

Producing of High Fiber Chicken Meat Nuggets by Using Different Fiber Sources

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ABSTRACT

This research was aimed to producing high fiber chicken meat nuggets by using orange albedo or eggplant pulp powder as fiber sources, since they incorporated separately in chicken meat nuggets at addition levels of 5 and 10 %. The results showed that orange albedo powder has higher fiber content than eggplant pulp powder, whereas protein content of eggplant powder is higher than that of orange albedo powder. The oil binding ability of orange albedo powder is significantly higher than that of eggplant pulp powder while the water binding capacity of both is very similar, also orange albedo powder has significantly higher emulsion capacity than eggplant pulp powder. The results showed that pH value of fried chicken nuggets is higher than that of raw ones and in contrary, water holding capacity of raw chicken meat nuggets is higher than that of fried ones. Incorporation of orange albedo or eggplant pulp powders in chicken meat nuggets are significantly increased its fiber content as compared to control, also data show that chicken meat nuggets containing orange albedo powder exhibited higher fiber content as compared to the comparable containing eggplant powder ones but carbohydrates content of chicken nuggets that contain eggplant powder was higher than that containing orange albedo powder. The addition of fiber sources was increased frying yield of chicken meat nuggets especially with the higher addition level (10 %), there was no significant difference between frying yield of chicken meat nuggets formulated with orange albedo powder or eggplant pulp powder. In regard to frying shrinkage, the addition of fiber sources decreased chicken meat nuggets shrinkage, since chicken meat nuggets formulated with 10 % of both fiber sources exhibited significantly lower shrinkage values as compared to control and chicken nuggets formulated with 5 % of both fiber sources. The moisture retention is increased as the fiber addition level increased. The incorporation of orange albedo fiber at 5 % or eggplant pulp powder at 5 % or 10 % did not affect the sensory quality of chicken meat nuggets when compared to control, but addition of 10 % orange albedo powder was had detrimental effect on tenderness, juiciness, texture and overall acceptability of chicken meat nuggets.

Key words: Chicken nuggets, orange albedo, fiber, eggplant pulp.

Introduction

Fibers can be used in meat products to increase the bulk and reduce cooking loss with no or fewer changes in textural parameters by enhancing water binding and fat binding capabilities in addition to the economic advantages for both consumers and processors (Cofrades *et al.*, 2000). Consumers demand for high fiber meat products was increased in the last years, since high fiber foods are correlated with the human health protection from several diseases. Dietary fibers are important ingredient lacking in meat products which associated with various health disorders such as colon cancer, obesity and cardiovascular diseases (Larsson and Wolk, 2006). Thus, incorporation of dietary fibers into meat products enhances their nutritional value and desirability.

Recently, food industry was concerned on using food processing by-products and high fiber plants as sources of dietary fiber to provide high fiber meat products as functional meat products for consumers. Orange albedo is a principal component of citrus peel, which has a better quality than other sources of dietary fibers due to the presence of associated bioactive compounds (Flavonoids and V.C) with antioxidant properties, which have health promoting effects than the dietary fiber itself

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(Marin *et al.*, 2002; Viuda-Martos *et al.*, 2010). Addition of orange fiber to cooked sausages improves the nutritional value, decreases the residual nitrite level, and increases the oxidative stability (Fernández-Ginés *et al.*, 2003). So, isolation of functional compounds from citrus by-products as fiber (Aleson-Carbonell *et al.*, 2003, 2004; Fernández-Ginés *et al.*, 2003; Fernández-López *et al.*, 2004) and polyphenols (Tang *et al.*, 2001) can be of interest to the food processors as they can use these compounds as food additives to produce high fiber foods and to retard oxidative changes, which improve food quality and nutritive value.

On the other hand, the consumption of eggplant fruits are correlated with using high amounts of oils which used in preparation of eggplant containing diets as fried eggplant and some other Egyptian foods which play a role in increasing lipid content in the diet. Eggplant fruits contain several antioxidants including phenolic acids, carotenoids lycopene, lutein, and α -carotene, as well as the flavonoids myricetin and kaempferol (Ben-Amos and Fishler, 1998; Mian and Mohamed, 2001; Dias, 2012). Eggplant is an excellent source of dietary fiber and minerals such as manganese, molybdenum, potassium magnesium and copper in addition to vitamins including K and, vitamin C, vitamin B6, folate, and niacin (Ensminger *et al.*, 1986; Wood, 1988). Guimarães *et al.* (2000) showed a significant decrease in blood levels of low-density lipoproteins and total cholesterol in human volunteers who were fed eggplant powder which due to the high content of dietary fiber. Thus this work was aimed to using orange albedo powder and eggplant pulp powder as sources of dietary fibers to produce high fiber chicken meat nuggets and evaluation of physical, chemical and sensory properties of chicken meat nuggets.

