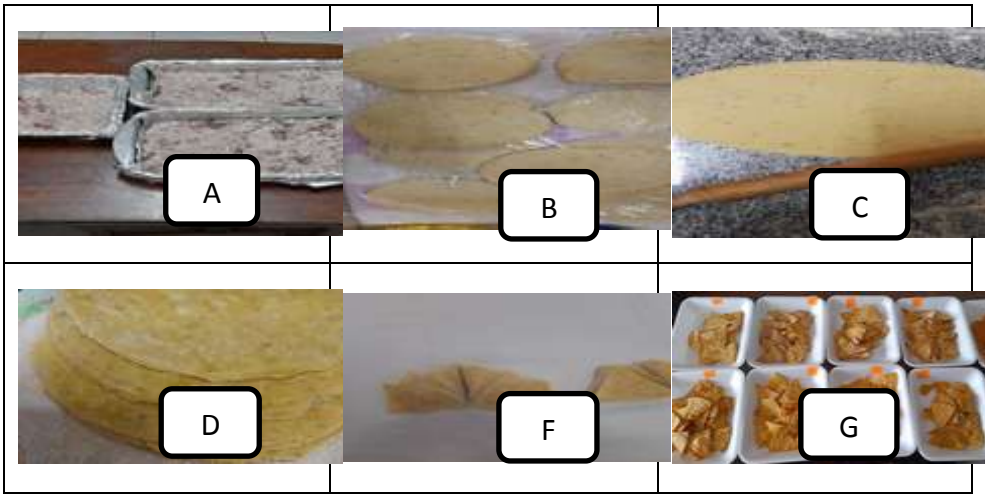

Fig. (2). A: cooked fish meat; B, C, D & F: forming of snacks with fish powder, and G:cooked snacks(baked and fried).

Analytical Methods

Moisture, crude protein, lipid content and ash content were determined **(AOAC, 2000)**. The pH value was measured according to **Egbert *et al.*, (1992**) using a digital pH meter (Hydrolab model Crison-Spain MM40^{+}). Total volatile basic nitrogen (TVB-N) content was determined according to the method described by **Pearson (1976**). Trimethyle amine nitrogen (TMA-N) content was determined according to Spectrophotometric method as described by **AOAC (2000)**. TBA value was measured according to the method described by **Tarladgis *et al.*, (1960**). Amino acids (**AOAC, 2012**) were determined at the Regional center for food and feed (RCFF), Agriculture Research Center, Giza, Egypt. Amino acid score (AAS) using **FAO/WHO/UNU reference protein (1985)**, essential amino acids Index (EAAI)(**Hidvegi and Bekes,**

1983),biological value (BV) (**Oser, 1959**), gram daily requirements (GDR) and percent satisfaction (PS/150g) USRDA(1989) were calculated. The major elements (Na and K) were measured by GBC Atomic Absorption reader (Model Savant with GF 5000 Graphite Furnace). Calcium and magnesium were determined as described by **AOAC (2012**). Total plate count (TPC) of investigated fish samples were examined according to **Oxoid (1982).** Sensory tests (appearance, texture, odor, taste, overall acceptability) of cooked fish snacks were carried out according to the procedure of **Fey and Regenstein (1982).**

Statistical analysis, the results obtained (n=3) were statistically analyzed using SPSS (Ver. 16) and they were expressed as mean ± SD.

Results and Discussion

The yield and chemical composition of grass carp flesh

Table (2) shows the chemical composition, quality criteria and mineral composition of raw grass carp and fish powder. The yield of grass carp flesh achieved by hand-filleting was 42.٨٥% and the values of chemical composition were 73.29% moisture, 17% crude protein, 7.5% lipid, and 1.84% ash content. TVB-N, TMA-N, and TBA values recorded 22.4 mg/100g, 4.15 mg/100g and 0.85 mg MAD/kg samples, respectively, and the pH value was 5.46. Total plate count (TPC) of raw carp fish flesh of grass carb recorded 1.0×10^{3}cfu/g. Also, minerals were 450 mg/100g Ca, 180 mg/100g Mg, 350 mg/100g Na and 260 mg/100g K. On the other side, values of moisture, crude protein, lipid and ash content of fish powder were 9.66%, 77%, 18.0% and 4.3% respectively. TPC recorded 1.0×10^{2}cfu/g.

Minerals composition, K was the most dominant element (1040 mg/100g) while other minerals decreased in fish powder.

Table (2): Chemical composition, quality criteria and mineral composition of raw grass carp and its powder.

