Co-oxidation of meat proteins and glucose during a simulated gastric digestion: consequences of a severe pro-oxidative environment

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Introduction: The occurrence of oxidative reactions during food digestion has become a topic of increasing interest (de La Pomélie et al., 2018). Protein oxidation involves loss of essential amino acids and impaired digestibility (de La Pomélie et al., 2018). The intake of oxidized proteins and amino acids has also been linked to safety and health concerns (Estévez & Xiong, 2019). Protein oxidation is normally attributed to Fenton-like radical-mediated mechanisms (de La Pomélie et al., 2018). Yet, reducing sugars and Maillard products have been shown to be as effective as free radicals in inducing oxidation of meat proteins (Luna & Estévez, 2019). The present study was designed to investigate the effect of glucose and glyoxal on the nature and intensity of oxidative reactions occurred during simulated gastric digestion of emulsions prepared with meat lipids and myofibrillar proteins (MP).

Material and methods: MP from porcine muscle (100 mg/mL) were suspended in 100 mM phosphate buffer pH 6.5 with 0.6 M NaCl to guarantee a homogenous dispersion. Thirty mg of a mixture of triolein and glyceryl trinoleate (1/0.5; w/w) was added to protein suspensions that were sonicated in an ice bath for 3 min. Depending on the addition of various chemical species, namely, myoglobin (Mb; 10mg/mL); glucose (GLU; 10 mg/mL); Mb+GLU (10 mg/mL of each species); glyoxal (GO; 10mg/mL) and GO+Mb (10 mg/mL of each species), six experimental groups were considered, along with a CONTROL group (no reactants added). All experimental units were prepared in triplicate. All experimental units (10 mL, total volume per unit) were dispensed in 25 mL screw-capped polycarbonate vials and subjected to a simulated gastric digestion in accordance with the procedure described by Luna & Estévez (2019). Samples were taken before the simulated gastric digestion (BD), and immediately after digestion (AD) and all of them were kept at -80ºC for further analyses. They were analysed for TBARS, protein carbonyls, reactive oxygen species, advanced glycation end-products and protein digestibility according to Luna & Estévez (2019). Data was analysed by repeated measures ANOVA and Tukey's tests by SPSS 15.0.

Results: The simulation of gastric digestion led to a significant and remarkable increase of lipid and protein oxidation. The latter was particularly severe as the concentration of protein carbonyls increased up to 30-fold times in the experimental emulsions. The concentration of protein carbonyls was significantly higher in Mb+GLU systems followed by GO and GO+Mb. The ability of glucose to induce both lipid and protein oxidation was dependent on the generation of ROS and this occurred more severely in the presence of Mb. The severe carbonylation caused by GO, conversely, was independent of Mb and ROS generation. The dicarbonyl was found remarkably efficient in promoting protein oxidation and the formation of AGEs which emphasizes the connection between protein oxidation and the Maillard reaction. The oxidative damage to proteins was likely connected to the impaired digestibility observed in meat proteins incubated with glucose and GO.

Conclusion: These results show the relevance of the Maillard-mediated pathway in the oxidative damage caused in meat proteins during simulated gastric digestion and identifies glucose and their oxidation products as inducers of a severe pro-oxidative environment which includes the formation of ROS.

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Literature:

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