PHYSICOCHEMICAL AND SENSORY PARAMETERS OF CHICKEN NUGGETS WITH PARTIAL SUBSTITUTION OF MEAT AND FAT FOR PEA FIBER

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Abstract – The objective of this paper was to evaluate the physicochemical parameters of chicken nuggets produced with pea fiber addition as a partial substitute of meat or fat. Three treatments were processed: 1) Control (C), 2) Fiber Less Meat (FLM) – reduction of 10% of meat and addition of 2 % of pea fiber (plus 8% water) and 3) Fiber Less Fat (FLF) – reduction of 10 % of fat and 2% pea fiber (8% water) addition. After the processing, the products were characterized regarding the pH level, objective color, texture profile, weight loss after frying and sensory evaluation. The treatment C presented pH value (5.48) inferior ($p<0.05$) to the treatment FLM (5.72) and FLF (5.81). The texture profile evaluation scored higher levels ($p<0.05$) of firmness for the FLF treatment (1686.32 g) compared to the treatment C (1,217.16) and FLM (1,274.50). The parameters elasticity and cohesiveness did not differ ($p>0.05$) among the treatments. Results for weight loss after frying and all sensory attributes evaluated (aroma, texture, flavor and general acceptability) did not show differences ($p>0.05$) among treatments. One can conclude that it is possible to partially substitute meat and fat for pea fiber (plus water) not compromising most technological parameters and product acceptability.

Key Words –meat product, sensory acceptance, texture, color.

I. INTRODUCTION

The modern consumers are interested in savory and convenient products, but also are concerned about the nutrition facts, the safety and the benefits the food may offer (1).

One of the main reasons meat is concerned is the presence of saturated fat, which is considered a risk factor associated to heart conditions and cancer. Other concerns such as related to the food safety have caused a reduction of meat consumption in some regions, such as European Union (2). Several types of fibers have been individually evaluated, or combined with other ingredients in the elaboration of meat products with reduced fat such as restructured and emulsified products (3).

The addition of fiber in the food may change the consistence, the texture, the rheological behavior and therefore, the sensory characteristics of the final product. Regardless the nutritional objective, the fiber can be used with technological and economical purposes (4). Besides its neutral flavor, it was noticed that the use of fiber provides water retention and decrease of loss during cooking. The main kinds of fiber used in cooked meat products are orange, beetroot, wheat, oat, and pea (5).

The use of pea fiber was mentioned only by Anderson *et al.* (6). These authors used pea fiber in concentration that varied from 10 to 16% in ground meat and noticed that it would be useful in the development of food products that require fat retention during cooking, due to the increased fat retention from 33% to values around 85-98% when pea fiber was added.

The objective of this paper was to evaluate physicochemical and sensory parameters of chicken nuggets produced with pea fiber addition as a partial substitute of meat (aiming product cost reduction) and fat (aiming a healthier product with less fat).

II. MATERIALS AND METHODS

A. Experimental treatments

Three formulations of chicken nuggets were developed (Table 1), as follows: 1) Control treatment (C): no fiber addition, similar to a commercial product, 2) Fiber Less Meat Treatment (FMC): 10% of chicken meat reduction, addition of 2% of pea fiber and 8% of water 3) Fiber Less Fat treatment (FLF): reduction of 10% of chicken skin (fat source), 2% of pea fiber addition and 8% of water. The experiment was repeated twice.

Table 1: Formulations used in the production of chicken nuggets.

	C[1]	FLM[2]	FLF[3]
Ingredients	%	%	%
Chicken Breast fillet	70	60	70
Chicken skin	20	20	10
Pea Fiber	-	2	2
Water	4.65	12.65	12.65
Refined Salt	1.50	1.50	1.50
White Pepper	0.05	0.05	0.05
Garlic paste	0.30	0.30	0.30
Fresh Onion	3	3	3
Sodium Tripolyphosphate	0.25	0.25	0.25
Antioxidant (sodium erythorbate)	0.25	0.25	0.25

[1]Control; [2]Fiber less meat; [3]Fiber less fat.

