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Original paper

Comprehensive study on catfish (*Clarias gariepinus*) burger as affected by fortification using carrot and cauliflower

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Abstract

This work was conducted to prepare catfish burgers (CFB) using some fresh vegetables such as carrot, cauliflower and mixture of them. Vegetables were partially substituted of catfish meat at different levels of (2.5, 5, 10, 15 and 20%), compared with the control sample (without vegetables). Sensory properties were done in different sessions by a trained panel and generic consumers to assess product acceptability. The best samples were 2.5, 5 and 15% of cauliflower, carrots and mixture, respectively, which were selected from organoleptic values and analyzed. The addition of vegetables to catfish burger showed better cooking properties like decrease cooking loss, increase moisture retention, cooking yield and shrinkage. Proximate chemical composition, minerals, and vitamins (A, C and E) were determined. A little decrease in moisture and protein of prepared samples was reported compared with the control, furthermore, carrot and cauliflower improved the ash, fiber, fat and minerals content of CFB, except potassium (K) in burger fortified with 5% carrot as well as Mg, Zn and Fe in burger fortified with cauliflower and mixture vegetables. Also, adding investigated samples to CFB increased vitamin A and E compared with the control, but vitamin C was not defined in all samples including the control.

Keywords Catfish burger; Carrot; Cauliflower; Vitamins; Minerals.

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Introduction

Many studies have been demonstrated on high-quality fishery fast food products such as fish fingers, fish crackers, fish balls, fish cake and fish burgers. In recent years, consumers preference has significantly directed towards fast foods consumption since there has been rapid urbanization and an increase in the working women population. The working people along with new generation students and young people are now more interested in fast foods. Catfish (*Clarias gariepinus*) is mainly fresh water fish species that are well adapted to enclosed water and resistant to handling and diseases.

It is produced in Egypt in large quantities together with the Nile fishery, especially in Nasser's lake, in the first pond in Wadi El-Rayan Lake and together with fish farming and other freshwater lakes. Catfish is considered a good nutritionally food because it contains vitamins, minerals, protein and unsaturated fatty acids (Nelson et al., 2016). However, many consumers do not prefer it in the fresh form because of its shape is undesirable for the consumer. One of the most important mince based products is the catfish burgers (CFB). CFB is a tasty and popular item in the fast foods industry.

Vegetables are vital among food crops because they provide humans with the necessary amounts of several vitamins and minerals. It is considered a rich source of folic acid, carotene, riboflavin, ascorbic acid and minerals (Van Duyn et al., 2000; Woodside et al., 2013 and Amao, 2018). Adding fresh vegetables to animal and fish meats is useful in providing them with some vitamins, minerals and dietary fiber, and reduces the fat content in them, in addition to being economically beneficial for the high prices of meat and fish.

Carrot (*Daucus carota*) is one of the important widely consumed root vegetables, a good source of beta carotene, iron, pectin, dietary fiber, minerals etc. It is known as a source of phenolic compounds and carotenoids, which inhibits lipid oxidation (Soria et al., 2009). Cauliflower (*Brassica oleracea l. var. botrytis*) has been mentioned as a vital source of vitamin B6, dietary fiber, folic acid, vitamin B5 and minerals and contain many bioactive compounds, especially organo sulphur phytochemicals possessing anticarcinogenic activity and other phytochemicals, which are known to have antioxidants activity **(**Hegazy and Ammar, 2019). Antioxidants included in these vegetables help the body against oxidative stress. Among Brassica vegetables, kale, broccoli and Brussels sprouts are satisfied sources of antioxidants, carotenoids and vitamins (Podsędek., 2007). They may protect humans from chronic diseases, such as cancer and cardiovascular disease.

The objectives of this work were to evaluate the effect of adding various levels of (cauliflower, carrot and mix of them) as natural sources of antioxidants and dietary fiber on chemical composition, minerals content, vitamins, cooking properties and sensory characteristics of CFB.

