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GREEN TEA EXTRACT ALTERS THE FUNCTIONAL PROPERTIES OF MEAT EMULSIONS BY GENERATION OF PROTEIN CROSS-LINKS

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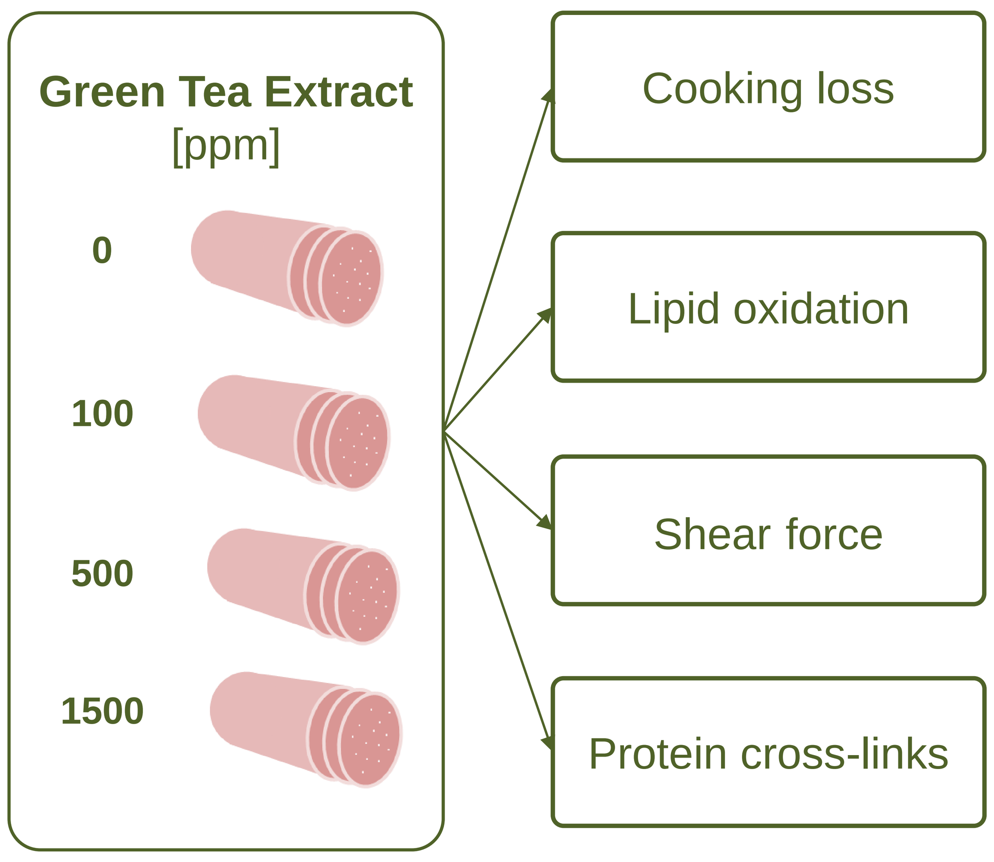
Objective

To determine the dose-dependent effects of green tea extract as a natural phenolic antioxidant on the oxidation and functional properties of meat emulsions.



Conclusions

- Green tea extract protected against lipid oxidation at all applied concentration levels
- Cooking loss and textural properties were altered as a result of increased protein cross-linking when 1500 ppm Green Tea extract was applied
- On the contrary, 100 ppm Green Tea extract reduced protein disulfide cross-linking and still protected against lipid oxidation

Introduction

Intermolecular disulfide bonds via oxidation of protein thiols play an essential role for the gel strength of heat-induced muscle protein gels *(1, 2),* by enhancing the rheological and mechanical properties of the gel matrix *(3)*.

Phenolic antioxidants reduce oxidation and oxidation-derived off-flavor formation during production and storage of meat products. However, studies have shown that phenolic compounds are able to react with thiol groups to form covalent thiol-quinone adducts (TQ-adducts) *(4)*.

Quinones are generated when phenols are oxidized and has been shown to reduce total thiol concentration in beef stored under high-oxygen modified atmosphere (5) and in Bologna-type sausages (6).

It is suspected that TQ-adducts impair the gel-forming ability of the meat proteins, as it was recently found that addition of green tea extract, added as a natural antioxidant, altered the textural properties of Bologna-type sausages as detected by a sensory panel (6).

