PSYLLIUM (*PLANTAGO OVATA FORSK*) GEL AND EMULSION GEL AS FAT REPLACERS IN PHOSPHATE-FREE AND LOW SALT SAUSAGES

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I. INTRODUCTION

Sodium tripolyphosphate is an important additive for the meat industry due to its ability to increase protein solubility and water retention [1]. However, due to the health issues associated with consumption of phosphates, their reduction or total replacement has been studied. Fibers such as psyllium (*Plantago ovata Forsk*) are considered promising alternative to replace additives, sodium chloride, the main source of sodium, and fat in meat products. This study investigated the effect of psyllium gel and emulsion gel in the physicochemical and microstructural properties of phosphate-free meat emulsions with reduced fat and sodium content.

II. MATERIALS AND METHODS

Two distinct strategies were developed to replace pork backfat. The first strategy was based on using emulsion gels containing water, vegetable oil, and psyllium (EGs) to substitute 100% of the backfat. The second one used only psyllium gels (PG) containing water and this prebiotic fiber aiming to reduce the backfat by 50%. Emulsion gels (EGs) were produced with psyllium (6% and 12%), canola oil (40%) and water in a homogenizer (Thermomix TM5). Gels (PG) were produced with psyllium (15% and 20%) and water using a mixer (Electrolux, 400W power, turbo function). Both were stored at 4 °C for 24 hours until use. Six phosphate-free treatments were developed with a 25% reduction in sodium chloride (NaCl) (1.5 g/100g), 62% beef, 0.015% sodium nitrite, 0.57% spices, 0.05% sodium erythorbate, and ice (FC1: 15.87%; FC2: 25.87%; F1 and F2: 15.87%; F3 and F4: 5.86%). Two control treatments, FC1 and FC2, with 20% and 10% of pork backfat, respectively. F1 and F2 with 100% of fat replacement by EG (produced with 6% and 12% of psyllium, respectively), and F3 and F4 with 50% of fat replacement by PG (produced with 15% and 20% of psyllium, respectively). Sausages were produced according to Felisberto et al. 2015 [2]. Emulsion stability (ES) [3], cooking loss [4], pH (MA 130 Metler pH meter), water activity (a_w) (Aqualab, Decagon Devices, INC., PULLMAN, USA), and scanning electron micrographs (SEM) were analyzed. The results were assessed using analysis of variance (ANOVA) using IBM SPSS Statistics 20 software. Tukey's test ($P < 0.05$) was used to determine significant differences between treatments.

III. RESULTS AND DISCUSSION

Table 1 shows that the absence of phosphates, the fat and NaCl reduction, mainly affected FC2. This was expected, since the lack of a structuring agent reduces the water retention capacity (WRC) of the meat system [5]. The samples containing EGs (F1 and F2) and PG (F3 and F4) showed lower liquid loss, which was not influenced by the absence of phosphate or by fat and sodium reduction, which may be associated with the hydrophilic and gelling properties of psyllium [6]. FC1 had the lowest cooking loss ($P < 0.05$) than other sausages, probably due to role of animal fat in the technological properties of meat emulsion. Sausages with PG (F3 and F4) also presented a good liquid retention, which may be related to the quantity and functional properties of psyllium fibers.The pH of the sausages varied from 6.28 to 6.19, and was affected by the lipid reformulation. The presence of EGs and PG had an impact on reducing the pH, which was expected due to pH values of psyllium (6.06). The a_w values ranged from 0.9884 to 0.9789. Despite the differences observed, all the treatments showed values typical of an emulsified meat product.

Table 1 – Effect of PG and EG on phosphate-free sausages with reduced sodium and fat content

	ES (%)	Cooking loss (%)	pH	a_w
FC1	2.73 ± 0.38^b	11.12 ± 1.10^d	6.28 ± 0.01^a	0.9820 ± 0.001^b
FC2	11.60 ± 0.77^a	18.11 ± 1.59^a	6.26 ± 0.01^b	0.9818 ± 0.001^b
F1	1.87 ± 0.54^c	17.77 ± 1.58^a	6.22 ± 0.01^c	0.9814 ± 0.001^b
F2	0.03 ± 0.01^d	16.39 ± 1.94^b	6.19 ± 0.01^d	0.9833 ± 0.001^a
F3	0.02 ± 0.01^d	14.22 ± 1.26^c	6.26 ± 0.01^c	0.9784 ± 0.001^c
F4	0.00 ± 0.00^d	14.15 ± 1.43^c	6.26 ± 0.01^c	0.9789 ± 0.001^c

Means in the same column with different letters indicate significant differences (P < 0.05). FC1: 100% pork backfat; FC2: 50% pork backfat; F1: replacement of 100% pork backfat with EGs produced with 6% psyllium (1.2% Psyllium in the final product); F2: replacement of 100% of pork backfat with EGs produced with 12% psyllium (2.4% Psyllium in the final product); F3 - replacement of 50% pork backfat by PG (gel at 15% concentration - 3% Psyllium in the final product); F4: replacement of 50% pork backfat by PG (gel at 20% concentration - 4% Psyllium in the final product).

As shown in the micrographs (Figure 1), both strategies, samples with EGs (F1 and F2) and those with PG (F3 and F4) exhibited continuous and compact structures.

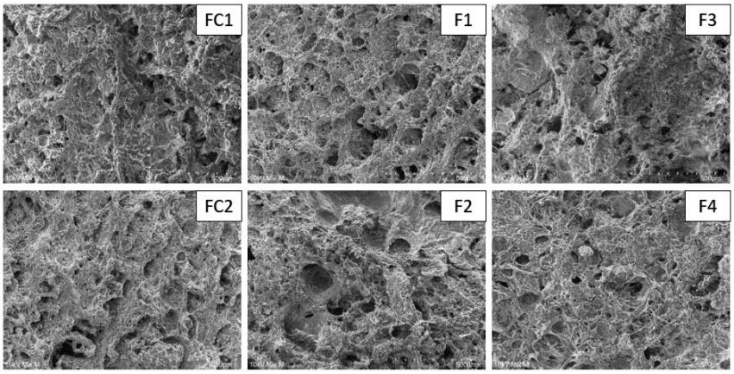

Figure 1. Scanning electron micrograph (SEM) images of sausages (magnification 100×, scale bar = 500 μm).

IV. CONCLUSION

Structured gels of psyllium are a promising non-meat ingredient for use in emulsified meat products, standing out as an effective substitute for phosphate salts in low-fat and sodium products. Its incorporation can make meat products healthier, in line with demands for clean label options.

ACKNOWLEDGEMENTS

We would like to thank the Coordination for the Improvement of Higher Education Personnel (CAPES) for granting the first author a doctoral scholarship.

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