

# FATTY ACIDS PROFILE OF CHICKEN NUGGETS ADDED WITH CHIA FLOUR (*Salvia hispânica* L)

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**Abstract – The objective was to reformulate chicken nuggets through the replacement of chicken skin with chia flour, aiming healthier fatty acids profile. Five formulations were processed with different levels of chia flour (Zero, 5, 10, 15 and 20%) replacing same levels of chicken skin. The replacement of chicken skin with chia flour did not affect protein and lipid content but increased the ash content and decreased the moisture. The SFA and MUFA decreased but PUFA increased with higher concentrations of chia flour. Furthermore, omega-3 (linolenic acid) increased from 0.89 to 32.16% in treatments Zero and 20% chia flour, respectively. Healthier chicken nuggets with improved fatty acids profile were obtained through the replacement of chicken skin with chia flour.**

**Key Words – Healthiness, linolenic acid, meat product.**

## I. INTRODUCTION

The reformulation of meat products can be realized by reduction of compounds present in the composition, such as: fat, saturated fatty acids, salt and nitrites, or by the incorporation of functional ingredients as fibers, vegetable proteins, monounsaturated and polyunsaturated fatty acids and antioxidants [1]. In a recent evaluation of the lipid profile of chia flour, Segura-Campos et al. [2] found that 91.88% were unsaturated fatty acid and 68.52% of this value corresponded to  $\alpha$ -linolenic polyunsaturated fatty acid. Souza et al. [3] affirmed that the addition of chia's by-product (chia flour partially defatted) in hamburger is an alternative method for obtain a nutritionally balanced food due the high  $\alpha$ -linolenic acid content. Thus, the aim of the present study was the reformulation of chicken nuggets by the addition of chia flour (*Salvia hispânica* L) in substitution of chicken skin, aiming a meat product with healthier fatty acids profile.

## II. MATERIALS AND METHODS

The study was performed at the College of Animal Science and Food Engineering of University of São Paulo, Brazil. Five formulations of chicken nuggets with different levels of chicken skin replacement by chia flour were processed: 1) Control (20% of chicken skin and 0% of chia flour), 2) Chia5% (15% of chicken skin and 5% of chia flour), 3) Chia10% (10% of chicken skin and 10% of chia flour), 4) Chia15% (5% of chicken skin and 15% of chia flour) and 5) Chia20% (0% of chicken skin and 20% chia flour). The other ingredients used were: 77.7% of chicken breast fillet, 1.5% of sodium chloride, 0.05% of sodium erythorbate, 0.25% of sodium tripolyphosphate, 0.30% of onion powder, 0.15% of garlic powder and 0.05% of white pepper. After battering and breading, the nuggets were fried in palm fat at 180 °C until 72 °C of internal temperature. All analysis of nuggets were realized after the frying and the experiment were repeated three times. For proximate composition analysis, the official AOAC methodology [4] was used to determine protein (981.10), ash (920.153) and moisture (950.46) contents. Lipid content was determined by the Bligh & Dyer method [5]. Fatty acids profile was analyzed by FAME gas chromatography according to the official AOCS methods Ce 2-66 and Ce 1-62 [6] and quantification was based on the ratios of the area of each fatty acid to the area of the internal standard, methyl tridecanoate C13:0, using the response correction factors of the flame ionization detector and the conversion of methyl esters of fatty acids to fatty acid [7]. The results were evaluated by ANOVA using SAS statistical program and the means were compared by Tukey test, at 5% of significance.

## III. RESULTS AND DISCUSSION

Results of proximate composition and fatty acid profile of chicken nuggets are presented in Table 1. The protein and lipid contents were not affected ( $p>0.05$ ) by the replacement of chicken skin with chia flour. According Brazilian [8] and European [9] regulations, the evaluated products can be classified as high protein content and as a food rich in

proteins, respectively. It was observed that from Chia10% treatment the replacement of chicken skin by chia flour decreased the moisture content and increased the ash content ( $p < 0.05$ ). These variations are due to the addition of chia flour, which presents higher mineral and lower moisture content than the chicken skin.