Chemical composition;			**Quality indices;**			**Minerals (mg\100g);**		
Constituent (%)	**Raw**	**Fish powder**	**Index**	**Raw**	**Powder**	**Element**	**Raw**	**Powder**
Moisture	٧٣.29 ±1.29	9.66±0.66	pH value	5.46±.11	6.0±0.30	Ca	450	270
Crude protein	١٧.00 ±0.60	77±1.06	TVN content (mg \100g)	22.4 ±١.98	29± 0.99	Mg	180	140
Fat	± ٧.٥٠1 .11	18±0.66	TMA content (mg \100g)	4.15± 0.07	3.55±0.01	Na	350	210
Ash	١.١٤ ± ١.٨٤	4.3±0.44	TBA value (mg MAD\ kg)	0.90 ±٠.٠٣	0.22±0.01	K	260	1040
			TPC (cfu\g)	$1.0\times10^{3}\pm0.01$	$1.0\times10^{2}\pm0.70$			

TVB-N: total volatile basic nitrogen, TMA-N: trimethylamine nitrogen, TBA: thiobarbituric acid, TPC: total plate count.

Our results are in agreement with those founding by Abdelaal *et al*., (2014); El-Sayed (2016) and Saber (2017) for

yield, Abdelaal *et al.*, (2014); El-Sayed (2016) and Mahmoud (2016); Mahmoud (2017); Saber (2017); Abd-Allah (2019)and EFSA (2020) for physico-chemical and microbial load and (EPA, 2002; EL-Shreif, 2005and Abd-Allah, 2019)for mineral composition. This variation in the yield and chemical composition of grass carp and its powder are due to several factors such as age, sex, habitat, environmental conditions and fishing season, specimens of the same species and drying process (Shearer, 1994; Hadjinikolova, 2008 and Miroslav *et al*., 2011).Also Lee; *et al.*, (2016) reported that fish powder could serve as safety and mineral source.

Amino Acids composition

Amino acids composition (g/100g) of raw grass carp fish and its powder is presented in Table (3). Ten EAAs; threonine, valine, isoleucine, leucine, tyrosine, phenylalanine, histidine, lysine, cysteine, and methionine were detected in both raw carp flesh and its powder samples. Lysine, Leucine and Valine were the most dominant EAAs being 6.50, 4.96 and 3.39g/100g in raw and 7.14, 4.22 and 3.56 g/100g in fish powder, respectively. Total EAAs were 29.81 and 27.9 g/100g of raw carp and its powder, respectively. The highest values (6.50 and 7.14 g/100g of lysine) were found while the lowest ones (0.65 and 0.44g\100g of cysteine) were found in both raw carp and its powder, respectively. Values of essential amino acids index (EAAI) recorded 87.50 and 81.47 and biological values (BV) were 83.64 and 77.07, respectively. Also, amino acid score (AAS) was a higher than 100 in both raw fish and its powder. It could be noticed that drying process of raw led to a slightly increase in values of valine, histidine, lysine whereas other

EAAs decreased in fish powder. High values were reported by **Abd-Allah (2019),** essential amino acids content of carp fish protein concentrate (FPC) obtained were 52.91 g/100g. According to AAS, both raw fish and its powder have a high nutritional quality.

Table (3): Essential amino acids (EAAs) content of raw carp flesh and its powder compared with FAO\WHO\UNU (1985) Pattern.

EAAs	**FAO/ WHO/ UNU (1985) Pattern g\16g N**	**Raw fillets**			**Fish powder**		
		g\100g	**g\16g N**	**AAS**	**g\100g**	**g\16N**	**AAS**
Threonine	0.90	2.74	16.12	1791	2.26	3.25	361
Valine	1.30	3.39	19.94	1534	3.56	5.12	394
Isoleucine	1.30	2.92	17.18	1322	2.77	3.98	306
Leucine	1.90	4.96	29.19	1536	4.22	6.07	190
Tyrosine	1.90	2.27	13.35	1538	2.07	2.98	325
Phenylalanine		2.70	15.88		2.22	3.19	
Histidine	1.60	1.86	10.94	684	1.93	2.77	173
Lysine	1.60	6.50	38.24	2390	7.14	10.31	644
Cysteine	1.70	0.65	3.82	855	0.40	0.58	146
Methionine		1.82	10.71		1.33	1.91	
Total EAAs		**29.81**			**27.90**		
EAAI		**87.50**			**81.47**		

BV		**83.64**		**77.07**	

Tryptophan did not determine. EAAs: essential amino acids, AAS: amino acid score, BV: biological value.

