STRUCTURE, TEXTURE, AND SENSORY PROPERTIES OF HYBRID MORTADELLA WITH WHOLE AND DEFATTED CRICKET (*GRYLLUS ASSIMILIS*) FLOUR

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I. INTRODUCTION

Edible insects have stood out worldwide as potential solutions to improve food security and dietary diversity, demonstrating that they can be viable substitutes for conventional protein sources due to their high nutritional value, biofunctional properties, and environmentally sustainable rearing methods [1]. The development of hybrid meat products with insect proteins is a promising trend to reduce the consumption of traditional animal protein and increasing the acceptance of alternative protein sources, especially in Western society. Therefore, the study investigated the impact of replacing lean meat with cricket (*Gryllus assimilis*) flour, whole and defatted, on the structural and sensory characteristics of mortadella.

II. MATERIALS AND METHODS

Beef (*Quadriceps femoris*, 72.3% moisture, 20.8% protein, 4.2% fat and 1% ash), pork (*Longissimus thoracis et lumborum*, 69.4% moisture, 7.8% lipids, 21.2% protein, and 1.5% ash), and pork back fat (10.8% moisture, 82.3% lipids, 6.05% protein, and 0.44% ash) were used to produce mortadella. Hakkuna (Brazil) kindly provided the dehydrated crickets (*Gryllus assimilis*), that were ground in a hammer mill and then sieved through 20 mesh meshes. Lipid extraction of flour was carried out according to the method of Ndiritu et al. (2017) [2] with some modifications. Five treatments were prepared with 5 and 10% replacement of lean meat with WCF (whole cricket flour) and DCF (defatted cricket flour), respectively, F5W, F10W, F5D, F10D, besides the control (FC), with 60% meat. All treatments had 0.015% sodium nitrite, 1.58% spices, 1.5% sodium chloride, 0.05% sodium erythorbate, 0.5% sodium tripolyphosphate, and 16.35% ice. The products were prepared according to Câmara & Pollonio [3]. Texture profile analysis (TPA) was evaluated (25 ºC) in a TA-xT2i texture analyzer, with eighteen cubes (20 mm) that were axially compressed (2 cycles of 30% compression, probe P35) at a constant speed of 1 mm/s. The parameters evaluated were hardness (N), springiness, cohesiveness, and chewiness (N). To evaluate the microstructure, the samples (1 cm^2 and thickness of 0.2 cm) were freeze-dried and analyzed in a scanning electron microscope TM 4000 Tabletop Microscope (Hitachi Technologies, Japan), using an acceleration of 15 kV in Analy mode. The images were obtained with an increase of 200x. After approval of the study (CAAE 67415023.2.0000.5151) by the Research Ethics Committee of the Federal University of São João del-Rei, the samples were subjected to sensory acceptance and CATA tests with 89 consumers. The results were assessed using analysis of variance with general linear models, considering the treatments as a fixed effect and the experiment replications as a random term (n = 3), using Statsoft. Inc. version 7 software (TIBCO Software Inc., California, USA). Tukey's test ($P < 0.05$) was used to determine significant differences between treatments.

III. RESULTS AND DISCUSSION

Cricket flour influenced considerably the textural parameters (Table 1). Adding WCF decreased the firmness, cohesiveness, and chewiness values, and F10W differed from all other treatments ($P < 0.05$), while adding DCF increased the chewiness values. These results are in consonance with the microstructural images (Figure 1). Figure 1 has shown that F10W presented a very heterogeneous, spongy, and more discontinuous structure with coalescence of the fat globules. In FC, a more cohesive structure is observed with larger fat globules with well-defined and delimited borders, which are characteristic of emulsified meat products. Figure 2 (A, B, C) presents the results of the acceptance test and CATA. The F10W treatment was removed from sensory studies because it was characterized by high instability of the meat emulsion in previous studies. Data from the acceptance test (Figure 2A) showed that the treatment with the highest level of replacement of meat with cricket flour (F10D) exhibited lower values for all attributes and differed ($P < 0.05$) from the other treatments. Consumers

had a similar perception of the mortadella samples with WCF and DCF at levels of 5%, as there were no differences from the control, except for color. CATA results (Figure 2B) show that FC and F5W were perceived to have a mortadella flavor, aroma, and ideal color. The study also indicated that F5D was described as having an ideal amount of salt, texture, and juiciness, which aligns with instrumental texture data. In contrast, F10D was associated with the terms low juicy and sandy. Figure 2C demonstrated that the attributes of juicy, ideal color, ideal texture, and ideal amount of salt were associated with the overall liking of the mortadella.