**Table 1.** Results of proximate composition and fatty acid profile of the chicken nuggets.

| Analysis                      | Treatments         |                    |                     |                     |                    | SEM  |
|-------------------------------|--------------------|--------------------|---------------------|---------------------|--------------------|------|
|                               | Control            | Chia5%             | Chia10%             | Chia15%             | Chia20%            |      |
| Proteins (%)                  | 17.61 <sup>a</sup> | 17.90 <sup>a</sup> | 19.42 <sup>a</sup>  | 19.98 <sup>a</sup>  | 20.92 <sup>a</sup> | 0.73 |
| Lipids (%)                    | 14.42 <sup>a</sup> | 13.72 <sup>a</sup> | 13.73 <sup>a</sup>  | 14.10 <sup>a</sup>  | 14.03 <sup>a</sup> | 0.46 |
| Moisture (%)                  | 49.15 <sup>a</sup> | 48.71 <sup>a</sup> | 47.34 <sup>ab</sup> | 45.51 <sup>bc</sup> | 43.67 <sup>c</sup> | 0.39 |
| Ash (%)                       | 1.99 <sup>b</sup>  | 2.01 <sup>b</sup>  | 2.26 <sup>a</sup>   | 2.27 <sup>a</sup>   | 2.41 <sup>a</sup>  | 0.05 |
| <b>Saturated (SFA)</b>        | 36.22 <sup>a</sup> | 33.24 <sup>b</sup> | 30.50 <sup>bc</sup> | 28.31 <sup>c</sup>  | 25.24 <sup>d</sup> | 0.61 |
| Palmitic (C16:0)              | 31.88 <sup>a</sup> | 29.17 <sup>b</sup> | 26.65 <sup>c</sup>  | 25.38 <sup>c</sup>  | 23.09 <sup>d</sup> | 0.40 |
| Stearic (C18:0)               | 4.35 <sup>a</sup>  | 4.06 <sup>a</sup>  | 3.85 <sup>a</sup>   | 2.93 <sup>a</sup>   | 2.15 <sup>a</sup>  | 0.51 |
| <b>Monounsaturated (MUFA)</b> | 41.68 <sup>a</sup> | 37.15 <sup>b</sup> | 32.75 <sup>c</sup>  | 28.16 <sup>d</sup>  | 23.92 <sup>e</sup> | 0.69 |
| Palmitoleic (C16:1)           | 2.46 <sup>a</sup>  | 1.72 <sup>ab</sup> | 1.26 <sup>bc</sup>  | 0.59 <sup>cd</sup>  | 0.06 <sup>d</sup>  | 0.23 |
| Oleic (C18:1)                 | 38.92 <sup>a</sup> | 35.43 <sup>b</sup> | 31.49 <sup>c</sup>  | 27.57 <sup>d</sup>  | 23.86 <sup>e</sup> | 0.52 |
| <b>Polyunsaturated (PUFA)</b> | 22.40 <sup>e</sup> | 29.62 <sup>d</sup> | 36.75 <sup>c</sup>  | 43.54 <sup>b</sup>  | 50.84 <sup>a</sup> | 1.23 |
| Linoleic (C18:2 n6)           | 21.51 <sup>a</sup> | 21.02 <sup>a</sup> | 20.23 <sup>a</sup>  | 19.19 <sup>a</sup>  | 18.68 <sup>a</sup> | 0.72 |
| Linolenic (C18:3 n3)          | 0.89 <sup>e</sup>  | 8.60 <sup>d</sup>  | 16.52 <sup>c</sup>  | 24.35 <sup>b</sup>  | 32.16 <sup>a</sup> | 0.64 |

a, b, c, d, e Means with different letters in a row are significantly different ( $p < 0.05$ ). SEM - standard error of mean.

The replacement of chicken skin with chia flour in chicken nuggets decreased total SFA and MUFA but the mean values of total PUFA increased ( $p < 0.05$ ). Chia20% showed PUFA content (50.84) more than twice higher as the Control treatment (22.40%) due the presence of chia flour, which has high  $\alpha$ -linolenic fatty acid content.

#### IV. CONCLUSION

One can conclude that is possible to obtain healthier chicken nuggets with improved fatty acids profile through the replacement of chicken skin with chia flour.

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