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QUALITY ATTRIBUTES OF COMMON CARP FISH BALLS SUPPLEMENTED WITH SOME LEGUME FLOURS

BY

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ABSTRACT

Fish balls were extended with germinated chickpea and lentil or burghul at levels of 15 and 30%. Proximate chemical composition as well as the quality characteristics of prepared fish balls such as cooking properties, hardness, water holding capacity, plasticity and sensory attributes were determined. Common carp fish balls extended with 30% of germinated chickpea or lentil had higher water holding capacity and plasticity values than other treatments. Shrinkage was ranged from 4.39 to 7.38% in fried fish balls extended with different substitution levels of germinated chickpea and lentil or burghul. Both cooking loss and cooking yield were significantly ($p<0.01$) affected by different extenders materials. The addition of aforementioned extenders improved the hardness value of fish balls. The lower value was achieved by 30% germinated lentil followed by 30% germinated chickpea and finally 15% germinated lentil. As the substitution level increased there were significantly ($p<0.01$) enhancements in all sensory attributes of prepared fish balls especially when fish balls prepared by substituting fish meat by 30% of germinated chickpea followed 30% of germinated lentil.

Key words: Carp fish – extenders- fish balls –legumes – quality attributes – physical properties – eating quality – sensory evaluation

INTRODUCTION

In Egypt, one of the most important fresh water fish is the carp fish. The carp fish were from different Egyptian sources, which included various lakes, fresh waters and fish farms. Their advantages are due to lively faster of their growth and easily their breeding (Ibrahim, 2004). In recent years, the preference of the consumers was direct towards the fast food consumption since there has been a rapid urbanization and an increase in working women population. Minced fish flesh offers great opportunity for the preparation of new fishery products tailored to the requirements of a wide range of consumer interests. There have been many studies about the production and quality stability of the fishery fast food products including fish cake, fish balls and fish burgers (Taskaya, *et al.*, 2003).

Varlik *et al.* (2000), determined the shelf – life of chilled anchovy's balls. Results showed excellent quality of anchovy's balls for 60 days, fair quality for 105 days and were marketable until the 120 th day. Erosy and Yilmaz (2003), investigated the chemical components and quality changes in Africa catfish mince balls, vacuum and non vacuum packaged in polyethylene materials during 6 months of storage at – 18 C°. Akkus *et al.* (2004), revealed that the shelf – life of fish balls prepared using raw and boiled fish during cold storage at 4 C° ±1 was 9 days depending on its quality criteria.

Initial attempts develop that product (fish ball) resulted in poor textural attributes. This problem could dissolve by adding sugar and salt at 1 % with 30 % hydrated textural vegetable protein as reported by Martin, (1976). Vegetable proteins are an economic versatile substitute for animal proteins traditionally used as functional ingredients in food formulation. The addition of vegetable proteins improves the keeping quality and stability of the meat sausage (Hegazy, 1981). Motohiro and Numakura (1978) found that various fish gel products from frozen minced fish meat with mixture of 0-10 % of soy protein isolated, had few differences between control and tested boiled samples depending on organollepticall characteristics. Mostafa *et al.* (2002) showed that substitution of catfish and albacore tuna meat in fish pattie with levels of 0, 5, 10, 15 and 20 % of soybean flour were reduced the production coasts and improved the quality attributes of the product. In recent years legumes have been investigated regarding their potential use in developing functional foods. Legumes provide energy, dietary fiber, proteins, minerals and vitamins required for human health. However it considered as poor man's meat. Inclusion of legumes in the daily diet has many physiological effects in controlling and preventing various metabolic diseases such as mellitus, coronary heart disease and colon cancer (Tharanathan & Mahadevamma, 2003).

Therefore, the main objective of this work was carried out to produce fish balls from low price fish (common carp fish) with the addition of vegetable flours such as chickpea, lentil and burghul at different ratios to enhance the quality of that product.

