PEA FIBER ADDITION IN FRANKFURTER SAUSAGE AIMING MEAT AND FAT CONTENT REDUCTION

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Abstract – This work was carried out in order to analyze physicochemical characteristics and sensory acceptance of frankfurters formulated with pea fiber addition. Three formulations were processed: Control (C): similar to commercial formulation; Fiber/Less Meat (FLM): reduction of 5% meat and addition of 2% pea fiber and Fiber/Less Fat (FLF): reduction of 8% fat and addition of 2% pea fiber. The FLF formulation presented lower pH value than the C formulation. Control formulation presented higher processing yield. In the sensory evaluation, the FLM formulation was given higher scores by the consumers. One can conclude that the partial substitution of meat and fat with pea fiber in frankfurters is possible, without decreasing most of the physicochemical characteristics and sensory acceptance.

Key Words – cost reduction, meat products and food fibers.

I. INTRODUCTION

The offer of healthier products that may bring benefits to people's good eating habits is an increasing trend appreciated by consumers [1]. According to this trend, research involving fiber use in meat products has been developed aiming at the reduction of fat content and caloric value, besides improving the physical structure such as the product texture [2].

Fiber not only provides nutritional benefits but also offers technological and economical improvements to the food industry. The fiber addition may change the consistence, the texture, the rheological behavior and, therefore, the sensory characteristics of the final product [3]. The fiber addition in meat products has been practiced in emulsified product due to its neutral flavor, the capability of retaining water, providing reduction in weight loss after cooking [4, 5, and 6].

Therefore, the objective of this study was to analyze the effects of pea fiber addition, as a partial substitute of meat (aiming at product cost reduction) and fat (aiming at a healthier product), on physicochemical characteristics and sensory acceptance of frankfurter sausages.

II. MATERIALS AND METHODS

A. Experimental Design

Three different formulations were manufactured (Table 1): 1) Control (C): no pea fiber, similar to a commercial formulation, 2) Fiber Less Meat (FLM): reduction of 5% of meat, addition of 2% of pea fiber and 3% of water, and 3) Fiber Less Fat (FLF): reduction of 8% of pork fat, addition of 2% of pea fiber, and 6% of water. The experiment was repeated twice.

B. Frankfurter Sausage Processing

All raw materials, water (as ice) and ingredients were weighed individually. The frankfurter mass was comminuted in a cutter (Brand: Tecmafrig) for approximately 10 minutes and removed from the equipment with temperature lower than 14ºC. The emulsions were stuffed with a pneumatic stuffer (V25, Sirman) in cellulose casings with 22 mm of diameter (Viscofan do Brasil, São Paulo) and hand tied in segments of approximately 15 cm. They were cooked in a smokehouse (SL 218, Arprotec) with straight steam and closed chimney for approximately 1 hour and 30 minutes, until reaching internal temperature of 72ºC. After cooking, the frankfurters were cooled by water aspersion, the casings were removed and the products were vacuum packed (MI 60, Selovac) and stored at 4ºC until the analyses.

C. Physicochemical parameters

Proximate Composition: AOAC Official Methods of Analysis [7] were used to determine moisture content (950.46), fixed mineral residue or ash content (920.153), and protein content (928.08). The lipid content was determined by the Bligh & dyer method [8].

pH analysis: Determination of pH values was performed by a portable pH meter (Model HI 99163, Brand HANNA) with perforation electrodes. The screening was performed in triplicate with a three point perforation in each sample.

Instrumental Color Analysis: The samples were submitted to objective color analysis using a portable colorimeter (Model MiniScan XE, Brand HunterLab) applying L*, a* and b* scales from the evaluation system CIELab - "Commission Internationale de L'éclairage". The samples were cut lengthwise to determine the inside color. The analysis was performed in triplicate, in which 3 measures were taken from each sample.

Table 1: Formulations used in frankfurter sausage elaboration.

	C[1]	FLM[2]	FLF[3]
Ingredients	%(m/m)	%(m/m)	%(m/m)
Beef	55	50	55
Pork backfat	25	25	17
Pea fiber	-	2	2
Ice	17.25	20.25	23.25
Condiment	1	1	1
Salt	1	1	1
Curing salt (Sodium nitrite)	0.25	0.25	0.25
Antioxidant (Sodium erythorbate)	0.25	0.25	0.25
Emulsifier (Sodium tripolyphosphate)	0.25	0.25	0.25

[1]Control; [2]Fiber Less Meat; [3]Fiber Less Fat.