Materials and methods

Materials

Fresh vegetables, such as carrot (carr) (*Daucus carota*), cauliflower (cauf) (*Brassica oleracea L. var.* botrytis), and food additives including rusk powder, sugar, salt, garlic, onion powder and spices mixture (black pepper, coriander, cumin, cardamon, red pepper, cubeb and clove) were bought from the local market in Kafr El-Sheikh, Egypt .

Fresh catfish (*Clarias gariepinus*) was bought from the local fish market in Kafr El-Sheikh, Egypt.

Chemicals and reagents (analytical grade) were purchased from El-Gomhoria Company for chemicals and drug, Tanta city, Egypt.

Proximate chemical composition of vegetables, minced catfish and CFB

The proximate chemical composition of vegetables, minced catfish and catfish burgers (CFB) was preformed depending on AOAC. (2011).

Total carbohydrate was estimated by difference as follows: Carbohydrates (%) = 100 - (crude protein + crude fat + ash).

The available carbohydrates were calculated by difference according to the sequence equation: Available Carbohydrates (%) = 100 - (crude fibers + ash + crude protein + crude fat).

Catfish burger preparation

All black membranes, viscera, blood and swim bladder were removed from catfish samples after they were beheaded, gutted and rinsed with tap water. Pure fillets were produced by removing skin and bones. Flesh parts (about 47%) were sliced into fillets. The fillets were dipped in 1.0% chilled brine solution contained 0.5% acetic acid for 5 min to clean and remove any fishy odor, and fillets were drained. A kitchen meat mincer with a 3 mm diameter plate was used to mince the drained fillets.

Minced catfish was blended with various additives that are contained in (Table 1) (Al-Bulushi et al., 2005). Some modifications were done by replacing the catfish meat with five different levels (2.5, 5,10,15 and 20 %) of fresh carrot, cauliflower and the mix of carrot and cauliflower in the same proportions (1:1 w/w) of the previous five mixings, but equally between cauliflower and carrot.

Every prepared CFB formula was separated into equal parts separately (50 g weight), placed between two sheets of

Table 1. Substitution levels of the vegetables (Carrot, cauliflower and mixture of them) used in the preparation of catfish burger.

Substitution Level of Minced fish (%)	Carrot, cauliflower or mixture of them (g)	Minced catfish (g)
0	-	75.00
2.5	1.75	73.25
5	3.50	71.50
10	7.50	67.50
15	11.25	63.75
20	15.00	60.00

Table 2. Recipes of CFB.

%	Ingredients
75.0	Fish mince
9.0	Sunflower oil
8.0	Starch
2.0	Salt
0.40	Sod. Bicarbonate
2.50	Onion
0.08	Garlic
0.30	Polyphosphate
2.00	Spices mix

*Spices mixture composed of 32% black pepper, 22.5% coriander, 15% cumin, 10% cardamom, 9% red pepper, 7.5% cubeb and 4% clove.

transparent casings and gently pressed to reach the desired burger size. (8.5 cm and 1 cm of diameter and thickness, resepctively) using forming machine (manually operated) (NOAW-Affetacrane, Italy). CFB cooked by frying with a little oil at 170 Cº for 10 min (5 min per side).

Sensory properties of burgers

Sensory of properties prepared cooked CFB fortified by various levels (2.5, 5, 10, 15, and 20%) of Carrot, Cauliflower, and mixture of them were evaluated as described by Crehan et al., (2007).

Determination of minerals content

Minerals content of fresh vegetables and produced burgers were measured by using atomic absorption spectrophotometer (BB model Avanta Σ mar GBC, Australia**)** as described in the AOAC methods (AOAC 2008).

Determination of Vitamins

The method of AOAC. (2008) was used to determine vitamin A content of fresh vegetables, and CFB.