Materials and Methods

Materials:

Orange albedo:

Albedo was obtained directly from commercial oranges (*Citrus sinensis*) was obtained from Egypt local market.

Eggplant fruit:

Eggplant fruits (*solanum melongena*) were purchased from Egypt local market.

Ingredients of chicken meat nuggets:

Chicken breast meat (deboned and skinned), condiments (Fresh onion and garlic 1:1), bread crust, batter, refined wheat flour, spices mix, skim milk powder, fresh whole eggs, sunflower oil, sugar and salt were obtained from Egypt local market.

Chemicals:

Sodium tripolyphosphate and sodium nitrite were obtained from Adwic Laboratory Chemicals Company, while analytical chemicals and reagents, which used in the analytical methods (analytical grade) were produced by sigma chemical co. (St. Louis, mo., (USA) and obtained from EL-Gamhouria Trading Chemicals and drugs Company, Cairo, Egypt.

Methods:

Technological methods:

Preparation of Orange albedo powder:

Orange albedo layer was separated manually by thin knife from the flavedo layer and then dried in air oven at 50 ± 5 °C for 24 hr. Dried albedo layer was ground in laboratory grinder (model Braun

KM 32, Germany) into fine powder to pass through 60 mesh sieve, then it packed in tightly sealed polyethylene bags and kept in freezer until further use and analysis (Fernández-Ginés *et al.*, 2003).

Preparation of eggplant pulp powder:

Eggplant fruits were washed, peeled, sliced, blanched in boiling water for 5 min. to inhibit the enzymatic reactions and dried in air oven at 50 ± 5 °C for 24 hr. The dried eggplant pulp was ground in laboratory grinder (model Braun KM 32, Germany) into fine powder to pass through 60 mesh sieve, then it packed in tightly sealed polyethylene bags and kept in freezer until further use and analysis.

Preparation of chicken meat nuggets:

Chicken meat nuggets were formulated according to the methods described by Kumar and Tanwar (2011) according to the formula in table 1 with addition of salts and fiber sources with the showed ratios from the basic chicken meat nuggets. Chicken nuggets were formed into characteristic shapes ($5 \times 3 \times 1$ cm, each weighing 25g), then pre-dusted, battered and breaded according to the method of (Dogan *et al.*, 2005).

Table 1: Chicken meat nuggets formulation.

Main ingredients (%)	Treatments				
	Control	Orange albedo powder		Eggplant pulp powder	
		5%	10%	5%	10%
Chicken breast meat	60	60	60	60	60
Sunflower oil	10	10	10	10	10
Ice flakes	10	10	10	10	10
Refined wheat flour	3	3	3	3	3
Skim milk powder	2.5	2.5	2.5	2.5	2.5
Whole liquid egg	5	5	5	5	5
Condiments	5	5	5	5	5
Salt	2	2	2	2	2
Spices mix	1.5	1.5	1.5	1.5	1.5
Sugar	1	1	1	1	1
Total	100	100	100	100	100
Additives (%)					
Sodium tripolyphosphate	0.25	0.25	0.25	0.25	0.25
Sodium nitrite	0.015	0.015	0.015	0.015	0.015
Orange albedo powder	-	5	10	-	-
Eggplant pulp powder	-	-	-	5	10

Frying of chicken meat nuggets:

Chicken meat nuggets were fried in sunflower oil at 180 ± 2 °C as described by (Kim *et al.*, 2015). Then chicken meat nuggets were allowed to cool, packaged in polyethylene bags and kept in frozen storage at -18 °C until analysis.

Analytical Methods:

Chemical analysis:

Gross chemical composition of orange albedo, eggplant pulp and chicken meat nuggets was determined according to AOAC (2012), while, total carbohydrates were calculated by subtraction.

Determination of selected Functional Properties of orange albedo and eggplant pulp powders:

Emulsifying Capacity and emulsion stability:

Emulsifying capacity was determined according to Ockerman (1985), while emulsion stability was determined according to Cserhalmi *et al.* (2001).

Water and oil binding capacity:

Water and oil binding capacity was determined as described by Sosulski and McCurdy (1987).