Processing yield: Approximately 2 kg of each formulation was weighed in triplicate before and after cooking under described conditions (item II B). The processing yield was calculated by this equation:
Yield (%) = (final weight/ initial weight) x 100.

D. Sensory Analysis

An affective acceptance test was performed with 60 consumers using a 9-point hedonic scale varying from "I like extremely" (9) to "I dislike extremely" (1). The analyzed attributes were aroma, texture, flavor and general acceptance. To proceed with the analysis the frankfurter was heated in water for 5 minutes and afterwards cut in 2 cm pieces and kept heated in a stove (approximately at 45ºC).

E. Statistical Analysis

Results were subjected to analysis of variance (ANOVA) and Tukey's test for means comparisons. It was used the program SAS (Statistic Analysis System), 9.1.3 version, considering 5% of significance level.

III. RESULTS AND DISCUSSION

The C formulation presented the lowest ($p<0.05$) moisture content (61.72%) (Table 2). The highest moisture content in FLM and FLF formulations is due to the highest amount of water added (3 and 6% respectively) compared to the control treatment sample. Regarding the ash content, FLM and FLF formulations presented higher values ($p<0.05$) compared to C (Table 2), and this difference may be related to the fixed mineral residue content of the pea fiber used.

Table 2: Proximate composition (mean ± standard error) of frankfurter sausage formulations.

(%)	C[1]	FLM[2]	FLF[3]
Moisture	61.72 ± 0.07^{c}	62.41 ± 0.02^{b}	65.47 ± 0.01^{a}
Ashes	3.43 ± 0.06^{b}	3.67 ± 0.01^{a}	3.87 ± 0.01^{a}
Lipids	19.11 ± 0.02^{b}	19.29 ± 0.02^{a}	14.41 ± 0.03^{c}
Protein	15.19 ± 0.09^{a}	13.96 ± 0.02^{b}	15.43 ± 0.03^{a}

[1]Control; [2]Fiber Less Meat; [3]Fiber Less Fat. Different low case letters on the same row indicate significant differences ($p<0.05$) among control and the other formulations.

As expected, the FLF formulation presented lower ($p<0.05$) lipid content (14.41%) compared to the other formulations. The absolute values were very close between C and FLM formulations (19.11 and 19.29% respectively). The reduction in the lipid content in FLF formulation, approximately 24.59% when compared to C formulation, is very close to the 25% reduction necessary for a product to be considered "light", according to Brazilian Ministry of Health [9]. It was found lower protein content ($p<0.05$) to FLM formulation. This result is derived from the reduction of 5% of meat, which is the main protein source in this formulation. Technical Regulations of Identity and Quality of Frankfurter [10] require that the moisture and fat contents must be 65 and 30% respectively at the most, whereas protein content must not be lower than 12%. Therefore, it is noticeable that only FLF formulation did not comply the current legislation,

showing slightly higher moisture (65.47%) than the allowed. FLF formulation presented lower ($p<0.05$) pH when compared to the C formulation, although differences ($p>0.05$) were not found in relation to FLM formulation (Table 3). Possibly, the pH reduction in the FLF formulation is due to the fat content variation, since the fiber used showed pH value close to 7.16. According to Viuda-Martos et al. [11], the fiber, as well as the protein, is a neutral product, unless it is fermented, which is not expected from a cooked meat product.

Table 3: Physicochemical characteristics (mean ± standard error) of frankfurter sausage elaborated with or with no pea fiber.

	C[1]	FLM[2]	FLF[3]
pH	6.31±0.01[a]	6.22±0.03[ba]	6.01±0.07[b]
L*	59.6±0.9[a]	57.2±0.9[a]	55.39±0.03[a]
a*	9.4±0.3[a]	9.6±0.4[a]	10.52±0.05[a]
b*	10.32±0.08[ba]	10.58±0.03[a]	10.09±0.01[b]
Processing yield (%)	86.04[a]	84.49[b]	82.66[c]

[1]Control; [2]Fiber Less Meat; [3]Fiber Less Fat. Different low case letters on the same row indicate significant differences ($p<0.05$) among control and the other formulations.

