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Chemical, Physical and Sensory Evaluation of Untraditional Chicken Nuggets Formula Using Taro Flour (*Colocasia esculenta* L. Schott)

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ABSTRACT

This research aimed to prepare untraditional chicken nuggets formula to investigate the potential of replacement wheat flour and skimmed milk powder with taro flour and its effect on the physicochemical and sensory properties of prepared chicken nuggets to samples. Chemical composition of raw material was determined and the chicken nuggets were evaluated for its chemical composition, physical, texture profile analysis and sensory properties. Obtained results showed that, taro flour had low fat and high ash content in compared with wheat flour. So, the replacement of wheat flour and skimmed milk powder with taro flour led to decrease fat content and increase ash and carbohydrate content compared to control nuggets sample. Also, the replacement improved the emulsion stability, cooking loss and water activity properties. So, the replacement of wheat flour and skim milk with taro flour can improve the texture profile analysis of chicken nugget samples and sensory evaluation especially the color properties.

***Keywords**:* Chicken nuggets, Taro flour, Chemical composition, Physicochemical properties.

INTRODUCTION

Taro (*Colocasia esculenta* L. schott) is an edible starchy tuber pertinence to Araceae family. This tuber is one of the most widely cultivated edible aroids in the tropical and subtropical reason of the world including West Africa and West Indies, Asia, Caribbean, Pacific and Polynesian Iceland and South Africa (Onwueme, 1999). The varieties of taro available in the world include *Cyrtosperma chamissonis* (giant swamp taro), *Xanthosoma sagittifolium*, *Colocasia esculenta* (taro) and *Alocasia macrorrhiza* (giant taro) (Kaushal and Sharma, 2013).

Taro spoilage rapidly as a result of its high moisture and has been estimated to have a shelf-life of up to one month if undamaged and stored in a shady place. One of the best methods to decrease postharvest losses, expand its scope of usage and consequently benefit immensely from its economic potential is by processing them into flour and/or starch (Perez *et al.*, 2005). Successful performance of flours as food ingredients depend upon the functional characteristics and sensory qualities they impart to the end product (Kaur and Singh 2007).

Chicken nuggets are a suitable and tasteful way for consumers to enjoy chicken. There is a substantial amount of variation in chicken nugget formulations depending on application. Some chicken nuggets are made up of all white or all dark meat, and some as a mixture of both meat types. There are many agents as to why these formulations vary so much, but finally it becomes an economic decision for the processor. The consumer demand for a lower expensive nugget has led to the development of "value" nuggets, which substitute chicken meat with binders and extenders to decrease the cost of production. Many extenders can be used in chicken nuggets, including hydrocolloids, gums, starches, or textured vegetable proteins (Maningat *et al.*, 1999).

Thus this work was aimed to using taro powder as a replacer of wheat flour and skimmed milk powder to be safe for gluten and lactose allergy patients. In addition to its nutrients to develop low fat chicken nuggets and evaluation of physical, chemical and sensory properties of chicken nuggets.

MATERIALS AND METHODS

Materials:

Taro (*Colocasia esculenta* L. schott) was purchased from a local market in Tanta City, Gharbiya Governorate, Egypt. Chicken breast meat (without bones and skin), condiments namely dried onion and garlic, bread crust, wheat flour (72% extraction), skim milk powder, black pepper powder and salt were obtained from local market of Tanta City, Gharbiya Governorate, Egypt.

All chemicals and solvents were purchased from El-Gomhoria Company for Chemicals and Drugs, Tanta City, Gharbiya Governorate, Egypt.

Methods:

Preparation of Taro flour

Raw taro was washed in tap water and then peeled. Taro samples were diced into 1 × 1 cm size. The samples were spread evenly on different trays, and dried in electric drying oven (UNOX , XBC605, Made in Italy) at 45±5°C for 24 h. The dried samples were milled into flour using the laboratory grinder (Model Moulinex type, No Y45, made in Spain) and passed through 100 µm mesh sieve to obtain uniform sized flour. The flour was then packed in sealed plastic bag and stored at ambient temperature (25 °C) until further used (Hossain, 2016).