MATERIALS AND METHODS

Materials:

Common carp (*Cyprinus carpio.)* samples were obtained from EL-Sarwo farm, EL- Dakahlia governorate, National Institute of Oceanpgraphy and Fisheries, at 2005 season. The fish samples were put in ice box and transferred to Food Science Depart., Fac. of Agric., Ain Shams University for further technological treatments and analysis.

Different dry legumes, chickpea (*Cicer avietinum)* and lentil (*Lens esculenta.)* samples. and burghul were obtained from local market.

Methods:

Preparation of germinated legume flours:

Samples of chickpea and lentil were washed, soaked and then germinated at a perforated tray covered with filter paper where legume seeds

were put on one layer and covered by another layer of filter paper, followed by the addition of tap water on the upper filter paper. Germination was carried out at the laboratory room temperature (30 ± 5°C) for 4 days. The sprout seeds were dried at 40°C for 10 hours, then finely ground and packaged for further investigation.

Preparation of fish balls:

Fish balls were prepared according to the method described by KÖse *et al.* (2001). The fish samples were washed, hand deboned, manually cut to small pieces and washed again to get rid of any blood traces, and then drained for a few minutes. Fish meat was ground through a 0.64 cm plate using a laboratory Universal Kitchen machine (Varimix – Spomoasy, Poland), then the minced fish meat was mixed with different germinated legume flours and burghul to produce fish balls having different levels of substitution (0, 15 and 30 %). Other additives such as vegetable oil, starch and spices were incorporated in all fish ball batches as indicated in Table (1). Mixing was carried out by the mixing device of the Varimix Kitchen machine. Finally, around 20-25g of the mixture was shaped into fish ball. Fish ball samples were placed in polyethylene bags and kept frozen (at -18° C) until analysis and cooking.

Table (1): Recipes used in the preparation of fish balls containing different levels of germinated legume flours and burghul

Ingredients	% Substitution levels		
	Control	15	30
Common carp minced meat	75.0	63.75	52.5
Germinated chickpea flour (GCF)	-	11.25	22.5
Germinated lentil flour (GLF)	-	11.25	22.5
Burghul	-	11.25	22.5
Vegetable oil	9.0	9.0	9.0
Starch	8.0	8.0	8.0
Sodium chloride	2.3	2.3	2.3
Sodium bicarbonate	0.4	0.4	0.4
Polyphosphate	0.3	0.3	0.3
Onion	2.5	2.5	2.5
Garlic	0.5	0.5	0.5
Spices mixture*	2.0	2.0	2.0

Spices mixture* black pepper (42 %), cumin (23 %), all spices (18 %), clove (2 %), coriander (5 %), cubeb (2 %), cardamom (2 %), red pepper (1 %) and ginger (5 %).

Cooking method:

Frying was carried out in an electrical fryer pan (Moulinex brand) using sunflower oil at 150°C for 5 min, immediately removed and drained to remove excess oil.

Analytical methods:

Moisture, crude protein, fat and ash contents were determined according to the A.O.A.C. (2000).

Percentages of cooking loss, cooking yield and shrinkage were estimated according to Roland *et al.* (1981) where:

$$\% \text{ Cooking loss} = \frac{\text{Raw weight - Cooked weight}}{\text{Raw weight}} \times 100$$

$$\% \text{ Cooking yield} = \frac{\text{Cooked weight}}{\text{Raw weight}} \times 100$$

$$\% \text{ Shrinkage} = \frac{\text{Raw diameter – Cooked diameter}}{\text{Raw diameter}} \times 100$$

Hardness of fish ball samples was determined according to Sanderson *et al.* (1988), by measuring Tension Compression (TC^2). An anvil of 1 mm diameter was used to penetrate the sample at a crosshead speed of 250 mm/min. The results were calculated as g/cm^2.

Water holding capacity (WHC) and plasticity were determined according to the method described by Volovinskaia and Merkoolora (1958). Results were presented in cm^2 per 0.3 g sample.

