

QUALITY CHARACTERISTICS OF CHICKEN NUGGETS WITH REDUCED AMOUNTS OF SODIUM CHLORIDE AND ADDED DIETARY FIBER

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Abstract - The aim of this study was to evaluate the effect of reduced amounts of sodium chloride and added dietary fiber on quality characteristics of chicken nuggets. Considering their high protein value, it would be important to develop alternatives to provide them with the characteristics of a functional food. Thirteen batches of nuggets were produced according to the combination of factor levels (percentage of sodium chloride and wheat fiber -Vitacel® WF 200-) resulting from the application of a central composite design. Analytical determinations were: pH; moisture and cooking loss; whiteness; Warner Bratzler hardness and texture profile analysis. The effect of different amounts of sodium chloride and added fiber on chicken nuggets quality was evaluated applying response surface methodology. Furthermore, overall acceptability of nuggets was evaluated by a panel of regular consumers and the data was analyzed using ANOVA.

According to results, 50% or less of sodium chloride could be reduced in nugget formulation, adding 2% of wheat fiber to a product with less cooking loss, tenderer characteristics and with a slight decrease in whiteness, without affecting consumer acceptability. This approach is promising for producing low sodium nuggets with added wheat fiber.

I. INTRODUCTION

Chicken nuggets are snacks present in the market, a source of highly nutritious protein with the characteristic of being a semi-ready food consistent with the trend of food consumption involving rapid preparation (1). Considering their high protein value, it would be important to develop alternatives to provide chicken nuggets with the characteristics of a functional food. A functional food either contains components that have beneficial physiological effects or lack components that depending on intake

amounts may negatively impact consumer's health (2). The incorporation of natural fiber and reduced chloride sodium (NaCl) content would be an appropriate strategy to adapt chicken nuggets to this new concept.

Dietary fiber has undoubtedly an important role in maintaining a normal laxative effect and on the microbial population of the large intestine (3). In addition, gastrointestinal tract and cardiovascular diseases, obesity and diabetes have low incidence in populations consuming diets rich in fibers. A study on the diet of Argentina adolescents (4) found that only 1% of this population said ingesting five servings of the food needed to incorporate the minimum dietary fiber recommended by nutritionists. Hence the importance of this addition would have in the diet, being that children and adolescents are the age groups that prefer this type of snacks.

Moreover, functional characteristics of chicken nuggets will also improve with the reduction in content of NaCl. The importance of table salt in human physiological functioning is well known. However, excessive consumption of sodium may cause organic problems: water retention and high blood pressure, the last one being a major risk factor for coronary heart disease and stroke (5). Based on this general knowledge, there is a tendency to reduce the amount of NaCl in the diet. Common salt is the main source of sodium in meat products and the reduction of its content in them is an important objective to reduce the total sodium diet (6). Nevertheless, the reduction in the amount of NaCl and an increase in the amount of fiber in chicken nuggets could affect their sensory characteristics, and probably some other technological feature as cooking loss. The aim of this paper was to evaluate the effect of reduced amounts of NaCl and

added wheat fiber (F) on quality characteristics of chicken nuggets.

II. MATERIALS AND METHODS

Thirteen batches of chicken nuggets were produced according to the combinations of factor levels (percentage of NaCl and F Vitacel[®] WF-200) and random order resulting from the application of a central composite design. The experimental design included five repetitions of the central point. Amounts of each component in the working study are shown in Table 1.

The manufacturing process was carried out in pilot plant by mixing the minced chicken breast meat with spices and additives regularly used for commercial nuggets. Paste batches were prepared, replacing the removed NaCl by a potassium chloride and magnesium chloride mix (50/50), adding F in place of the same percentage of fat matter (butter). The units formed as discs (diameter 4cm), breaded in flour, egg and breadcrumbs, were fried in sunflower oil (180°C) until 71 °C (internal temperature). Nuggets were kept frozen in zip lock bags. Analytical determinations performed in the nuggets were: pH (pH meter with puncture electrode), % moisture (7) and %cooking loss (by weight difference before and after cooking). Warner Bratzler shear test and texture profile analysis (TPA) were made, computing hardness (WB,N), cohesiveness, springiness and chewiness (1).