Table (4): Nonessential amino acids (NEAAs) composition (gm\100gm) of raw carp and its powder.

NEAAs	Raw fish	Fish powder
Asparagine	6.64	6.59
Serine	2.41	2.07
Glutamine	9.72	10.55
Glycine	3.25	3.12
Alanine	3.75	3.53
Arginine	4.04	2.65
Proline	2.64	1.89
Total	**32.45**	**30.4**

From Table (4),it was found that seven nonessential amino acids (NEAAs); asparagine, serine, glutamine, glycine, alanine, arginine, and proline were detected in both raw carp flesh and its powder samples. Total NEAAs were 32.45 and 30.40 g\100g of raw carp and its powder, respectively. Glutamine and asparagine were the most dominant NEAAs; being 9.72 and 6.64g/100g in raw fish and 10.55 and 6.59g/100g in fish powder, respectively. The highest values of NEAAs were glutamine, asparagine and arginine while the lowest ones were proline and serine of both raw carp and its powder, respectively. With regard the effect of drying process, it was noticed that all NEAAs except glutamine decreased. The results of amino acids composition are in accordance with those reported by **Murueta *et al*. (2007); Khoshkhoo *et al*. (2012) and Abd-Allah (2019). Tian *et al.* (2017)** in glutamic

acid and vice versa in arginine, proline and glycine where they found that these acids were higher in fish powder obtained from common carp than the fresh muscles. Also, **Pires *et al.* (2012)** reported that raw cape hake was richer in glutamic acid and glycine than Cape hake protein powder.

Processed fish snacks

Table (5) demonstrates the effect of cooking methods on the chemical composition of snacks incorporated with different levels of grass carp powder. Moisture content of fried and baked snacks products of grass carp fish showed a relatively increase with increasing fish powder concentration. It recorded 2.78%, 3.21%, 2.68%, 2.77% and 3.47±0.10 % for fried snacks; control, 5%, 10%, 15 and 20%, respectively, the corresponding values for baked snacks increased to be 4.60±0.13, 5.21±0.15, 3.33±2.98, 2.65±3.13 and 4.94±0.01%, respectively. Crude protein of fried snacks recorded 4.89%, 11.42%, 18.23%, 21.94% and 35.15% while it recorded 13.58, 24.37, 30.23, 32.19% and 37.78% for baked snacks for control, 5%, 10%, 15 and 20%, respectively. The values of lipid content were 2.1%, 1.9%, 2.74%, 3.00% and 3.98% for fried snacks products; control, 5%, 10%, 15 and 20%, respectively while in baked snacks recorded 0.56%, 0.75%, 1.34%, 1.93% and 4.60% at the same levels of fish powder, respectively. The results of ash content were 2.24%, 2.24%, 3.50%, 2.36% and 2.44% for fried snacks; control, 5%, 10%, 15 and 20%, respectively while in baked snacks recorded 3.06%, 2.80%, 2.84%, 2.36% and 3.00% % at the same levels of fish powder, respectively. The Carbohydrates were 90.25%, 84.39%, 75.52%, 72.74%, 58.42% and 58.42% for fried control, 5%,

10%, 15 and 20%, respectively and 82.80%, 72.08%, 40.58%, 38.51% and 30.62% for baked snacks, respectively. Total energy of processed fish snacks ranged from 399.46-410.1 Kcal and 300.17-395.30 Kcal for fried and baked snacks, respectively. Based on these results, it could be noticed the general trend of moisture contents of fish fried snacks in present study were lower than which of fish baked snacks. The Increases in chemical composition of fishery products especially protein content are due to the increase in fish powder per cent and may be attributed to decrease in moisture as affected by the thermal process throughout cooking methods. A remarkable variation in lipid content of fried carp products is due to fish powder levels, recipes and cooking method. On the other hand, it was found that, the loss in lipid content in case of baked snacks is due to drip throughout this process**.** Slightly variation in ash content of snacks studied is due to recipes and cooking method and may be attributed to the loss of moisture too. Similar observations are reported by **Mostafa *et al.* (2002)**; **Garcia-Arias *et al*., (2003); Gokoglu *et al*., (2004); Baohua *et al.*, (2006); Ibrahim *et al.*, (2008); Weber *et al.*, (2008); Abd-Elsalam (2013); Elsayed, (2016) and Saber (2017).**