B. Chicken nugget Processing

According to the producer (Roquette Freres, France), the pea fiber used in the present study presents the following composition: 10% moisture), fiber level (dry basis) of 50%, proteins level (dry basis) of 10% (at most) and starch (dry basis) about 35%.

The chicken and the fat (chicken skin) were ground in an electric grinder, with an 8 mm blade for meat and 2 mm for fat. Subsequently, the meat, the fat, and the other ingredients were mixed for 10 minutes until it got a homogeneous mixture. The mixture was separated in about 25 g pieces. After shaping them, they were breaded following the steps: first, they were pre-dusted, next were batter-coated and finally breaded. Then, the pieces of chicken nuggets were pre-fried in vegetable fat at 180 °C during about 4 minutes, until they reached the minimum temperature of 72ºC. After pre-frying, the products were packed, frozen and stored at – 18 °C.

C. Physicochemical parameters

pH values: The determination of pH was performed through a portable pH meter (Model HI 99163, Brand HANNA) with perforation electrode. This determination was run in triplicate.

Objective Color Analysis: It was performed in a portable colorimeter (model MiniScan XE, brand HunterLab). The sample was cut in half, in a way the reading was run only in the meat mixture. The color was expressed through the evaluation system CIELab - "Commission internationale de l'éclairage": L*, a* e b*. The analysis was run in triplicate, in three samples of each treatment.

Texture Profile Analysis (TPA): It was performed in texture meter (TA-XT2i, Stable Micro Systems, Godalming, UK) previously calibrated with standard weight of 2kg. For the analysis, all the product cover was removed, and the samples were chopped in cubes (2x2x1cm) and only the meat was subjected to analysis. The samples were comprised in up to 50% of the sample height, using an aluminum probe (SMS P/20) with speed of 0.3 mm/s and time between two compressions of 1.0s. The texture analyses were performed with ten samples (per treatment). The parameters evaluated were: firmness (g), elasticity (mm), cohesiveness (dimensionless) and chewy characteristics (gxmm).

Weight loss after frying: First, the breaded samples were weighted raw and were subjected to the process of frying in an electric fryer with vegetable fat pre heated at 180ºC for 2 minutes. After removing the excess of fat, the samples were weighed again. It was run in triplicate for each treatment. The percentage of weight loss was calculated according to the equation: % Weight loss after frying = (Initial Mass – Final Mass) x100/Initial mass.

D. Sensory evaluation

It was performed an affective acceptance test with 60 consumers to evaluate the differences concerning the formulations. For this, it was used a nine points hedonic scale, varying from “I extremely liked it” with score equal to 9 to “I extremely disliked it” with score equal to 1. The characteristics evaluated were: aroma, texture, flavor and general acceptability. The frozen samples were heated in an electric stove at 180ºC for 12 minutes. After, the samples were kept heated in a shelf dyer (about 60ºC), and the samples were discharged in case of not being consumed in a period of 20 minutes.

A. Statistical Analysis

The results were subjected to an analysis of variance (ANOVA) and the Tukey’s test for means comparisons. It was used the program

SAS (Statistic Analysis System), considering 5% of significance level.

III. RESULTS AND DISCUSSION

The results of the physicochemical analyses of different formulation of chicken nuggets are expressed on Table 2.

The control treatment presented inferior ($p<0.05$) pH level compared to the treatments FLM and e FLF. The presence of pea fiber in the treatment FLM and FLF may have caused the increase of pH levels. Verma *et al*. (7), found pH levels varying between 5.73 and 5.98 by evaluating chicken nuggets with reduction of meat (8.46 to 12.45%) and apple pulp addition (8 to 12%), levels closed to the ones found in the products with fiber addition in the present study.

The color parameters L* and b* did not differ ($p>0.05$) among treatments, thus the composition change in the treatments did not alter these parameters (Table 2). Regarding the parameter a*, the treatment FLF differed ($p<0.05\%$) from the treatments C and FLM, but the variation (-0.75 to -1.09) probably would not change the acceptability by the consumers concerning the product appearance.

Wan Rosli *et al*. (8) by evaluating the partial substitution of the meat content in chicken nuggets for hiratake mushroom (Pleurotus sajor-caju) known as oyster mushroom in the levels of 13.5% and 27%, found higher levels of L* and b* for the control samples but compared to the parameter a* there was no difference.