Vitamin C was analyzed for used fresh vegetables and produced CFB using HPLC reverse phase coupled with a Diode Array detector (DAD). A wight of 5 g from sample was weighted into a 0.1 L flask. In 20 ml of Tris (2-carboxyethyle)-phosphine hydrochloride acid solution the sample was dissolved and acidified. The solution was diluted to 100 mL with 1 % TCA solution and was shaken. The mixture was filtered by 0.45 mm membrane filter and put into HPLC vial for VC determination (Brause et al., 2003). To analyse Vitamin E, HPLC (Diode Array and Fluorescent detector) was used. The sample (5 g) was put into a flask (250 ml). The pyrogallol acid was added, after that, 40 ml of 95% ethanol was added. Saponification process was done by 50% KOH (10 mL). 10 mL of glacial acetic acid was added to neutralize the KOH (Deveries and Silvera, 2002). Vitamin E was extracted into a mixture of tetrahydrofuran (THF) and ethanol (1:1) solution. The extract was filtered using a 0.45 1m membrane filter into a HPLC vial for analysis.

Cooking properties of different fish burgers

Cooking loss

The cooking loss of the prepared burgers was calculated using the formula of Essa and Elsebaie (2018). As following:

$$\text{\% Cooking loss} = \frac{\text{Weight of raw burger (g)} - \text{Weight of cooked burger (g)}}{\text{Weight of raw burger (g)}} \times 100$$

Cooking yield and moisture retentions

Cooking yield fat, moisture retentions were measured as reported by Aleson et al., (2005) according to the following equations.

% Cooking yield = Weight of raw burger (g)/ Weight of cooked burger (g) × 100

% Moisture retention = moisture of raw burger /moisture of cooked burger × 100

Shrinkage and the thickness decrease measurements

Shrinkage and thickness increase were measured according to equations described by Berry, (1992) as follows:

$$\% \text{ Shrinkage} = \frac{\text{Diameter of uncooked sample (cm)} - \text{Diameter of cooked sample (cm)}}{\text{Diameter of uncooked sample (cm)}} \times 100$$

$$\% \text{ Thickness increase} = \frac{\text{Thickness of raw sample (cm)} - \text{Thickness of cooked sample (cm)}}{\text{Thickness of raw sample (cm)}} \times 100$$

Statistical analysis

All results were studied to analysis of variance by one-way ANOVA by Sigma Stat (v.3.5. Systat Software Inc.). The significant variance between the means of treatments was estimated at the $P \leq 0.05$ level by Duncan's new multiple range test (Steel and Torrie, 1981).

Results and discussions

Chemical composition of fresh carrot cauliflower and minced catfish

Chemical composition of fresh carrot, cauliflower and minced catfish was shown in Table (3). The results reported that carrot contained 88.21, 5.52, 0.86, 4.57, 7.00 and 82.48 % for moisture, crude protein, fat, ash, crude fibers and available carbohydrates on (dry weight), respectively. These values are nearly with slight differences with those obtained by Karmoker et al., (2011) and Sultana et al., (2014).

Also, chemical composition in cauliflower were 91.54, 23.21, 7.75, 8.36, 12.06, 8.46 and 36.62% for moisture, crude protein, fat, ash, crude fibers and available carbohydrates on (dry weight), respectively. These results were very close to that found by Aamer and Emara, (2016) and Baloch et al., (2015).

Additionally, the results showed that the chemical composition of fresh minced catfish were 62.23, 5.01, 23.15 and 9.61 for moisture, protein, fat and carbohydrates, respectively. These results were agreement with that found by Dale (2001), who found that the components of proximate composition in five samples to be quite consistent. The proximate composition ranged from 7.0 to 4.9 % moisture, crude protein ranged from 59.2 to 61.9, fat 8.2-9.3 %, ash 22.8-24.1 % and crude fibers were 0.3-0.5 %.

Minerals and vitamins content of fresh carrot and cauliflower

Results in Table (4) showed that fresh carrot and cauliflower have high content of all minerals. The results revealed that carrot contained 929.80, 122.80, 7.19, 4.03, 17.85, 0.33, 6.09 and 109.41 mg/100g, for Na, Ca, Mg, Zn, Fe, K, Cu and P, respectively. These results were higher than the results noticed by Butnariu and Butu, (2015). Cauliflower contained 313.85, 125.55, 7.01, 3.32, 3.91, 304, 3.91 and 456.04 mg/100g for Na, Ca, Mg, Zn, Fe, K, Cu and P respectively. These results are nearly to the result obtained by Abou-Taleb (2015) and Aamer and Emara, (2016).