Physical analyses of chicken meat nuggets samples:

PH Value:

pH value of chicken meat nuggets was determined according to Kim *et al.* (2015) by using a digital pH meter (Jenway, 3510 pH meter, UK).

Water holding capacity (WHC) of chicken meat nuggets samples:

Water holding capacity (WHC) of chicken meat nuggets was evaluated by filter press method as described by Soloviev (1966).

Cooking measurements:

Frying yield of chicken meat nuggets:

Frying yield of chicken meat nuggets was calculated after frying of chicken meat nuggets according to Kim *et al.* (2015).

Frying Shrinkage of chicken meat nuggets:

Frying shrinkage (%) of chicken meat nuggets was calculated after frying of chicken meat nuggets as the decrease of diameter and thickness of sample according to Wang *et al.* (2010).

Moisture retention of chicken meat nuggets:

Moisture retention values of chicken meat nuggets were calculated by the method described by Aleson-Carbonell *et al.* (2005).

Sensory evaluation:

Chicken meat nuggets were sensory evaluated by ten members of Food Science and Technology department's staff, Faculty of Agriculture, Al-Azhar University on the basis of interest, experience in sensory evaluation and availability. Panelists were instructed to evaluate appearance, color, taste, tenderness, juiciness, flavor, texture and overall acceptability using 10 point scale for grading the quality of samples as described by Crehan *et al.* (2000).

Statistical Analysis:

Analysis of variance was performed using the General Linear Model (GLM) procedure of the SAS statistical package (SAS, 2008). Duncan's multiple range tests were determined at the 5% significance level.

Results and Discussion

Table (2) shows the gross chemical compositions of orange albedo and eggplant pulp powders. The results indicate that there are significant differences between orange albedo and eggplant pulp powders in all components, since moisture, protein and carbohydrates contents of orange albedo powder are significantly lower than that of eggplant pulp powder whereas fat, ash and crude fiber contents of orange albedo powder are significantly higher than those of eggplant pulp powder. The results of orange albedo are similar to that found by Fernández-López *et al.* (2004), whereas results of eggplant pulp were on the line with the foundation of Khan *et al.* (2015).

Table 2: Gross chemical composition of orange albedo and eggplant pulp powders.

Samples	Components %					
	Moisture	Protein*	Fat*	Ash*	Crude	Carbohydra
Orange albedo	62.67 ^b	3.65 ^b	4.28 ^a	8.64 ^a	71.44 ^a	11.99 ^b
Eggplant pulp	92.20 ^a	12.43 ^a	2.30 ^b	6.15 ^b	38.46 ^b	40.66 ^a

* On dry basis. ** Values are means of three determinations,

***Means in the same row with the same superscript did not significantly different at $P \leq 0.05$.

Table 3 shows the functional properties of orange albedo and eggplant pulp powders. From the data it obvious that there is no significantly difference in the water binding capacity of orange albedo and eggplant powders, while the oil binding capacity of orange albedo powder is significantly higher than that of eggplant pulp powder which may due to the high hydrophobic properties of orange pulp powder (Fernández-Ginés *et al.*, 2003). In regard to emulsion capacity from the date it could be noticed that the emulsion capacity of the orange albedo powder is significantly higher than that of eggplant powder while the emulsion stability of them is very similar.

Table 3: Functional properties of orange albedo and eggplant pulp powders.

Parameter	Orange albedo	Eggplant pulp
Water binding capacity (g/g)	8.22 ^a	8.33 ^a
Oil binding capacity (g/g)	2.40 ^a	1.20 ^b
Emulsion capacity (ml oil/g protein)	213.0 ^a	28.10 ^b
Emulsion stability (%)	65.00 ^a	66.00 ^a

* Values are means of three determinations,

**Means in the same row with the same superscript did not significantly different at $P \leq 0.05$.

Table 4 shows the effect of addition different fiber sources on the physical properties of high fiber chicken meat nuggets. The data in table 4 reveal that there is not significant different between control and containing dietary fiber chicken meat nuggets in pH values. This trend was observed in both emulsion (raw chicken meat nuggets) and fried chicken meat nuggets. The pH values of fried chicken meat nuggets were higher than raw ones which agree with Kim *et al.* (2010) who reported that cooked meat batter was had higher pH value than uncooked meat batters, the increase of pH during cooking may be due to the release of alkali compounds from amino acids upon heating (Choe *et al.*, 2013; Kim *et al.*, 2010).