Sensory attributes were evaluated by a panel group of ten members, randomly selected from the staff members of the Dep.of Food Sci., Fac. of Agric., Ain Shams Univ. Panelists were asked to evaluate appearance, color, odor, taste, tenderness, juiciness and overall acceptability according to 9- point hedonic scale (Larmond, 1974).

The statistical analysis system (SAS 1996) was used to carry out mean values, standard error in addition to an over all analysis of variance (ANOVA) and least significant differences (LSD) at 0.01.

RESULTS AND DISCUSSIONS

Chemical composition of fresh common carp fish and extended materials:

Table (2) shows chemical composition of fresh common carp fish. Fish samples contained 77.55 % moisture, 78.17 % protein, 14.30 % fat, 5.03 % ash and 2.5 % free nitrogen extract on dry basis. These results are in accordance with those reported by Shaltout, (1989). The moisture contents were 12.33 %, 9.55 % and 15.25 % for burghul, chickpea and lentil, respectively. The protein content was about 21 % and 23 % in lentil and chickpea, respectively. Fat content was 5.42 % in chickpea and it was higher than that of lentil and burghul, i.e. it was 1.08 % and 0.92 % for lentil and burghul flours, respectively. Ash content was around 1-3 % in different extender materials. Burghul had the highest content of free nitrogen extract; it was 89.51 % whereas, it was in chickpea and lentil 69.32 % and 74.81 %, respectively. These results are in accordance with those of Nabila, (1983).

Chemical composition of raw common carp fish balls:

Data in Table (3) show the chemical composition of raw common carp fish balls samples substituted with 15 % and 30 % ratios of different extender materials (burghul or germinated chickpea and lentil flours). It could be observed

that moisture content was ranged between 61.89 – 63.71 % and 58.96 – 60.89 % in common carp balls contained 15 and 30 % levels of different investigated extender materials, respectively. While it was 65.21 % in control sample. Generally it was noticed that as the level of legume flours increased the protein, fat and ash contents decreased while carbohydrate increased. The highest content of protein, fat and ash were observed in control sample 76.83 %, 12.77 and 6.61 % on dry basis, respectively. This means that such extender materials are considered as carbohydrate non meat protein sources as mentioned by Ibrahim, (2004).

Table (2): Chemical composition of fresh common carp fish and burgul and different legume flours on dry basis ± SE.

Sample	Moisture %	Protein %	Fat %	Ash %	FNE *
Common carp fish	77.55 ± 0.11	78.17 ± 0.03	14.30 ± 0.30	5.03 ± 0.12	2.50 ± 0.01
Burghul	12.33 ± 0.01	8.65 ± 0.10	0.92 ± 0.10	1.12 ± 0.02	89.51 ± 0.11
Chickpea	9.55 ± 0.03	22.65 ± 0.02	5.42 ± 0.02	2.61 ± 0.11	69.32 ± 0.11
Lentil	15.25 ± 0.02	20.85 ± 0.02	1.08 ± 0.03	3.25 ± 0.30	74.81 ± 0.21

FNE *: free nitrogen extract calculated by difference.
SE: Standard error

Table (3): Chemical composition of raw common carp fish balls as affected by different substitution levels of legume flours on dry basis ± SE

Treatments	Moisture %	Protein %	Fat %	Ash %	FNE *
Control	65.21 ± 0.21	76.83 ± 0.22	12.77 ± 0.31	6.61 ± 0.03	3.69 ± 0.20
Burghul 15 %	63.71 ± 0.12	67.08 ± 0.01	11.32 ± 0.04	4.52 ± 0.03	17.08 ± 0.01
Burghul 30 %	60.89 ± 0.11	56.72 ± 0.21	9.52 ± 0.13	3.92 ± 0.20	29.84 ± 0.12
Chickpea 15 %	62.57 ± 0.30	68.67 ± 0.13	12.19 ± 0.01	5.33 ± 0.02	13.81 ± 0.22
Chickpea 30 %	59.38 ± 0.21	62.29 ± 0.03	11.33 ± 0.02	5.10 ± 0.10	21.28 ± 0.11
Lentil 15 %	61.89 ± 0.11	70.08 ± 0.03	11.83 ± 0.30	5.15 ± 0.02	12.94 ± 0.12
Lentil 30 %	58.96 ± 0.01	64.46 ± 0.02	10.62 ± 0.01	4.21 ± 0.12	20.55 ± 0.11