Internal color was measured on the longitudinal cut (CIELAB system: L*, a*, b*, D65 as illuminant, 2° as standard observer) calculating whiteness (W) by the equation $100 - [(100 - L^*)^2 + a^{*2} + b^{*2}]^{0.5}$.

Table 1 Content of sodium chloride and fiber, in each batch of chicken nuggets

| Batch (n°) | Fiber (%) | Sodium chloride (%) |
|------------|-----------|---------------------|
| 1 | 1,0 | 1,2 |
| 2 | 1,7 | 0,7 |
| 3 | 0,3 | 0,7 |
| 4 | 1,0 | 1,2 |
| 5 | 0,0 | 1,2 |
| 6 | 1,0 | 1,2 |
| 7 | 1,0 | 1,9 |
| 8 | 1,0 | 0,5 |
| 9 | 2,0 | 1,2 |
| 10 | 1,0 | 1,2 |
| 11 | 1,7 | 1,7 |
| 12 | 0,3 | 1,7 |
| 13 | 1,0 | 1,2 |

The effect of different amounts of NaCl and F on the chicken nuggets quality characteristics studied was evaluated applying response surface methodology (RSM). Model validation was carried out by ANOVA, verifying the significance of all effects.

Furthermore, overall acceptability was evaluated by a panel of regular consumers of nuggets (60) by means of a 10 cm unstructured scale, ranging from "dislike very much" (0) to "like very much" (10). This data was analyzed with ANOVA.

All statistical analysis was performed using Statgraphics Centurion XV (StatPoint Tech, Inc., Warrenton, VA, USA), with a confidence level of 95%.

III. RESULTS AND DISCUSSION

The pH of nuggets fluctuated from 6.18 to 6.34. Perlo *et al.* (8) observed nuggets pH values within this range. RSM indicated that pH was significantly affected by the percentage of NaCl ($p=0.0028$) whereas pH was less influenced by the amount of F ($p=0.0490$). It is observed (Figure 1) that as the amount of NaCl decreases in chicken nuggets, pH increases, similarly to low sodium cooked frankfurters (9). Meanwhile, F adds very little variability, with a slight increase of pH in nuggets with higher %F, as observed by Choe *et al.* (10) in cooked sausages with pig skin and wheat fiber. This trend may be due to the pH of F (7,5). Moisture was significantly affected by F ($p=0.0247$) and NaCl ($p=0.0304$). The higher values relate to intermediate amounts of NaCl and high F (Figure 2). In addition cooking loss was only significantly affected by NaCl% ($p=0.0129$). Like moisture, it behaves showing the minor cooking loss for intermediate values of NaCl and the maximum percentage of F (Figure 3).

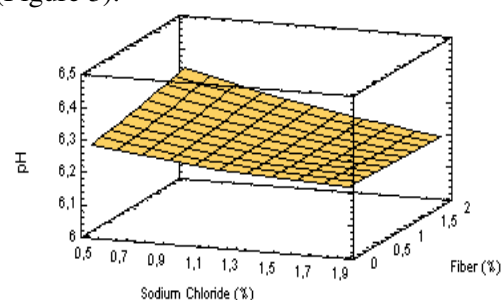


Figure 1 Response surface plot for pH

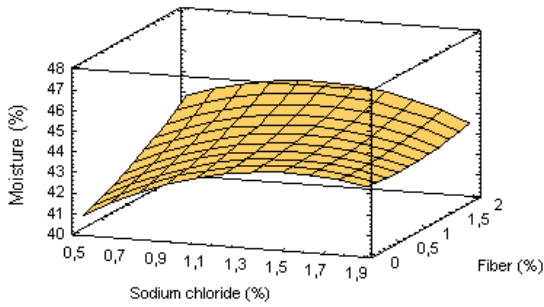


Figure 2 Response surface plot for Moisture

Dietary fibers are known to have good hydration properties, improving cooking yields in meat products (11), although this outcome does not emerge visible here. Possibly, the increase in moisture binding by the added wheat fibers and increased amounts of NaCl, counteracts the effect of decreasing pH when salt increases. Perhaps this influences the fact that both the maximum values found for moisture and the best results for cooking loss are within the range of intermediate values for sodium chloride and the maximum percentage of fiber studied. Moreover, results are very interesting from a technological viewpoint since a minor cooking loss means a greater processing yield, even in formulations with low amounts of NaCl.