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Preparation of chicken nuggets

Chicken nuggets were prepared according to the method of (Bintoro, 2008). The formulas T_0, T_1, T_2 and T_3 are presented in Table 1. Chicken breast meat was cleaned and ground by meat grinder (Moulinex, model No 205, made in France). Mixed the minced breast meat with wheat flour, skim milk powder (SMP), salt, dried onion, dried garlic and black pepper powder. The mixture was served as (control sample). The final mixture put in freezer at -18°C for 5 min. Chicken nuggets were shaping and cooling for 15 min at 5ºC. Samples were stored in polyethylene bags until analysis and the other were fried.

Table 1. Ingredients of chicken nuggets formulas as (g/100g)

Ingredients (g)	Treatments			
	T_0	T_1	T_2	T_3
CBM	80	80	80	80
WF	8	8	0	-
SMP	8	0	8	-
TF	-	8	8	16
Dried garlic	1.4	1.4	1.4	1.4
Dried onion	0.8	0.8	0.8	0.8
Salt	1	1	1	1
Black pepper powder	0.8	0.8	0.8	0.8
Total	100	100	100	100

Where: CBM= chicken breast meat - WF= wheat flour – SMP= skim milk powder

TF= taro flour T_0= control sample, T_1= replaced milk with taro flour, T_2= replaced wheat flour with taro flour, T_3= replaced milk and wheat flour with taro flour

Chicken nuggets were fired (for sensory evaluation) in domestic fryer (T-fal Deep Fryer, Model FR8000). by using sunflower oil at 180ºC for approximately 4 min until an internal temperature of 72°C was reached (Kim *et al.*, 2015).

Analytical Methods:

Chemical analysis:

Chemical composition of taro flour (TF), wheat flour (WF), skim milk powder (SMP), chicken breast meat (CBM) and chicken nuggets were estimated for their moisture, ash, fat, and protein contents (AOAC, 2000).While, total carbohydrates content were calculated by using equation:

Carbohydrates % = 100-(moisture + ash + protein + fat)

Physical properties:

Percent cooking loss

Cooking loss was estimated according to Polizer *et al.* (2015).

$$\%\ \text{cooking loss} = \frac{weightofsamplebeforecooking - weightofsampleaftercooking}{weightofsamplebeforecooking} \times 100$$

Emulsion stability

The Emulsion stability of the sample was estimated as per the technique recommended by Cserhalmi *et al.* (2001). Twenty five grams of emulsion was taken and placed in a polyethylene bag and heated at 80° C for 30 minutes in a water bath. Cookout was drained and cooked mass was cooled and weighted and loss in weight was expressed as percentage.

Water activity

The water activity was measured directly with an Aqua Lab water activity meter (Decagon Devices, models CX2, Pullman,). Measurements were carried out at room temperature for each determination (Piga *et al.*, 2005).

Texture Profile Analysis (TPA)

The remaining reheated nuggets were allowed to cool at room temperature for 1h before analyzing TPA. Hardness, springiness, cohesiveness, and chewiness were all determined according to Peleg (2008). Chewiness is the product of springiness × gumminess. Gumminess and chewiness are mutually exclusive depending on the state of the product; gumminess is the products of hardness × cohesiveness (Bourne, 2002).

Sensory evaluation

Fried chicken nuggets were sensory evaluated by ten members of Food Science and Technology department's staff, Faculty of Home Economic, Al-Azhar University , appearance, color, flavor, tenderness, juiciness and overall acceptability were tested using 10 point scale for grading the quality of samples as described by Crehan *et al.* (2000).

Statistical Analysis

The statistical analysis was carried out using SPSS. Statistical software (version 11.0 SPSS inc., Chicago, USA), the results were expressed as mean. Data were subjected to analysis of variance (ANOVA) according to Armitage and Berry (1987).