The color parameters L* and a* did not differ ($p>0.05$) among formulations. Regarding the variable b*, FLM and FLF formulations differed ($p<0.05$) between each other, although both did not present differences ($p>0.05$) compared to C (Table 3). Possibly the difference found for the parameter b* is due to the variations of meat and fat content in the formulations. It is remarkable that the variation of b*, despite significant, was very small and does not represent meaningful changes to the consumers. Savadkoohi et al. [12] studied the effect of blanched tomato residue addition (1 to 7%) as a fiber source in frankfurter made of beef, and reported that the frankfurter formulated with the tomato residue in concentrations higher than 3% presented a higher value of a* but regarding the variables L* and b* the formulations did not present significant difference when compared to the commercial formulation (with no tomato residue addition). In several studies the significant changes in the color parameters of meat products with fiber addition or products as a fiber source are attributed to the color of the fiber used. Fibers that contain dark and yellow pigments can cause greater interference in color measures [13, 14, and 15]. The color of the pea fiber is white, not interfering in the product color in this study. The C formulation presented the highest ($p<0.05$) processing yield (86.04%) and the values declined ($p<0.05$) in the FLM (84.09%) and FLF (82.66) formulations (Table 3). It may be considered that, the concentration of pea fiber was not enough to absorb the higher content of water added to the FLM (20.25%) and FLF (23.25%) formulations. This behavior was not expected, since the insoluble fibers are expected to have high water retention ability and should contribute to the reduction of losses during cooking [3]. Meat products cooking losses depends on the temperature and the cooking time [16], the cooking method [17], the additives used [18], the casing [19] and the fat and moisture content [20]. Several findings have been reported relating to processing yield of emulsions systems. Choi et al. [19] analyzing the partial substitution of fat (20%) by 2% of oat bran fiber, 10% of several vegetable oils (canola, grape seed and corn) and 10% of water in a meat emulsion system found lower losses during the cooking process in the formulations with oat bran and vegetable oils addition. Pietrasik et al. [21] analyzed bologna sausage with higher (22%) or lower (10%) fat content, 4% of flour and pea fiber addition and did not find differences among formulations regarding to the yield after cooking. In the sensory acceptance test, FLM obtained higher ratings ($p<0.05$), compared to C and FLF formulations, regarding the attributes texture, flavor and general acceptance. Regarding the attribute aroma, FLM differed ($p<0.05$) from the Control but not ($p>0.05$) from FLF formulation (Table 4).

Table 4: Sensory acceptance of different formulations of frankfurter sausage (mean ± standard error).

Characteristics	C[1]	FLM[2]	FLF[3]
Aroma	6.85±0.18[b]	7.31±0.16[a]	6.98±0.17[ba]
Texture	6.13±0.20[b]	7.31±0.17[a]	6.0±0.22[b]
Flavor	7.08±0.18[b]	7.68±0.14[a]	6.81±0.18[b]
General Acceptance	6.75±0.17[b]	7.51±0.16[a]	6.65±0.16[b]

[1]Control; [2]Fiber Less Meat; [3]Fiber Less Fat. Different low case letters on the same row indicate significant differences ($p<0.05$) among control and the other formulations.

These are promising results since the frankfurter formulation with higher acceptance for most of the evaluated sensory attributes was the FLM, with pea fiber addition (2%) and reduction of meat content (3%), considered cheaper and healthier. Fernandez-Gines et al. [2] used lemon albedo (0 to 10%) in bologna sausage formulations and found, during the sensory analysis, a juiciness reduction and firmness increase with the increase of added lemon albedo level, but regarding smell and flavor attributes, no differences were found.

IV. CONCLUSION

In the tested conditions, the partial substitution of meat and fat by pea fiber (plus water) interfered in some of the frankfurters physicochemical characteristics evaluated. However, these changes did not compromise the sensory acceptance of the frankfurter with lower fat content and yet may have been responsible for a better sensory acceptance of the frankfurter with lower meat content, when compared to the control sample. Thus, one can conclude that the partial substitution of meat or fat with pea fiber (plus water) in frankfurters is a viable option to produce cheaper and healthier products.

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