FNE *: free nitrogen extract calculated by difference.
SE: Standard error

Physical properties of raw common carp fish balls:

Figs (1 & 2) show the water holding capacity (WHC) and plasticity values as cm^2/0.3 g of raw common carp fish balls with different ratios of substituting germinated legume flours and burghul. From these Figs, it could be found that there was an enhancement in both WHC and plasticity in samples contained different extender flours than control sample. As the substitution level of the same legume flour was higher, the values of WHC were lesser, while, the opposite trend was appeared in values of plasticity. Common carp fish balls with 30 % of germinated lentil or chickpea flours had higher WHC and plasticity values than other treatments. These results agree with those of Pietrasik and Shand, (2003).

Table (4) shows physical properties of processed carp treatments. Shrinkage was ranged between 4.39 % - 7.38 % in fried treatments with different substitution levels while, it was 12.74 % in fried control sample. This is due to the denaturation of the fish proteins and loss of water and fat which contribute to the shrinkage process. This means that parameter was significantly ($p<0.01$) affected by such additions. Both cooking loss and cooking yield were significantly ($p<0.01$) affected, it was 28.09 % and 71.91 % in fried control sample, respectively. This might be attributed to the excessive fat separation and water release during cooking. Meanwhile, it was around 9.593 % - 12.58 % and 87.42 % - 90.41 % in fried tested treatments, respectively. This means that addition of different extender materials improved the water binding ability in prepared fish ball samples. These results are in agreement with those reported by Ibrahim, (2004). Samples contained lentil flour at 30 % resulted significant ($p<0.01$) great in cooking yield and significant ($p<0.01$) low cooking loss values. This results in accordance with Serdaroglu *et al.* (2005).

Table (4): Physical characteristics (shrinkage, cooking loss,cooking yield and hardness) of fried common carp fish balls as affected by substitution with burghul, chickpea and lentil flours at 15 % and 30 %.

Treatments	Shrinkage %	Cooking loss %	Cooking yield %	Hardness value as g / cm^2
Control	12.74^{A}	28.09^{A}	71.91^{C}	613.33^{A}
Burghul 15 %	7.38^{B}	12.58^{B}	87.42^{B}	590.00^{A}
Burghul 30 %	5.44^{BCD}	10.83^{BC}	89.17^{AB}	506.67^{B}
Chickpea 15 %	6.42^{BC}	12.09^{B}	87.90^{B}	560.00^{AB}
Chickpea 30 %	4.39^{D}	9.83^{C}	90.17^{A}	346.67^{C}
Lentil 15 %	5.27^{CD}	11.25^{BC}	88.75^{AB}	396.67^{C}
Lentil 30 %	4.45^{CD}	9.59^{C}	90.41^{A}	226.67^{D}
LSD	1.97	2.21	2.21	76.26

LSD: Least significant difference

Means with the same letters are not significantly different ($p<0.01$)