Table 1 – Texture parameters of mortadella with partial replacement of lean meat by cricket flour

	FC	F5D	F10D	F5W	F10W
Hardness (N)	14.81±0.95^{a}	14.95±0.77^{a}	15.79±0.54^{a}	13.29±0.68^{b}	11.71±0.50^{c}
Springiness	0.94±0.01^{a}	0.93±0.01^{c}	0.93±0.00^{b,c}	0.94±0.01^{a,b}	0.92±0.01^{c}
Cohesiveness	0.84±0.01^{a}	0.80±0.00^{b}	0.81±0.00^{b}	0.81±0.01^{b}	0.79±0.01^{c}
Chewiness (N)	10.91±0.85^{b,c}	11.63±0.62^{b}	12.65±0.70^{a}	10.38±0.26^{c}	8.58±0.30^{d}

* The values represent the mean ± standard deviation. ^{a,b,c,d} Means in the same row with different letters indicate significant differences ($P < 0.05$). FC: control with 60% of meat; F5D: 5% replacement of lean meat with DCF; F10D:10% replacement of lean meat with DCF; F5W: 5% replacement of lean meat with WCF; F10W: 10% replacement of lean meat with WCF.

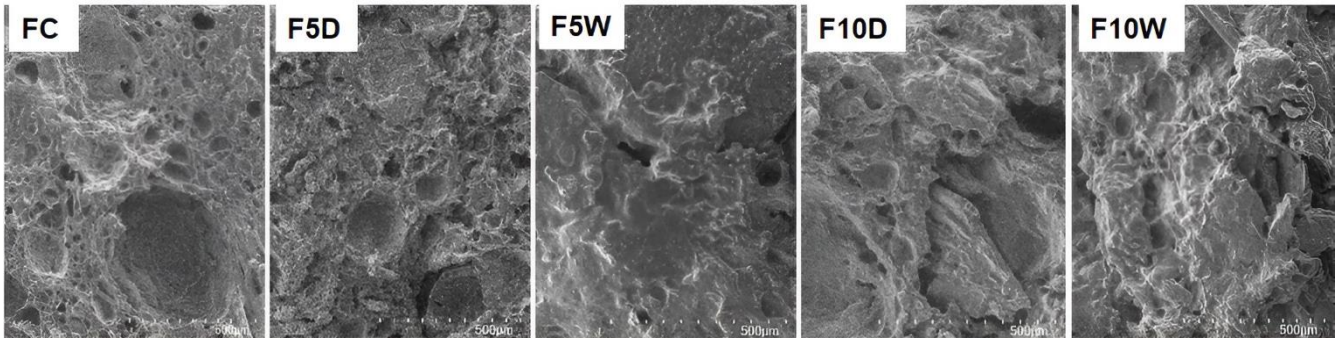

Figure 1. SEM images of mortadella with WCF, DCF and control (200 x magnification, Scale bar =500 µm)

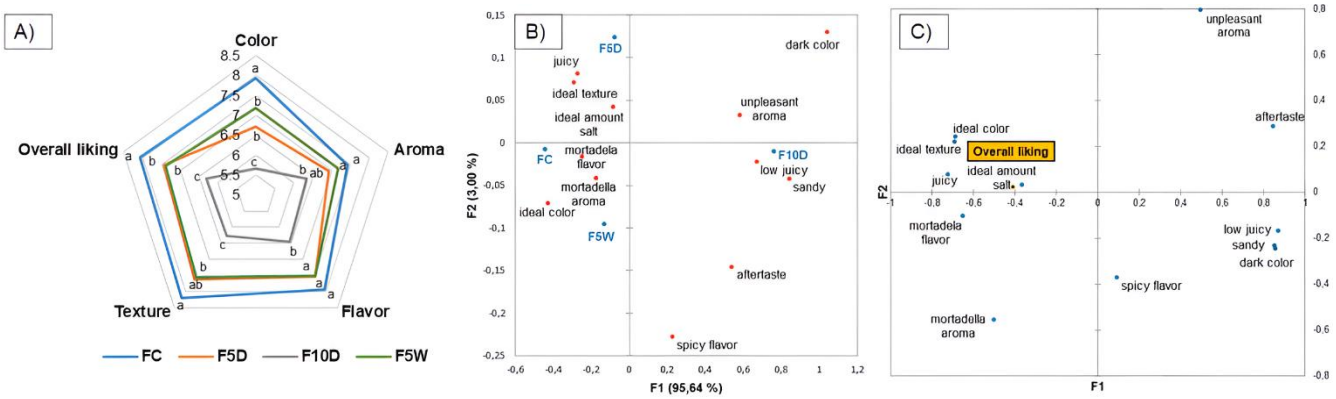

Figure 2. (A) Sensory acceptance of mortadella with partial replacement of lean meat by cricket flour. Equal letters in the same attribute are not statistically different ($p>0.05$). (B) Representation of samples and attributes in the first two dimensions of correspondence analysis of mortadella samples using CATA questions. (C) Correlation between sensory attributes and overall liking in the first two dimensions of principal coordinate analysis.

IV. CONCLUSION

Replacing up to 5% of lean meat with whole and defatted cricket flour may be a relevant strategy to produce hybrid meat emulsion with adequate sensorial, microstructural, and textural properties.

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