Moreover, carrot and cauliflower are rich in vitamins content, carrot had 15264.13, 689.95, 40.65, while cauliflower contains 2061.69, 1196.87, 26.01 IU, and mg/100g for vitamins A, C, and E, respectively. These results are higher than those obtained by Butnariu and Butu, (2015).

Sensory properties of CFB

Data presented in Fig. 1, showed the sensory properties of cooked burger samples prepared with different levels of vegetables (carrot, cauliflower and mixture of them). Results indicated that there were no significant differences at $p \leq 0.05$ for color, taste, odor, texture, tenderness, Juiciness and overall acceptability between prepared burgers fortified by vegetables and the control burger. Therefore, from these results supplemented burger with 5% carrot, 2.5% cauliflower and 15% mixture of them could be recommended to be produced as burger with good quality acceptable sensory quality attributes.

Chemical composition of cooked CFB

Moisture, protein, fat, ash and total carbohydrates contents of the cooked control and fortified CFB with different levels of carrot, cauliflower, and mixture of them (5, 2.5 and 15 %) were shown in Table (5). The results showed that the

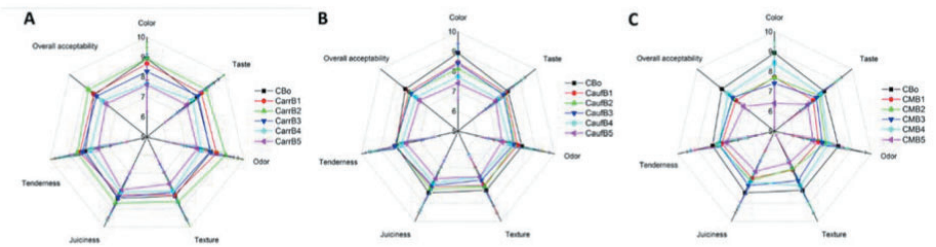

Figure 1. Hedonic sensory properties of cooked catfish burgers fortified by different levels of (A) carrot, (B) cauliflower and (C) mixture of them.

control of cooked burger (CB0) contained 47.06% moisture, 55.27 % protein, 28.14 % fat, 7.58 % ash and 9.01 % carbohydrates. From the tabulated data, it could be noticed that moisture content of cooked CFB decreased by adding vegetables. The decrease in moisture is due to the addition of fresh vegetables. These observation is in the line with Kassem and Emara, (2010), who stated that cooking of the burger patties reduced that there was about 5-7% less moisture, and Modi et al.(2004) reported that frying resulted in about 10% less moisture. The protein contents of cooked CFB had a trend like that of moisture. The decrease of protein contents in cooked CFB may be associated to the decrease in amount of catfish meat, and this is good to have burger rich in vegetarian protein. On the other hand, adding vegetables caused significantly increases in fat, fiber, and ash content in all samples including control. Increasing fat content may be related to the increase of fiber content by adding high ratio of vegetables that leads to absorb more oil when frying, or increasing fat content may be related to the oil used in frying process. A similar observation has been reported by (Dzudie et al.,2002). for beef patties prepared with common bean flour and in buffalo meat patties prepared using different legume flours (Modi et al.,2004). Increase both crude fiber and ash in this vegetable CFB due to the fact that vegetables are a rich source of crude fiber and minerals, and this is consistent with Aamer and Emara, (2016). Addition of dehydrated cauliflower powder with different levels to fish burger treatments led to increase in both of crude fibers and ash. Also, Kassem and Emara, (2010), who reported that 1% high ash depending on the formulation used in production of burger patties. Modi et al. (2004) reported that 0.4–1.2% higher ash content irrespective of binders.

Minerals content of CFB

Table (6) showed that adding fresh carrots at 5% in catfish burger CarrB2 caused increment in sodium (1395.0 to1434.4 mg/100g), calcium (106.25 to 334.3 mg/100g), magnesium (95.625 to 120.0 mg/100g), Zinc (16.125 to 20.19 mg/100g), iron (7.0 to 7.15 mg/100g), and phosphorus (55.23 to 82.58 mg/100g) than control prepared without adding vegetables.