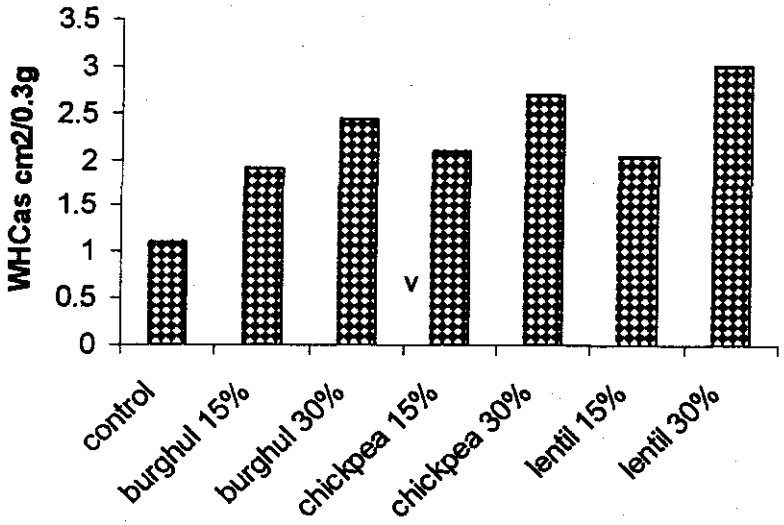

Fig (1): Water holding capacity of different common carp fish balls substituted with different extender flours.

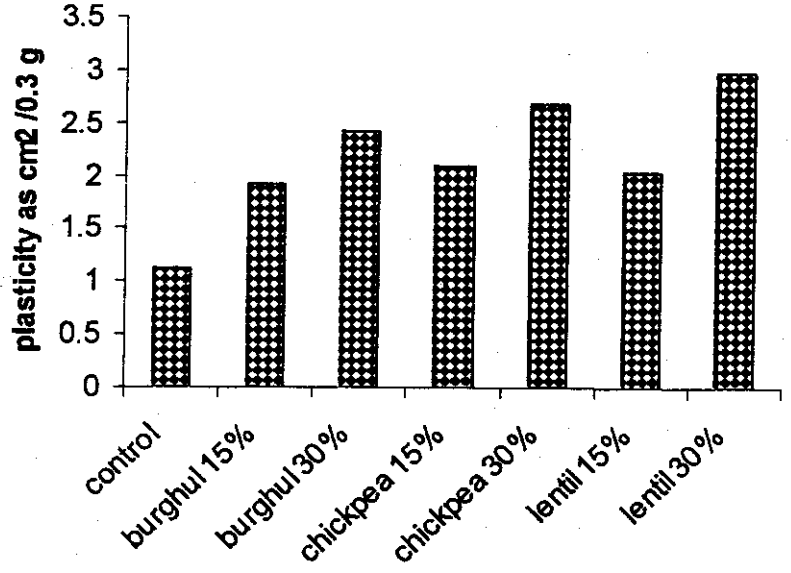

Fig (2): Plasticity values of different common carp fish balls substituted with different extender flours

Data also showed the texture values of different common carp fish balls containing different flours. As seen in Table (4), it could be regarded that all fish balls incorporating legume flours were significantly ($p<0.01$) tender (lower hardness values) than control sample. The addition of such flours had decreased the hardness values. The lower value was achieved by 30 % lentil flour followed by 30 % chickpea and finally 15 % lentil. That was taken the same trend as reported by Serdaroglu *et al.* (2005).

Sensory evaluation:

Sensory properties are the major concern for the utilization of plant proteins as reported by Modi *et al.* (2003). From obtained results given in Table (5), generally it could be mentioned that, as the substitution level was increased there were significantly ($p<0.01$) enhancements in all sensory attributes of prepared fish balls especially when fish balls prepared by substituting fish meat by 30 % of chickpea followed by 30 % lentil. On the other hand, fish balls prepared by substituting fish meat by 15 or 30 % of burghul had moderately lower sensory attributes in comparison to other treatments. Generally, it could be noticed that legume flours could be used as non meat ingredients in preparing fish products without any negative effects on the sensory attributes of prepared products. These results were confirmed with those by Serdaroglu *et al.* (2005).