In regards with color data, W was found to be affected by the amount of NaCl ($p=0.0352$), with slightly lower values for low-sodium formulations (Figure 4). The added wheat fiber, with its clear color in white tones, did not decrease W of chicken nuggets, like in restructured fish products and surimi (12, 13). Results could be related to changes in pH values, since they decreased as NaCl increased. It is clearly known that a decrease in pH leads to a paler chicken meat, in raw (14) and in cooked chicken meat (15). W is usually applied to surimi products and it was selected because

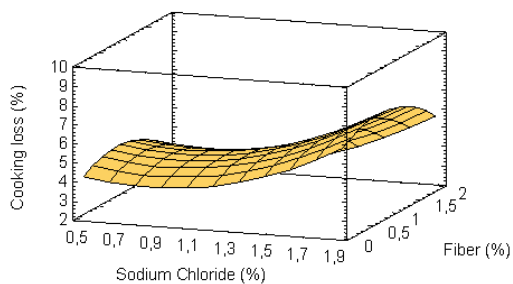


Figure 3 Response surface plot for Cooking loss

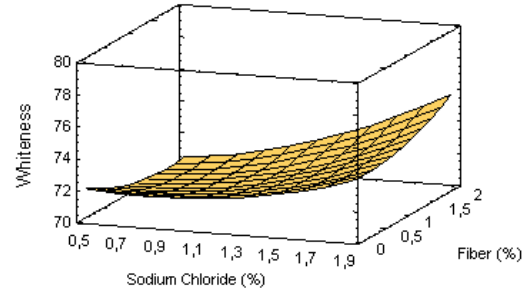


Figure 4 Response surface plot for Whiteness

chicken breast muscle approaches the white color of some fish species (16).

Only F showed to significantly affect WB values ($p=0,046$) in chicken nuggets, showing a decrease when the percentage of F increases (Figure 5). Otherwise, TPA texture parameters were not affected neither by NaCl% nor Fiber%. Other studies applied to different meat products (largely ground, restructured, emulsions and gels) found textural properties decrease as the amount of F increased, mainly hardness (13; 17; 18). Probably, wheat fibers were larger than the cells of the matrix thus making a disruption in the less homogenous protein network (13).

Moreover, taking into account the sensory test carried out, consumers did not find any significant differences between batches studied ($p<0,05$), being the mean score of overall acceptability 7.6 ± 1.4 . Poultry meat has neutral flavour, consistent and good texture, and light colour (19). These characteristics allow chicken meat products to acquire not only desired flavor profiles and/or textures (20), but also functional properties according to targeted consumers.

IV. CONCLUSION

The addition of fiber seems to mask sensory acceptability problems in a product reduced

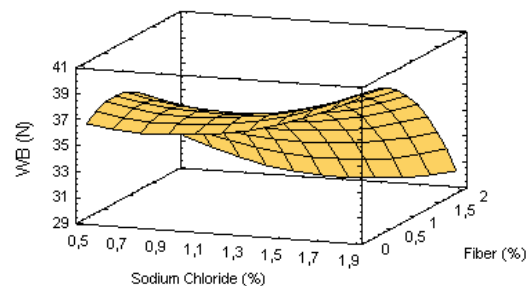


Figure 5 Response surface plot for WB

in sodium, and also it appears to be a good alternative for replacing, to some extent, salt functional properties. This approach is promising for producing low sodium nuggets with added wheat fiber. According to results, 50% or less sodium chloride could be reduced in nugget formulation, adding 2% of wheat fiber to a product with less cooking loss, tenderer characteristics and with a slight decrease in whiteness, without affecting consumer acceptability.

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