However, potassium content was decreased with little amount with adding fresh carrot from (1240.0 to1238.75 mg/100g). In catfish burger fortified with 2.5 % cauliflower CaufB1 there was also an excess of sodium, calcium and phosphorous, with a deficiency in magnesium, zinc, iron and potassium. As for the catfish burger fortified with a mixture of carrot and cauliflower CMB4 at a rate of 15%, with a ratio of 1: 1, an increase in the elements of sodium, calcium, potassium and phosphorus was observed with a decrease in the elements of magnesium, zinc and iron. As for the copper content of the CFB, it was absent in all samples, including the control sample. High level of Na content in each fish burger treatments might be due to salt addition with 2% during manufacturing process. However, the studied fish burger still considered as a good source for minerals needed for human (Aamer and Emara, 2016).

Vitamins content of CFB

Table (7) illustrated vitamins content of CFB with adding vegetables comparing with control sample prepared from catfish meat only. CFB with 5% fresh carrot (CarrB2) was high in vitamin A content as the ratio increased from 694.81 to 1506.57 comparing with the control (CB0). In CFB fortified with 2.5% cauliflower (CaufB1) was also increased in it's content of vitamin A to 725.354, but with a smaller percentage than CFB fortified with carrot due to the higher vitamin A content of carrot than cauliflower as shown in Table (1). As for the sample containing 15% mixture of carrot and cauliflower in a 1:1 ratio, it increased in content of vitamin A, but by average rate in the previous samples. The vitamin E content of CFB had a trend like that of vitamin A. These results are in the same trend with the findings Sule et al.(2019). Incorporation of carrot powder into pasta resulted increase in beta carotene a pro-vitamin A and vitamin E. As beta carotene not detected in pasta from 100% wheat flour. Highest value of 6.13mg/100g was obtained for 30% carrot enriched pasta. Vitamin E increased from (0.68 to 1.54mg/100g). Also, these results were in conformity with those reported by Bell et al. (2006), and James & Nwabueze (2013).

Cooking properties of burgers

The cooking properties of fortified and non-fortified burgers are presented in Fig. 2A. The results showed that, the addition of vegetables to burgers affected cooking characteristics of the burgers. Cooking yield was increased in burgers with an increase in vegetables level compared to control. The cooking yield was increased from 53.66% for CB0 to 59, 52, 61.34 and 58.75 % for CarrB2, CaufB1 and CMB4 burgers fortified with 5, 2.5 and 15 % carrot, cauliflower and mixture of them respectively. These results are in agreement with (Alesón-Carbonell et al., 2005 ; Naveena et al., 2006; Besbes et al., 2008; Alakali et al., 2010 and Al-Juhaimi et al., 2016) , who recorded similar results for the cooking yield in patties formulated with lemon albedo, finger millet flour, pea and wheat fiber concentrate, bambara groundnut seed flour and moringa seed flour, respectively. Also, El Zeny et al. (2019) found that cooking yield was increased in burgers with an increase in the chicory roots powder adding level compared to control. They explained this observation by the ability of these materials to the fat and water retention capacity and capability to keep moisture and fat in the patty matrix. As apparent in

Table 3. Chemical composition of fresh carrot, cauliflower and minced catfish (dry weight).

Materials	Moisture	Protein	Fat	Ash	Fiber	Dry matter	Total Carbohydrate	Available Carbohydrates
Fresh carrot	88.21±1.56	5.27± 0.75	0.68±0.08	4.57± 0.43	7.00±0.187	11.79±1.56	89.48±1.04	82.48±1.35
Fresh cauliflower	91.54± .54	23.21±0.14	7.75±0.91	8.36±0.55	12.06±1.56	8.46±0.68	48.62±1.31	36.62±1.36
Minced catfish	9.17±0.11	62.23±0.25	5.01±1.55	23.15±1.41	0.43±0.36	90.83±1.15	9.61±1.03	9.18±0.77

Data are represented as mean ± standard deviation (n=3). Values with the same superscript in the same column are not significant.