RESULTS AND DISCUSSIONS

Chemical composition of some raw material used in chicken nuggets preparation

The results of chemical composition of Chicken meat breast (CBM), wheat flour (WF), taro flour (TF) and skim milk powder (SMP) were presented in Table 2.It was observed that, CBM being 69.85, 20.96, 3.21, 1.08 and 4.90 % moisture, protein, fat, ash and carbohydrate, respectively Bogosavljevic-Boskovic *et al.* (2010); Kumar and Rani (2014); William and Jonathan (2017) whose found that, the composition of chicken breast ranged from 70- 86.83% moisture, 1.96- 2.78% fat, 22- 23.72% protein and 1.01- 1.09% ash.

Table 2. Chemical composition of some raw material used in chicken nuggets preparation

Chemical properties	Raw materials			
	CBM	WF	TF	SMP
Moisture	69.85^a	11.95^c	13.50^b	3.80^d
Protein	20.96^b	11.00^c	8.78^d	36.00^a
Fat	3.21^a	1.60^b	0.18^d	1.25^c
Ash	1.08^c	0.66^d	3.10^b	8.20^a
Carbohydrate	4.90^d	74.79^a	74.44^b	50.75^c

$^{a, b, c, d}$ Mean values in each column with different superscripts are significantly different (p ≤ 0.05).

Where: CBM= chicken breast meat - WF= wheat flour – SMP= skim milk powder - TF= taro flour

The compositions of WF include 11.95, 11.00, 1.60, 0.66 and 74.79 % moisture, protein, fat, ash and carbohydrate, respectively. These results agree with Hussein *et al.* (2010) and Hussein *et al.* (2018)whose found that, the wheat flour contained 9.86- 12.18% moisture, 10.70- 12.48% protein, 1.35- 1.58% fat and 0.56- 0.86% ash. TF had 13.50% moisture, 8.78% protein, 0.18

% fat, 3.10% ash and 74.44% carbohydrate. These results agree with Alcantara *et al*. (2013); Panyoo *et al*. (2013); Himeda *et al*. (2014) whose found that the content of protein ranged 2.0- 8.07%, fat 0.2- 1.0, ash 0.2- 2.7%.SMP contained 3.80, 36.00, 1.25, 8.20 and 50.75% moisture, protein, fat, ash and carbohydrate, respectively. These results are in line with Patil *et al*. (2016) and Pugliese *et al*. (2017) whose found that, the skimmed milk powder composed from 1.1- 4.2%, 31.91- 39.8, 0.2- 1.56 and 7.4- 8.5% moisture, protein, fat and ash, respectively. Finally, taro flour had the lowest content of fat compared to other components and the protein content of taro was higher than wheat flour.

Chemical composition of chicken nuggets samples with taro flour

The chemical composition of chicken nugget control and that replaced WF and SMP with TF was observed in Table 3. From the results, it was observed that, the moisture content of samples increased by replacing SMP and WF with TF. The replacement of SMP and WF with TF affected on protein content in all prepared sample chicken nuggets.

Control sample have the highest protein content (23.72%) followed by other samples that replaced WF with TF (22.06%), while adding of TF decrease the amount of protein to (19.72%) El-Gammal *et al.* (2018) whose found that, the chicken nugget contain 61.25, 9.51, 21.05, 2.25 and 5.94% moisture, fat, protein, ash and carbohydrate, respectively. Fat content also, decreased in all samples that replaced SMP and WF with TF, it may be due to the low fat content in TF. The highest fat content observed in control sample (8.20%) while the lowest one observed in SMP and WF with TF prepared sample (3.99 %).