Table 4: Effect of addition different fiber sources on the physical properties of high fiber chicken meat nuggets.

Parameters	Treatments				
	Control	Orange albedo		Eggplant pulp	
		5%	10%	5%	10%
Emulsion pH	6.37 ^a	6.36 ^a	6.32 ^a	6.38 ^a	6.35 ^a
Product pH	6.51 ^a	6.54 ^a	6.52 ^a	6.49 ^a	6.50 ^a
Emulsion WHC	78.86 ^b	79.17 ^b	82.19 ^a	78.93 ^b	80.27 ^{ab}
Product WHC	73.61 ^c	75.68 ^{bc}	78.62 ^a	76.67 ^{ab}	77.33 ^{ab}

* Values are means of three determinations,

**Means in the same row with the same superscript did not significantly different at $P \leq 0.05$.

In regard to water holding capacity, the data show that water holding capacity of both raw or cooked chicken meat nuggets is increased with increasing dietary fiber addition level, since treatments containing the high fiber level 10 % were had higher water holding capacity values than treatment containing low fiber level 5 % which in turn had water holding capacity value higher than that of control, thus addition of dietary to the chicken meat nuggets led to increment in water holding capacity. These results are on the line with Fernandez-Gines *et al.* (2005) who reported that addition of oat fiber increased WHC of meat products. Similar results were obtained by Talukder and Sharma (2010) who reported that WHC of chicken meat patties increased with increasing dietary fiber level.

These results also indicate that addition of orange albedo was superior in improving water holding capacity of chicken meat nuggets than eggplant pulp powder at the comparable addition levels. The highest water holding capacity value was observed for treatment which contains 10 % orange pulp powder, while the lowest WHC value was observed for control treatment. The added dietary fiber sources were improved the WHC because its high water binding capacity.

Table 5 shows the effect of addition different fiber sources on the chemical composition of high fiber chicken meat nuggets. The data show that addition of fiber decrease the water content of chicken meat nuggets because the low water content of orange albedo and eggplant pulp powders, these results are in agreement with the foundation of Yilmaz (2004) who mentioned that moisture content of low fat meatballs fabricated with different levels of rye bran was lower than that of control. Similar results were obtained by Talukder and Sharma (2010) in dietary fiber rich chicken meat patties.

The data, also indicate that there are no significant difference between protein, fat and ash contents of chicken meat nuggets which slightly increased with increasing fiber addition level because fiber sources contain protein, fat and ash, which previously stated by (Choe *et al.*, 2013; Choe *et al.*, 2009) in different meat products.

The results show that there are significant differences in fiber content between all treatments, which increase by addition fiber sources. The highest fiber content was observed for chicken meat nuggets containing 10 % orange albedo powder while the lowest value was observed for control treatment. The crude fiber content of chicken meat nuggets containing orange albedo powder was higher than this of chicken meat nuggets which fabricated with eggplant pulp powder in both addition levels while, a contrary situation was observed with carbohydrates content, since chicken meat nuggets containing eggplant powder were had higher carbohydrate contents than that containing orange albedo, since the highest carbohydrate content (11.60 %) was observed for chicken meat nuggets which contain 10 % eggplant powder while the lowest carbohydrate content (7.54%) was observed for control. Gross chemical composition results are on the line with the foundation of Kim *et al.* (2015).

Table 5: Effect of addition different fiber sources on the chemical composition of high fiber chicken meat nuggets.

Components (%)	Treatments				
	Control	Orange albedo		Eggplant pulp	
		5%	10%	5%	10%
Moisture	62.25 ^a	59.76 ^{ab}	57.50 ^b	59.62 ^{ab}	57.13 ^b
Protein *	54.56 ^a	54.74 ^a	54.92 ^a	55.07 ^a	55.58 ^a
Fat *	25.64 ^a	25.85 ^a	26.07 ^a	25.75 ^a	25.87 ^a
Ash *	6.43 ^a	6.86 ^a	7.29 ^a	6.73 ^a	7.45 ^a
Dietary fiber *	1.64 ^d	5.20 ^b	8.78 ^a	3.56 ^c	5.48 ^b
Carbohydrates*	11.73 ^a	7.35 ^{bc}	2.94 ^d	8.897 ^b	5.62 ^c