Table 4. Minerals (mg /100 g) and vitamins (IU and mg /100 g) content of fresh carrot and cauliflower.

vitamins (IU and mg /100 g)			Minerals (mg /100 g)								
Vitamin (E)	Vitamin (C)	Vitamin (A)	P	Cu	K	Fe	Zn	Mg	Ca	Na	Vegetable Sample
40.65	689.95	15264.13	109.41	6.09	.330	17.85	4.03	7.19	122.80	929.80	Fresh carrot
26.01	1196.87	2061.69	456.042	3.91	304	3.91	3.32	7.01	125.55	313.85	Fresh cauliflower

Table 5. Chemical composition of cooked burger fortified with different levels of carrot, cauliflower and mixture of carrot and cauliflower (dry weight).

Available Carbohydrates	Total Carbohydrate	Dry matter	Fiber	Ash	Fat	Protein	Moisture	Formulations
6.93±0.67	9.01±0.11	52.94±1.31	2.08±0.25	7.58±0.86	28.14±1.77	55.27±0.76	47.06±1.33	**CB0 (control)**
15.97±2.36	18.08±1.04	58.82±2.93	2.11±0.24	8.31±1.36	28.16±0.85	45.45±1.72	41.18±3.62	**CarrB2**
13.52±1.10	15.93±1.51	57.14±0.78	2.41±0.88	8.81±0.83	28.96±2.13	46.30±1.06	42.86±0.71	**CaufB1**
7.35±0.28	10.05±3.21	45.05±0.52	2.70±0.15	10.35±1.39	31.35±0.66	47.8±4.05	45.45±1.3	**CMB4**

Where: CB0, cooked cat fish burger (control); CarrB2, cooked cat fish burger fortified with 5 % carrot; CaufB1, cooked burger fortified with 2.5 % cauliflower and CMB4; cooked cat fish burger fortified with 15% mixture carrot and cauliflower. Data are represented as mean ± standard deviation (n=3).

Table 6. Minerals content of cooked catfish burgers fortified with different levels of carrot, cauliflower and mixture of carrot and cauliflower (mg/100g).

	Minerals (mg/100g)							
	Na	Ca	Mg	Zn	Fe	K	Cu	P
	Formulations							
CB0 (control)	1395.0	106.25	95.625	16.125	7.0	1240.0	Nd	55.23
CarrB2	1434.4	334.3	120.0	20.19	7.15	1238.75	Nd	82.58
CaufB1	1481.8	119.38	75.625	14.06	6.6	1231.25	Nd	106.78
CMB4	1417.0	116.88	71.875	14.75	5.950	1263.75	Nd	77.32

Where: CB0, cooked cat fish burger (control); CarrB2, cooked cat fish burger fortified with 5 % carrot; CaufB1, cooked burger fortified with 2.5 % cauliflower and CMB4; cooked cat fish burger fortified with 15 % mixture carrot and cauliflower.

Table 7 Vitamins content of cooked cat fish burger fortified with different levels of carrot, cauliflower and mixture carrot and cauliflower.

Formulations	Vitamin A (IU/100 g)	Vitamin C (mg/100 g)	Vitamin E (mg/100 g)
CB0 (control)	694.81	ND	23.916
CarrB2	1506.57	ND	30.28
CaufB1	725.354	ND	24.004
CMB4	850.90	ND	24.970

Where: CB0, cooked cat fish burger (control); CarrB2, cooked cat fish burger fortified with 5 % carrot; CaufB1, cooked burger fortified with 2.5% cauliflower and CMB4; cooked cat fish burger fortified with 15 % mixture carrot and cauliflower.