Sensory properties of fish snacks

Effect of different cooking methods on sensory properties of fried and baked fish snacks is presented in Table (6). The color, texture, odor, taste and overall acceptability had high scores for fried snacks more baked snacks. All the snacks products during the study showed a good acceptability by panelists. The highest accepted treatment (very good) was 10% fish powder

especially fried followed by baked snacks to record 9.3 and 9.2, respectively. This is due to Millard reaction that can play a pivotal role in food acceptance. These data confirmed by statistical analysis which compared between sensory characteristics of the studied snacks depending on cooking methods showed a significant correlation between baked and fried products based on color, texture, odor and taste ($P<0.05$). Besides, shape and overall acceptability showed a non-significant value; overall acceptability did not affect by the method of cooking. Our results are in accordance with several workers; (**Rizzi, 1993**); **Ibrahim, (2004[a]) and Hakimeh *et al.*, (2010).**

Depending on the best scores, it could be observed that 10% snacks products (fried and baked snacks) have been taken the high scores by panelists compared with other treatments. Therefore, these products were selected for determination of nutritional value i.e. amino acid composition and major elements (Ca, Mg, Na and K) concentrations.

Table (5): Chemical composition of processed snacks incorporated with different levels of grass carp powder.

Constituents %	Snacks incorporated with different levels of grass carp powder									
	Control		5%		10%		15%		20%	
	Fried	Baked	Fried	Baked	Fried	Baked	Fried	Baked	Fried	Baked
Moisture	2.78±0.45	4.60±0.13	3.21±0.14	5.21±0.15	2.68±0.00	3.33±2.98	2.77±0.50	2.65±3.13	3.47±0.10	4.94±0.01

Crude protein	4.89 ±1.79	13.58±5.55	11.42±0.70	24.37±1.14	18.23±1.66	30.23±3.08	21.94±1.74	32.19±2.90	35.15±3.90	37.78 ±15.80
Fat	2.1± 0.09	0.56 ±0.43	1.9± 0.47	0.75 ±0.18	2.74 ±0.25	1.34 ±0.15	3.00±0 .08	1.93 ±0.33	3.98 ±0.42	4.60± 0.03
Ash	2.76 ±0.04	3.06 ±0.13	2.24 ±0.26	2.80 ±0.08	3.50 ±0.82	2.84 ±0.02	2.32±0 .07	2.36 ±0.27	2.44 ±0.14	3.00± 0.47
Salt	3.33 ±0.08	2.95 ±0.19	2.16 ±0.41	2.69 ±0.50	2.57 ±0.33	3.33 ±0.08	2.87±0 .08	3.04 ±0.16	1.98 ±0.44	2.54± 0.49
Carbohydrate	90.25±0. 22	82.80±0. 55	84.39±0. 23	72.08±0. 99	75.52±0. 41	40.58±1. 01	72.74± 0.46	38.51±1. 55	58.42±0. 29	30.62 ±0.43
Total energy (kcal)	399. 46	390. 56	400. 34	392. 55	399. 66	295. 3	405 .72	300. 17	410. 1	315

Table (6): Effect of cooking methods on the sensory properties of snacks incorporated with different levels of grass carp powder.

Property	Snacks incorporated with different levels of grass carp powder									
	Control		5%		10%		15%		20%	
	Fried	Baked	Fried	Baked	Fried	Baked	Fried	Baked	Fried	Baked
Shape	Fried	Backed	Fried	Backed	Fried	Backed	Fried	Backed	Fried	Backed
Texture	9.3±0.12	8.75± 0.30	8.5±0.15	8.8± 0.22	9.0± 0.13	9.3±0.09	8.44± 0.10	7.31± 0.52	8±0.20	7.5±0.15
Color	8.87± 0.33	8.4±0.49	8.2±0.32	8.2± 0.22	8.9± 0.40	8.8±0.5	8.80± 0.43	8±0.77	8.2± 0.50	7.2±0.81
Odor	8.6±0.01	8.5±0.22	8.5±12	8.4± 0.15	9.0± 0.8	8.9±0.52	8.5±0.9	7.75± 0.55	7.9± 0.18	6.28± 0.22
Taste	8.6±0.17	8.5±0.55	8.25± 0.22	8.3± 0.33	9.0± 0.40	8.75± 0.15	7.5±0.13	7.40± 0.17	7.6± 0.12	7±0.22

Accep tabilit y	8.7±0. 19	8.4±0. 15	8.5±0. 13	8.4± 0.15	9.3± 0.78	9.2±0. 55	7.4±0. 44	7.4±0. 33	7.6± 0.3	7.4±0. 25

