EFFECTS OF FUNCTIONAL EMULSION GELS ON PHYSICOCHEMICAL, AND STRUCTURAL PROPERTIES OF BOLOGNA SAUSAGE

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Abstract – Emulsion gels (EG) prepared with soybean oil, soy protein isolate, chia flour, inulin or gelling agents and/or stabilizers (carrageenan, sodium caseinate and sodium tripolyphosphate) were used to replace fat (pork back fat) in Bologna sausage. Physicochemical and microstructureal characteristics of sausage containing EG were evaluated. Sausage containing EG presented a better profile of fatty acids, with high omega 3 content and a reduction of up to 41% of saturated fat. The microstructure of the reduced-fat sausages (~12% of fat) showed larger porosity when compared to the other samples (~18% of fat). Physicochemical, and microstructureal properties of the sausage made with pork back fat and gelled emulsion were similar to the control formulation, but with enhanced profile in fatty acids.

Key Words – gelled emulsion, meat products, replace fat, reduce fat, microstructure

I. INTRODUCTION

The excessive consumption of saturated fats and trans fats is associated to the development of several chronic diseases, such as hypertension, and consequently an increased risk of cardiovascular disease. The primary sources of saturated fat ingestion in human diet include meats and their by-products. In recent years, several studies have suggested new techniques for structuring liquid oils resulting in reformulated lipid systems with rheological and technological properties close to saturated fat. The use of gelled emulsions present great potential in the development of healthier foods [1], is a very promising technique to reduce fat and/or improve lipid profile [2] in meat products. In this context, this work aimed to evaluate the effect of the substitution of pork back fat by functional gelled emulsions on the physicochemical and microstructural properties of bologna sausage added of inulin and chia flour.

II. MATERIALS AND METHODS

Two treatments based on the protein source in the emulsion gels were elaborated: EG1 contained 5% Soy protein isolate (SPI), 1% sodium caseinate (CAS), 0.75% carrageenan, 0.5% sodium tripolyphosphate and 1% inulin. EG2 was made with 2.5% SPI, 2.5% chia flour and the same amount of the other ingredients added in EG1. In addition, both treatments were made with 51% soybean oil and 41% distilled water. The main steps to obtain emulsions gels were: heating of SPI and CAS with distilled water followed of adding of carrageenan, inulin, and sodium phosphate and mixing in GRINDOMIX GM 200 homogenizer (Retsch, Amsterdam, The Netherlands) at 10,000 rpm for 4 min. The oil was added gradually to the mixture of water, protein, and other components and homogenized for another 4 min. The samples were then vacuum packed in plastic containers and heated at 90°C for 30 min to gel the emulsion. Afterwards, they were stored in a refrigerated chamber at 2°C. Low-fat Bologna sausages were prepared according to the process described by Felisberto *et al.* [4].

Six formulations: FC1 (20% of pork back fat-PBF); FC2 (10% of PBF); F1 (10% of PBF and 14% EG1); F2 (14% of EG1); F3 (10% of PBF and 14% EG2); and F4 (14% of EG2) containing 63% of pork meat, 2% of NaCl, 0.25% of sodium tripolyphosphate, 0.015% of sodium nitrite and 0.05% of sodium erythorbate. In sausages were evaluated: Lipid content; fatty acid profile [5], Color parameters (L*, a*, b*) and Scanning electron microscopy. Analyzes were performed in triplicates.

Experiment was conducted in duplicate. Data were evaluated by analysis of variance (ANOVA). When statistically significant differences were found, Tukey's test was performed at 5% significance level ($p<0.05$) using SPSS (version 17, SPSS Inc., Chicago, IL, USA).

III. RESULTS AND DISCUSSION

For lipid content, when 50% of the pork back fat was replaced with functional lipid gels (F1 and F3) no fat reduction was observed, as previously elaborated in the experimental design. In sausages with total fat replacement by the gels, a

reduction of 27 and 22% fat was observed for F2 and F4, respectively. The fatty acid content (FAC) in sausages containing only pork fat (FC1 and FC2) showed that 78% of the total fat consisted of SFAs and monounsaturated fatty acids (MUFAs). The content of SFAs was reduced from 5.13 g/100g in FC1 to 3.84g/100g in FC2. The content of MUFAs and PUFAs was 7.45 and 3.53 g/100g in FC1 and it was reduced to 5.07 and 2.41 g/100g in FC2. A reduction of 12, 41, and 38% of SFAs and 13, 47, and 41% of MUFAs was achieved for F1, F2 and F4 respectively, compared to FC. In relation to the essential fatty acids (ω-3 and ω-6) there was an increase of 74, 39, 62, and 48% in F1, F2, F3 and F4, respectively.

In general, meat products made with gelled emulsions were lighter and less red ($p < 0.05$), whereas FC2, with a 50% reduction in pork back fat, without any substitution was characterized as darker and redder. The control treatments (FC1 and FC2) had the highest values of a* and b* in relation to treatments with addition of the gels, possibly due to the lower values of a* and b* of the emulsion gels. The increase in whiteness observed in the EG-based batters may be caused by composition of the gels which consisted of 51% oil, 49% water, hydrocolloids and other ingredients as observed in a previous study [3].

Regarding microstructural properties (Figure 1), FC1 presented a slightly rough and porous structure with suspended beads in the protein network, being in agreement with previous studies [4]. The microstructure of the reduced-fat samples (FC2, F2 and F4) showed larger cavities when compared to the other samples. In addition, in F2 and F4 the protein matrix was slightly more organized (more continuous network, compact structure), with loss of part of its spongy structure and more uniform distribution of fat, mainly F3 and F4.

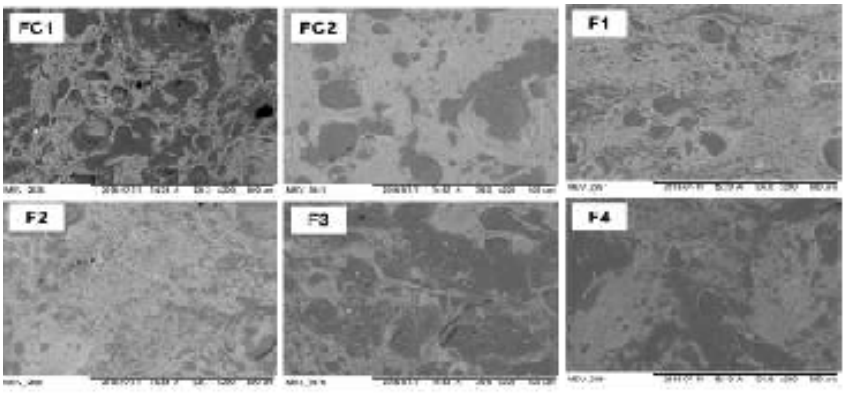

Figure 1. SEM images (200× magnification, bar=500 μm) of Bologna sausage with different formulations.

IV. CONCLUSION

The reformulation of the sausage using gelled emulsions to reduce pork back fat resulted in effects on the physicochemical and microstructural properties. However, when used together with the pork back fat, similar products to the control formulation were obtained, demonstrating its potential application as a fat substitute in meat products.

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