* On dry basis. ** Values are means of three determinations,

***Means in the same row with the same superscript did not significantly different at $P \leq 0.05$.

Table 6 shows the effect of addition fiber sources on cooking measurements of high fiber chicken meat nuggets. The addition of orange albedo or eggplant pulp powders in formulation of chicken meat nuggets at addition levels of 5 and 10 % result in increasing the frying yield of chicken meat nuggets, also the frying yield is increased as the addition level increased. The results show that there is no significant difference between frying yield of control and chicken meat nuggets treatments

containing 5 % fiber without regarding fiber source but chicken meat nuggets containing 10 % of both fiber sources were significantly had higher cooking yield than other treatments which agree with Aleson-Carbonell *et al.* (2005) who observed higher yields of the beef burger treatments formulated with lemon albedo than control. In this concept addition of wheat and oat bran result in increasing yield by reducing cooking losses in meat balls (Yilmaz, 2005; Yasarlar *et al.*, 2007). Similar results were obtained by Verma *et al.* (2016) who reported that cooking yield increased as the fiber content increased because of its water retaining properties.

The data also show that shrinkage of chicken meat nuggets as a result of frying is decreased with increasing fiber addition level, since the lowest shrinkage percent was observed for chicken meat nuggets which contain 10% orange albedo powder. These results are in agreement with Kim *et al.* (2015) who reported that fiber increased moisture absorption in frying food by formation of hydrogen bonding between water molecules and fiber, which reduce the displacement of water by oil (Fizman and Salvador, 2003), which on the line with Lario *et al.* (2004) who reported that, albedo has good fat and moisture retention.

In regard to moisture retention results reveal that addition of fiber increase moisture retention which in agreement with the foundation of Verma *et al.* (2016), since chicken meat nuggets which fabricated to containing 10 % fiber were exhibit higher moisture retention percent, the addition of 10 % eggplant pulp powder to chicken meat nuggets result in slightly non-significant higher moisture retention than that contain 10 % of orange albedo powder which may be due to the high water retaining properties of fiber, but there are not significant difference between chicken meat nuggets fabricated with 5 % fiber and control.

Table 6: Effect of addition different fiber sources on cooking measurements of high fiber chicken meat nuggets.

Parameters (%)	Treatments				
	Control	Orange albedo		Eggplant pulp	
		5%	10%	5%	10%
Frying yield	91.59 ^b	92.52 ^b	95.32 ^a	93.08 ^b	95.12 ^a
Frying Shrinkage	8.40 ^a	7.32 ^{ab}	6.17 ^b	7.37 ^{ab}	6.22 ^b
Moisture retention	66.50 ^b	67.48 ^b	72.10 ^a	68.39 ^b	73.45 ^a

* Values are means of three determinations,

**Means in the same row with the same superscript did not significantly different at $P \leq 0.05$.

Table 7 shows the effect of addition different fiber sources on sensory properties of high fiber chicken meat nuggets. The data in table 7 indicate that incorporation of orange albedo fiber at 5 % addition level or eggplant pulp powder at 5 % or 10 % addition level did not affect the sensory scores of chicken meat nuggets when compared to control, unlike addition of 10 % orange albedo powder which was it have detrimental effects on tenderness, juiciness, texture and Overall acceptability. These results are agree with that obtained by Kokare (2013). Thus high fiber chicken meat nuggets can be developed without affecting acceptability of the products with incorporation of 5% orange albedo fiber or 5 and 10 % eggplant pulp powder.

Table 7: Effect of addition of different fiber sources on sensory properties of high fiber chicken meat nuggets

Parameters	Treatments				
	Control	Orange albedo		Eggplant pulp	
		5%	10%	5%	10%
Appearance	9 ^a				
Flavor	9 ^a	8 ^a	8 ^a	8 ^a	8 ^a
Tenderness	9 ^a	8 ^a	6 ^b	9 ^a	9 ^a
Juiciness	9 ^a	8 ^a	6 ^b	8 ^a	8 ^a
Texture	9 ^a	8 ^a	6 ^b	8 ^a	8 ^a
Overall acceptability	9 ^a	8 ^a	6 ^b	8 ^a	8 ^a

* Values are means of three determinations,

**Means in the same row with the same superscript did not significantly different at $P \leq 0.05$.

Conclusion

High fiber chicken meat nugget can be produced with incorporation of orange albedo powder at addition level 5 % or by incorporation of eggplant pulp powder at addition levels of 5 and 10 %, since the addition of fiber sources enhance physical properties and cooking measurements of chicken meat nuggets without affecting its sensory properties.

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