INFLUENCE OF MEALWORM (*TENEBRIO MOLITOR*) FLOUR ADDITION AS MEAT REPLACER IN THE COMPOSITION AND MICROSTRUCTURE OF FRANKFURTERS WITH HEALTHIER LIPID CONTENT

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I. INTRODUCTION

Awareness of the importance of a healthy diet has increased, and the development of healthier meat products, mainly concerning their lipid content (quantity and quality), has gained attention [1]. In addition, there is a need for alternative and more sustainable sources of proteins to address the increasing protein demand caused by global population growth [2]. In this context, edible insects such as mealworms (*T. molitor*) may be an interesting choice for meat product reformulation because of their variety of nutrient compounds for human consumption, including proteins, healthier lipids (especially polyunsaturated fatty acids), minerals, and vitamins [3]. Some studies have already been conducted on partial meat replacement with mealworm in emulsified cooked sausages [4]. Therefore, this study investigated the composition and microstructure of meat replacement with mealworm flour (MF) in developing frankfurter sausages with healthier lipid content.

II. MATERIALS AND METHODS

Three different frankfurter treatments were manufactured [5]: a reduced fat control (RF-C) comprising 60% pork meat and 9% pork backfat and two treatments with MF addition as a meat replacer at 5% (MF5) and 7% (MF7). Sausages were properly homogenized, stuffed into cellulose casings, and heat-processed in a steam oven (CM-6, Rational, Germany) at 80 ºC for 60 min. After processing, the frankfurters were cooled overnight. The composition (moisture, fat, and protein), saturated (SFA), monounsaturated (MUFA), polyunsaturated fatty acids (PUFA), and hardness (N) (TA.XT.plus, Stable Micro Systems, Surrey, UK) were analyzed. Microstructure was studied by a stereo microscope (Stemi SV6, Zeiss) and scanning electron microscopy (SEM) using a Jeol JSM-IT700HR (Jeol Ltd., Tokyo, Japan) field emission. Analysis of variance and Tukey's HSD test were done, and differences were significant when $p < 0.05$.

III. RESULTS AND DISCUSSION

The moisture content ranged from 64.06 to 68.66 g/100 g, with MF5 and MF7 treatments lower ($p < 0.05$) than RF-C. Protein and fat content were between 15.78 and 17.82 g/100 g and 11.69 and 15.20 g/100 g, respectively. Treatments with MF addition had higher ($p < 0.05$) protein and fat content than RF-C. Similar behavior was observed in hardness since the highest ($p < 0.05$) values were observed in frankfurters with 5% and 7% of MF (19.29 N and 18.74 N, respectively) compared with RF-C (14.09 N). The healthier profile of frankfurters was evidenced by higher MUFA and PUFA contents in MF7 compared with RF-C (64.09 and 14.09 and 59.85 and 12.19 mg/g, respectively). According to Figure 1, it was evident that the gel structure was well-formed in all treatments. However, small fragments of MF, probably in the form of chitin, were observed in the MF5 and MF7 treatments (Figure 1, top), which appear to act as filler particles and could be related to the highest ($p < 0.05$) hardness observed in these samples. The frankfurters exhibited a uniform, smooth, and complex structure in the SEM (Figure 1, bottom). Although some relevant cavities were observed in MF5 and MF7 samples (Figure 1, bottom), this was probably due to the chitin or other compounds of MF, which improves the gel

network strength (Figure 1, top), resulting in higher hardness. However, in the RF-C sample, those cavities seem smaller (Figure 1, bottom) but promote a higher destabilization of the gel network and lower hardness.

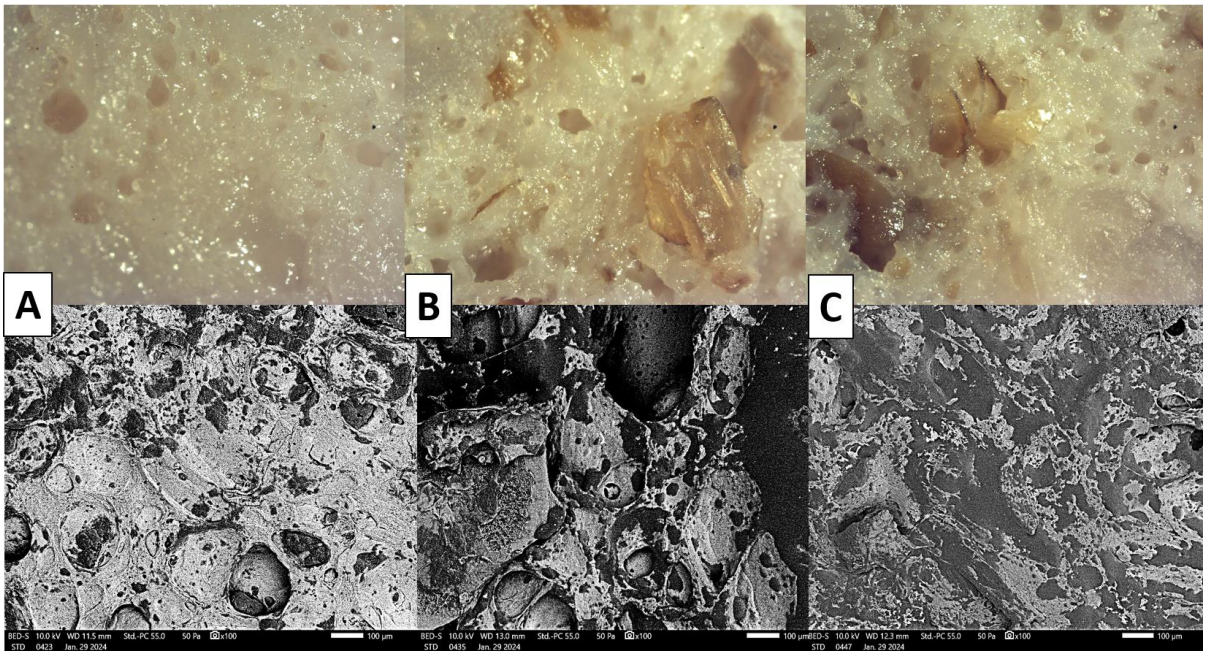

Figure 1. Microscopy photographs (top) and Scanning electron microscopy (bottom) of frankfurter sausages: A: RF-C = no MF addition; B: MF5 = 5% of MF addition; and C: MF7 = 7% of MF addition. Images at the top had a magnification of 4×. SEM images (bottom) white bar represents 100 µm.

IV. CONCLUSION

Incorporating MF at 5% and 7% levels affects the composition, textural, and morphological characteristics of frankfurter sausages in terms of improved protein and healthier lipid content, which were related to stronger hardness due to MF provides filler particles that reinforce the gel network of the products. In this respect, MF addition at 5 and 7% levels offers interesting potential to adapt the composition, texture, and structure of frankfurter sausages.

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