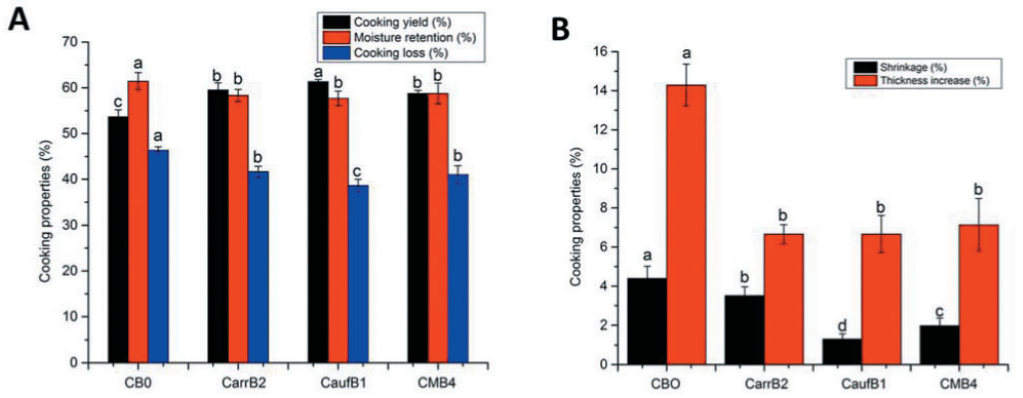

Figure 2. Cooking properties (%) of catfish burgers fortified with different levels of carrot, cauliflower and mixture of carrot and cauliflower (A) cooking yield, moisture retention and cooking loss, (B) shrinkage and thickness increase. Where: CB0, cooked cat fish burger (control); CarrB2, cooked cat fish burger fortified with 5 % carrot; CaufB1, cooked burger fortified with 2.5 % cauliflower and CMB4; cooked cat fish burger fortified with 15 % mixture carrot and cauliflower. Data are represented as mean ± standard deviation (n=3). Values with the same superscript in the same column are not significant.

Fig. 2A, the addition of fresh vegetables lessen the moisture retention of cooked burgers, where they were decreased with the increase of fresh vegetables level comparing to control sample. The decrease in moisture retention of the burgers may be caused to the decreases in the water absorption capacity of protein. Fig. 2B showed that the addition of fresh carrot, cauliflower and mixture of them at 5, 2.5, 15 %, respectively, was reduced the cooking loss compared to control CFB sample. The percentage of shrinkage was decreased with the fresh vegetables level and differed with the varying levels of fresh vegetables in burgers Fig. 2B. The control burger showed the highest shrinkage percent, 4.39 %, compared to 3.51, 1.3 and 1.97 % for CarrB2, CaufB1 and CMB4 burgers, respectively. The denaturation of protein catfish, water evaporation and drainage of melted fat and juices during cooking process are related to the shrinkage (Alakali et al.,2010; Al-Juhaimi et al., 2016).

As in the case of cooking loss and reduction in diameter, the highest thickness increase was observed in the control beef burgers (14.29 %). The thickness increase decreased with increasing the amount of fresh vegetables added, where the burger fortified with 15 % mixture of fresh vegetables had the lowest thickness increase followed by fortified with 2.5 and 5 % cauliflower and carrot. These results are in the line with Selani et al. (2015), and Heydari, et al.(2016). This action could be attributed to the binding and the stabilizing properties of fresh vegetables.

Conclusion

Addition of vegetables to CFB showed improvement in the cooking properties such as increase cooking yield, decrease cooking loss, moisture retention and shrinkage. Proximate chemical composition, minerals, and vitamins (A, C and E) were determined to evaluate the nutritional value of prepared burger. It was observed that there are a little decrease in moisture and protein of prepared samples than control, further more carrot and cauliflower improved the ash, fiber, fat and minerals content of,CFB except potassium (K) in burger fortified with 5% carrot as well as Mg, Zn and Fe in burger fortified with cauliflower and mixture vegetables. Also, adding vegetables to CFB increased vitamin A and E than control, but vitamin C was absent in all samples including the control.

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Conflict of interest

The authors have declared that there is no conflict of interest.

Highlights

- Carrot and cauliflower were added in a fresh form to the catfish burger.
- The cooking properties of fortified and non-fortified cooked catfish burgers were determined.
- The chemical composition, minerals and vitamins content of cooked catfish burger were measured.

- The sensory properties of prepared catfish burger fortified by vegetables and the control catfish burger were evaluated.

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