Nutritional value of processed snacks with 10% of fish powder (the best treatment)

Amino Acids composition

Table (7) exhibits the amino acids composition of the best snacks treatment. Ten essential amino acids (EAAs) were detected in both 10% fried and baked fish snacks. Total essential amino acids recorded the highest value (4.09 g\100g) of baked fish snacks than 3.85 g\100g of fried fish snacks products. Results showed that leu, valine and lys content were more in backed snacks than fried snacks. Leu, val and lys content in both fried and baked fish snacks were (0.71 and 0.77 g\100g), (0.57 and 0.66 g/100g) and (0.52 and 0.55 g/100g), respectively. Also, values of EAAs for fried and baked snacks were 52.83 and 53.33 and BV recorded 45.86 and 46.40, respectively. Restricted amino acid was histidine (88) in fried while histidine and (cysteine + methionine) (56 and 62, respectively) were found in baked snacks.

Table (7): Essential amino acids (EAAs, mg/100g) composition of the best processed snacks products (10% fish powder) compared with FAO\WHO\UNU (1985) Pattern.

EAAs	FAO\WHO\UNU (1985) Pattern g\16g N	Fried			Baked		
		g\100g	g\16g N	AAS	g\100g	g\16g N	AAS

Threonine	0.90	0.29	1.63	181	0.33	1.13	126
Valine	1.30	0.57	3.21	247	0.61	2.09	161
Isoleucine	1.30	0.36	2.03	156	0.39	1.33	102
Leucine	1.90	0.71	4.00	211	0.77	2.64	139
Tyrosine+ Phenylalanine	1.90	0.36 0.44	4.51	237	0.39 0.48	2.98	157
Histidine	1.60	0.25	1.41	*88	0.26	0.89	*56
Lysine	1.60	0.52	2.93	183	0.55	1.88	118
Cystine + Methionine	1.70	0.15 0.20	1.97	116	0.13 0.18	1.06	*62
Total EAAs		**3.85**			**4.09**		
EAAI		**52.83**			**53.33**		
BV		**45.86**			**46.40**		

Tryptophan did not determine. EAAs: essential amino acids, AAS: amino acid score, BV: biological value, *: restricted AA.

Table (8): Non-essential Amino Acids (NEAAs, mg/100g) composition of the best snacks products.

NEAAs	10% fried snacks	10%baked snacks
Asparagine	0.78	0.77
Serine	0.36	0.45

Glutamine	2.35	2.68
Glycine	0.41	0.41
Alanine	0.46	0.50
Arginine	0.42	0.44
Proline	0.69	0.83
Total	5.47	6.08

From Table (8), seven non-essential amino acids were recorded in both fried and baked fish snacks. Total NEAAs content were 5.47 and 6.08 g\100g of fried and backed snacks products, respectively. Glutamine content was the most dominant NEAAs of the processed snacks and it recorded 2.35 and 2.68 g\100g in fried and baked fish snacks, respectively.In general, baked fish snacks 10% is more valuable than fried snacks based on amino acids content.This variation in amino acids content of fried and backed snacks products is due to cooking method conditions. Similar trends were reported by **Ibrahim (2009); Pires*et al.* (2012); Lee *et al*., (2016) and Abd-Allah (2019).**

GDR and PS/150 of fried and baked snacks contained 10% fish powder are presented in Table (9) Showed that Histidine amino acid in fried sample showed the highest GDR and the lowest PS\150% which were calculated by (403g) and (37%), respectively. Also, The baked sample showed the same trend. Data indicated that Hestidine amino acid showed the highest GDR (388g) and lowest PS\150% (39%). Based on this data we concluded that the fish proteins are rich in the essential amino acids that should be consumed to satisfy the recommended daily requirements (GDR) for adults.

Table (9): GDR and PS\150g of fried and baked snacks contained 10% fish powder.

EAAs	USRDA (1989)	Fried			Baked		
		g\100g	GDR	PS	g\100g	GDR	PS
Threonine	0.567	0.29	196	77	0.33	172	87
Valine	0.719	0.57	126	119	0.61	118	127
Isoleucine	0.819	0.36	228	66	0.39	210	71
Leucine	1.1197	0.71	158	95	0.77	145	103
Phenylalanine +Tyrosine	1.197	0.36 0.44	150	100	0.39 0.48	138	109
Histidine	1.008	0.25	403	37	0.26	388	39
Lysine	1.008	0.52	194	77	0.55	183	82
Methionine +Cysteine	1.071	0.15 0.20	33	455	0.13 0.18	29	517

Major elements

Effect of different cooking methods on major elements (Ca, Mg, Na and K) of the processed snacks (10% fish powder) is shown in Table (10).