Table 3. Chemical composition of chicken nuggets samples with taro flour

Chemical properties	Treatments			
	T_0	T_1	T_2	T_3
Moisture	60.11^{c}	62.64^{b}	61.73^{bc}	63.96^{a}
Protein	23.72^{a}	20.67^{c}	22.06^{b}	19.72^{d}
Fat	8.20^{a}	6.34^{b}	5.48^{c}	3.99^{d}
Ash	2.32^{bc}	2.06^{c}	4.08^{a}	2.56^{b}
Carbohydrate	5.65^{d}	8.29^{b}	6.65^{c}	9.77^{a}

a, b, c ,d Mean values in each column with different superscripts are significantly different ($p \leq 0.05$). Where: T_0= control sample, T_1= replaced milk with taro flour, T_2= replaced wheat flour with taro flour, T_3= replaced milk and wheat flour with taro flour

Results in the same table showed also that, ash content changed in all replacement samples may be due to the high content of ash in TF. The highest content of ash found in samples replaced WF with TF (4.08%). Carbohydrate content were different in all prepared samples as a result of replacement SMP and WF with TF. The highest carbohydrate content being in prepared sample that replaced mix of SMP and WF with TF. These results were agreed with Ammar *et al*. (2009) and Lamrot (2018) whose found that, the replacement wheat flour with taro flour led to slightly decrease in protein and fat and observed increase in both of ash and carbohydrate.

Physicochemical properties of chicken nuggets samples

Data presented in Table 4 illustrate the physicochemical properties of chicken nuggets with TF. From the obtained results, it could be noticed that, the emulsion stability of chicken nuggets increased in sample that replaced SMP and WF with TF, the lower value was observed when replaced SMP with TF. There was difference between samples with regard to cooking loss with the highest loss for sample that replaced SMP with TF (2.30%) and the lowest loss for sample that replaced SMP and WF with TF (1.50 %) as shown in Table 4, showing that replaced SMP and WF with TF resulted in decreased cooking loss. In contrast, Santhi and Kalaikannan (2014) noticed lower values of cooking loss when oat flour was incorporated into chicken nuggets. Data showed that, increase in water activity values could be noticed in sample replaced WF with TF and sample that replaced SMP and WF with TF. Water activity values of the control and the chicken nuggets with TF ranged from 0.87 to 0.90.Showing an agreement with the work of (El-Gammal *et al.*, 2018) they studied evaluation of chicken nuggets formulated with loquat seeds powder and they found, water activity values of the control and the treated samples ranged from 0.968 to 0.981. However, there was no difference between control sample and sample that replaced milk with taro flour.

Table 4. Physicochemical properties of chicken nuggets samples with taro flour

Physicochemical properties	Treatments			
	T_0	T_1	T_2	T_3
Emulsion stability (%)	93	90	93	97
Cooking loss (%)	2.00	2.30	1.90	1.50
Water activity	0.87	0.87	0.88	0.90

Where: T_0= control sample, T_1= replaced milk with taro flour, T_2= replaced wheat flour with taro flour, T_3= replaced milk and wheat flour with taro flour

Texture profile analysis (TPA) of chicken nuggets samples

The texture profile analysis of chicken nuggets samples with TF are listed in Table 5. It's clear that treatment T_3 which contains 16% TF showed the highest value of firmness and gumminess which recorded 48.34 and 24.01 respectively. Also treatment T_1 which contains 8% WF and 8% TF showed the highest value in cohesiveness (0.76), while treatment T_3 showed the lowest value in springiness (0.73) respectively. The lowest value in firmness (31.43) was found in control sample. On the other hand presence of TF by 8% in treatment T_1 beside 8 % WF improved the cohesiveness power, where recorded the highest value (0.76). Aprianita *et al.* (2009) reported that, the high viscosity of taro starch would make them very useful in food applications. These results similar that of Mahmoud *et al.* (2016) in his study on the texture profile of ready-luncheon meat they found that presence of taro flour by 15% beside 10 % wheat flour in blend improved the cohesiveness power, where recorded the highest value (0.76).

Table 5. Texture profile analysis of chicken nuggets samples with taro flour

Texture profile properties	Treatments			
	T_0	T_1	T_2	T_3
Firmness	31.43	43.84	37.36	48.34
Cohesiveness	0.63	0.76	0.59	0.50
Gumminess	19.92	33.45	22.28	24.01
Chewiness	17.42	26.14	19.47	17.56
Springiness	0.87	0.78	0.87	0.73
Resilience	0.67	0.59	0.85	0.64

Where: T_0= control sample, T_1= replaced milk with taro flour, T_2= replaced wheat flour with taro flour, T_3= replaced milk and wheat flour with taro flour

These results agreement with the work of (Kumar *et al.,* 2013) in his study on quality and storability of chicken nuggets formulated with green banana and soybean hulls flours and they found that, significant differences were observed in hardness of flour added samples as compared to control.