Table (5): Sensory evaluation values of fried common carp fish balls as affected by substituting different legume flours

Fish samples	Appea-rance	Color	Odor	Taste	Tender-ness	Juici-ness	Overall accepta-bility
Control	7.0^{D}	7.5^{B}	8.5^{C}	9.0^{BC}	7.5^{E}	7.0^{D}	8.0^{D}
Burghul 15 %	7.8^{C}	7.6^{B}	9.0^{BC}	8.5^{C}	8.5^{D}	8.0^{C}	8.2^{D}
Burghul 30%	9.0^{B}	8.0^{B}	8.5^{B}	8.5^{C}	9.0^{C}	8.0^{C}	8.6^{CD}
Chickpea 15 %	9.0^{B}	9.0^{A}	9.5^{AB}	9.4^{AB}	9.5^{B}	9.2^{B}	9.0^{BC}
Chickpea 30 %	10.0^{A}	9.0^{A}	10.0^{A}	10.0^{A}	10.0^{A}	10.0^{A}	10.0^{A}
Lentil 15%	8.0^{C}	7.5^{B}	8.5^{C}	8.5^{C}	9.0^{C}	9.0^{B}	9.4^{AB}
Lentil 30 %	9.5^{AB}	8.8^{A}	9.5^{AB}	9.0^{BC}	9.6^{B}	9.4^{AB}	9.5^{AB}
LSD	0.502	0.670	0.531	0.821	0.430	0.724	0.731

LSD: Least significant difference.

Means with the same letters are not significantly different ($p>0.01$)

CONCLUSIONS

This study suggested that common carp fish can be successfully utilized for the production of low cost, nutritionally and high quality attributes fish balls. Incorporation of different investigated lgumes such as chickpea and lentil then burghul can be successfully used in fish ball formulations as extenders. Addition of aforementioned extenders could be utilized in improving both of physical and sensory characteristics of fish balls at each investigated level especially 30% level.

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خصائص جودة كرات سمك المبروك المدعمة بدقيق بعض البقوليات

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تم تصنيع كرات السمك المضاف اليها الحمص و العدس المنبت او البرغل (كمواد بديلة لبروتين السمك) عند مستويات استبدال ١٥و ٣٠%.تم تقدير التركيب الكيماوى للحم السمك و كذلك للمواد المستخدمة كبديل لبروتين السمك و كرات السمك المنتجة.كذلك تم تقدير خصائص الطهى مثل الفاقد من الطهى- الريع الناتج من الطهى- الانكماش - الصلابة - القدرة على الارتباط بالماء - البلاستيكية و الخصائص الحسية لكرات السمك المطهية.لوحظ ان كرات سمك المبروك المضاف اليها ٣٠% من الحمص او العدس المنبت اعطت قيم مرتفعة من القدرة على الارتباط بالماء و كذلك البلاستيكية بالمقارنة بالمعاملات الاخرى.و لقد تراوحت قيم الانكماش من ٤,٣٦ الى ٧,٣٨% لكرات السمك المقلية والمضاف اليها الحمص و العدس المنبت او البرغل عند اى من مستويات الاستبدال المستخدمة بينما اعطت العينات الكنترول قيمة انكماش مقدارها ١٢,٧٤%.و لقد تأثر كلا من الفاقد من الطهى و الريع الناتج من الطهى تأثرا معنويا بمختلف المواد المستخدمة كبديل لبروتين السمك.و لقد اعطت كرات السمك المحتوية على ٣٠% من العدس المنبت زيادة معنوية فى الريع الناتج من الطهى و انخفاض فى الفاقد من الطهى.كما وجد ان اضافة المواد سابقة الذكر كبديل لبروتين السمك قد ادى الى تحسين قوام المنتج وكانت اقل قيمة ظهرت مع المنتج المحتوى على ٣٠% من العدس او الحمص المنبت يليها المنتج المحتوى على ١٥% من العدس المنبت. لوحظ انة بزيادة النسبة المستخدمة من العدس و الحمص المنبت او البرغل كمواد بديلة لبروتين السمك ادى الى تحسن معنوى لكل الخصائص الحسية لكرات السمك المنتجة خاصة عند استخدام ٣٠% من الحمص المنبت يليها استخدام ٣٠% من العدس المنبت.