In the evaluation of texture, the parameters elasticity and cohesiveness did not differ ($p>0.05$) among the treatments. However, there were differences ($p<0.05$) among the treatments for the parameters firmness and chewiness. It may be possible that the highest firmness level found for the treatment FLF (1686.32 g) is resulted by the reduction of 10% of fat in the formulation. Wong *et al*. (9) recorded greater tenderness levels in hamburgers with fat levels of 12% and 20% compared to 4% demonstrating the positive factor of the fat for the tenderness of the product, confirming the results of the present study.

The levels obtained during the evaluation of weight loss after frying did not differ ($p>0.05$) among treatments. This result is considered favorable, since the pea fiber was capable of incorporate greater quantity of water that was added in the FLM treatment (8%) and FLF (8%), keeping a balanced formulation.

Table 2: Physicochemical Parameters (average ± standard error) chicken nugget formulated with or without pea fiber.

	C[1]	FLM[2]	FLF[3]
pH	5.48±0.03[b]	5.72±0.05[a]	5.81±0.03[a]
L*	69.90±0.23[a]	69.51±0.07[a]	69.68±0.30[a]
a*	(-)1.09±0.02[a]	(-)1.05±0.01[a]	(-)0.75±0.06[b]
b*	9.25±0.15[a]	9.15±0.02[a]	9.55±0.16[a]
Firmness (g)	1,217.16±71.64[b]	1,274.50±19.08[b]	1,686.32±56.05[a]
Elasticity (mm)	0.66±0.03[a]	0.69±0.01[a]	0.64±0.01[a]
Coesiviness	0.68±0.03[a]	0.68±0.02[a]	0.65±0.01[a]
Chewiness (g.mm)	597.31±17.50[ba]	573.96±14.90[b]	685.04±13.67[a]
Loss of Weight after Frying	4.10±0.06[a]	4.33±0.13[a]	4.20±0.01[a]

[1]Control: similar to the commercial formulation; [2]Fiber less meat: reduction of 10% of beef, addition of 2% pea fiber and 8% of water; [3]Fiiber less fat: reduction of 10% of meat fat, addition of 2% of pea fiber and 8% of water. Lower case letters differ in the same row indicating significant differences ($p<0.05$) among the control and the other treatments.

It was observed that no evaluated sensory attributes (Table 3) presented difference ($p>0.05$) among the treatments, thus the partial substitution of meat (10%) and fat (10%) for pea fiber (2%) and water (8%), did not change the acceptability of the products by the consumer. All the analyzed parameters obtained scores between 7.20 to 7.48, comprising in the hedonic scale "I liked it" and “I liked it very much”.

Similar results were reported by Pietrasik *et al.* (10), that comparing bologna with high fat levels (22%) and bologna with low fat levels (10%) with 4% of pea fiber, did not find differences ($p>0.05$) in sensory acceptability concerning the attributes appearance, color, flavor, texture and global acceptability.

Table 3: Sensorial Acceptability of different formulations of chicken nuggets (average ± standard error).

	C[1]	FLM[2]	FLF[3]
Aroma	7.45±0.15[a]	7.38±0.16[a]	7.20±0.18[a]
Texture	7.42±0.14[a]	7.38±0.16[a]	7.28±0.17[a]
Flavour	7.47±0.14[a]	7.40±0.15[a]	7.47±0.17[a]
General Acceptability	7.48±0.13[a]	7.42±0.15[a]	7.38±0.15[a]

[1]Control: similar to the commercial formulation; [2]Fiber less meat: reduction of 10% of beef, addition of 2% pea fiber and 8% of water; [3]Fiiber less fat: reduction of 10% of meat fat, addition of 2% of pea fiber and 8% of water. Lower case letters differ in the same row indicating significant differences ($p<0.05$) among the control and the other treatments.

IV. CONCLUSION

It is concluded that it is possible to add 2% of pea fiber (and 8% water) in chicken nuggets with the partial substitution of 10% of meat (cost reduction) or 10% of fat (calories reduction), without compromising most of technological parameters and the product acceptability.

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