Table (10): Minerals content (g\100g) of the best processed snacks incorporated with 10% fish powder compared with FAO\WHO\UNU (1985).

Element	FAO\WHO\UNU (1985)	Processed snacks incorporated with 10% fish powder;					
		Fried			Baked		
		mg\100g	GDR	PS\150g	mg\100g	GDR	PS\150g

Ca	**800-1000**	120	667 - 833	23-18	120	667 - 833	23-18
Mg	**350**	44	796	19	120	292	51
Na	**2400**	600	400	38	620	387	39
K	**3500**	260	1346	11	240	1458	10

Values of K and Ca recorded the highest values; 260 and 120 mg\100g for fried snacks whereas they were 240 and 120 mg\100g for backed snacks, respectively. In general, GDR and PS\150g of minerals investigated either in fried or in baked snacks were lower than the MPLs. Our results are similar with those reported by **Abd-Elsalam (2013)** and **Abd-Allah (2019).**

Conclusion

Based on the results obtained in this work, raw fish samples had high quality and safety and also processed fish snacks were highly accepted especially fried snacks compared with baked snacks products. Based on the sensory evaluation, processed fried and baked snacks contained 10% fish powder were the best treatments than others. Also, baked fish snacks (10%)were more valuable than fried fish snacks based on amino acids composition however; the fried snack recorded the highest scores of sensory evaluation. Therefore, this study recommends that grass carp fish is a good source of fish powder for fortification some snacks products as ready to eat products which preferred by many consumers.

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الملخص العربي

بالرغم من نجاح استزراع أنواع سمك المبروك في مصر، إلا أن عضلاتها تحتوى على أشواك عظمية صغيرة بجانب رائحتها الطينية ؛ الأمر الذى أدى إلى محدودية تسويقها. لذلك تم تصميم هذه الدراسة بهدف تقييم القيمة الغذائية للوجبات الخفيفة المحتوية على مستويات مختلفة (٠.٠ ، ٥ ، ١٠ ، ١٥ و ٢٠٪ وزن / وزن) من مسحوق مبروك الحشائش. وقد أظهرت النتائج المتحصل عليها مايلى: احتوى مسحوق لحم سمك مبروك الحشائش على ٩.٦٦ % رطوبة، ٦٩.٥٦ % بروتين، ١٦.٢٦% دهن، و ٣.٨٨% رماد (وزن رطب). سجلت الأحماض الأمينية الضرورية لمبروك الحشائش الخام،ومسحوق هقيم ٢٩.٨١ و ٢٧.٩٠ جم / ١٠٠ جم،بينما القيمة البيولوجية سجلت٨٣.٦٤ و٧٧.٠٧على التوالي. كما احتوي كلا من السمك الخام ومسحوقه على مستويات من الكالسيوم والماغنسيوم و الصوديوم والبوتاسيوم أقل من المستويات القصوى المسموح بها (و هى ٨٠٠ ، ٣٥٠ ، ٢٤٠٠ ، ٣٥٠٠ مجم / ١٠٠ جم عينة،على التوالي). وبناءًاعلى الاختبارات الحسية، فقد حصلت المنتجات المحتويةعلى ١٠٪ من مسحوق السمك على قيمأعلى مقارنة بالمعاملات الأخرى. وسجلت الأحماض الأمينية الضرورية للوجبات الخفيفة المقلية والمخبوزة قيما ٣.٨٥ و ٤.٠٩ مجم / ١٠٠ جم، بينما القيم البيولوجية فقد سجلت ٤٥.٨٦و ٤٦.٤٠على التوالي. سجلت المتطلبات اليومية من الأحماض الأمينية الضرورية للوجبات المقلية أعل نمن الوجبات المخبوزة، كذلك فان محتوى كلا من الماغنسيوم والصوديوم في الوجبات المقلية كان أعلى من المخبوزة فى حين كان محتوى الكالسيوم متساويا. وبناءا على النتائج المتحصل عليها ؛ فان الدراسة توصى بامكانية تعظيم الاستفادة من سمك المبروك من خلال الحصول على بودرة السمك لرفع القيمة الغذائية لبعض الوجبات الخفيفة التي يفضلها الكثير من المستهلكين.

الكلمات الافتتاحية: مبروك الحشائش، الوجبات الجاهزة، طرق الطهى، معايير الجودة.