Sensory evaluation of fried chicken nugget samples

The sensory evaluation of fried chicken nugget samples control and nuggets contain TF were evaluated in Table 6. The resulted revealed that, the replacement WF and mixture of WF and SMP with TF led to an improve the appearance and color. Appearance is the first characteristics perceived by the human senses and play an important role in the identification and final selection of food. Generally, all samples were acceptable by the sensory evaluation panels, but the acceptability rates varied. The nuggets with TF recorded the highest grades for appearance.

Table 6. Sensory evaluation of chicken nuggets samples with taro flour

properties	Treatments			
	T_0	T_1	T_2	T_3
Appearance	8.43^a	8.58^a	9.00^a	9.14^a
Color	8.00^b	8.07^b	9.14^a	9.14^a
Flavor	9.00^a	8.78^a	8.86^a	8.86^a
Tenderness	9.14^a	9.14^a	8.71^a	8.86^a
Juiciness	9.14^a	9.14^a	8.71^a	8.71^a
Over all acceptability	9.29^a	9.14^a	8.86^a	8.71^a
Total	53.00	52.85	53.28	53.42

Where: $^{a,\,b}$ Mean values in each column with different superscripts are significantly different ($p \leq 0.05$), T_0= control sample, T_1= replaced milk with taro flour, T_2= replaced wheat flour with taro flour, T_3= replaced milk and wheat flour with taro flour

The mean of color value in nuggets with TF recorded the highest color value it was 9.14. The nuggets with TF were lighter than those of control sample. These results agree with Sanful (2011) who found that, the replacement wheat flour with taro flour improved the color of bread. The results obtained in the same table observed that, there were no significant statistical differences ($p \leq 0.05$) in the tenderness, juiciness and over all acceptability among the samples. On the other hand samples replaced with TF gained the highest total sensory evaluation scores (53.42) for chicken nuggets.

CONCLUSION

The replacement WF and SMP with TF led to decrease the content of fat and increase the content of ash and carbohydrate compared to control sample. The replacement improved the emulsion stability and water activity while decreases the cooking loss. Also, the replacement improved the texture profile analysis of chicken nuggets samples and sensory evaluation especially the color properties.

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التقييم الكيميائي والفيزيائي والحسي لخلطة ناجتس الدجاج غيرالتقليدية باستخدام دقيق القلقاس

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يهدف هذا البحث إلى تحضير خلطة ناجتس دجاج غير تقليدية ودراسة إمكانية استبدال دقيق القمح ومسحوق الحليب منزوع الدسم بدقيق القلقاس وتأثيره على الخصائص الفيزيائية والكيميائية والحسية لعينات ناجتس الدجاح المحضرة. تم تقدير التركيب الكيميائي للمادة الخام وتقييم ناجتس الدجاج من حيث التركيب الكيميائي والفيزيائي والقوام والخواص الحسية. أوضحت النتائج أن دقيق القلقاس يحتوي علي نسبة منخفضة من الدهون ومرتفعة من الرماد مقارنة بدقيق القمح لذا فإن الاستبدال فى عينات ناجتس الدجاج أدى إلى خفض المحتوي الدهنى وزيادة محتوي كلا من الرماد والكربوهيدرات في عينات الناجتس مقارنة بالعينة الكنترول. كما أدي الاستبدال أيضا إلى تحسين ثبات المستحلب, فقد الطهي, النشاط المائي وأيضا الخواص الحسية لناجتس الدجاج كصفات اللون والقوام.

الكلمات المفتاحية: ناجتس الدجاج، دقيق القلقاس، التركيب الكيميائي، الخصائص الفيزيوكيميائية