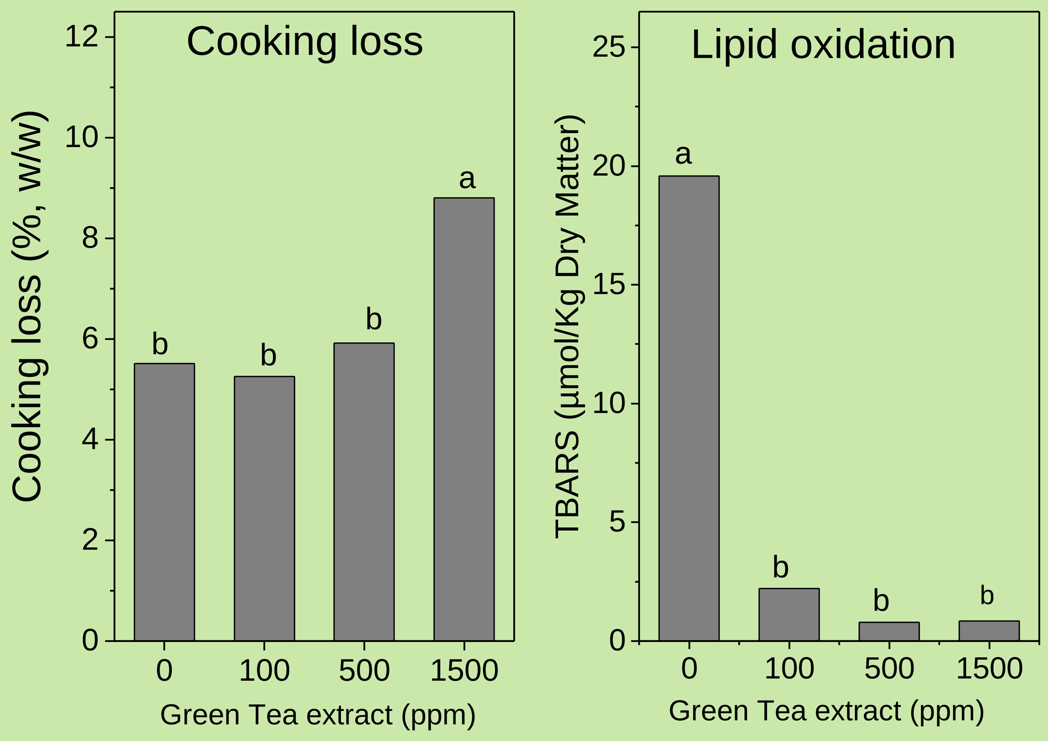


Figure 1.
Cooking loss (%, w/w) in meat emulsions added 0 (Control), 100, 500, or 1500 ppm green tea extract (GT) at day 0 (n=3). **Secondary lipid oxidation** products as determined by TBARS (umol/kg DM) in the same meat emulsions stored at 5 °C for 1 day (n=3).

Results and Discussion

Cooking loss was found to be significantly higher in meat emulsions containing 1500 ppm green tea extract, while neither addition of 100 nor 500 ppm green tea extract altered the water holding capacity as compared to the meat emulsion without Green Tea extract (**Figure 1, left panel**).

Addition of 100, 500, and 1500 ppm Green Tea extract significantly inhibited the formation of TBARS, as compared to the meat emulsion without Green Tea extract (**Figure 1, right panel**).

Further, Addition of 100 ppm Green Tea extract tended to increase stress and strain in the meat emulsion, while higher concentrations tended to reduce the two textural parameters (**Figure 2**) resulting in significantly reduced stress for 1500 ppm as compared to the meat emulsion without Green Tea extract indicating that the emulsion hardness was altered.

The protein band intensity was quantified after separation by SDS-PAGE to estimate the concentration of monomer myosin heavy chain (MHC) before and after reduction. MHC was more intense in samples after reduction (**Figure 3**), indicating that protein disulfides were reduced to yield a higher concentration of MHC, and indirectly that protein disulfide cross-links were generated during the production of the meat emulsions.

Further, results showed significantly higher MHC concentration in the meat emulsions added 100 ppm Green Tea extract and significantly lower MHC intensity in meat emulsions added 1500 ppm green tea extract as compared to the meat emulsion without Green Tea extract (**Figure 3**). This indicates that meat emulsions added 100 ppm Green Tea extract was less subjected to MHC cross-linking as compared to the meat emulsion without Green Tea extract, and that 1500 ppm green tea extract resulted in increased MHC cross-linking.

The degree of reducible MHC cross-links was evaluated by the intensity of MHC after reduction (**Figure 3**). In the presence of 500 or 1500 ppm Green Tea extract, the MHC levels were lower than for the meat emulsion without Green Tea or in the presence of 100 ppm Green Tea extract. This indicate that increasing concentrations of Green Tea extract, increase the formation of non-reducible protein polymerization, as the MHC lost were not fully recovered after reduction.

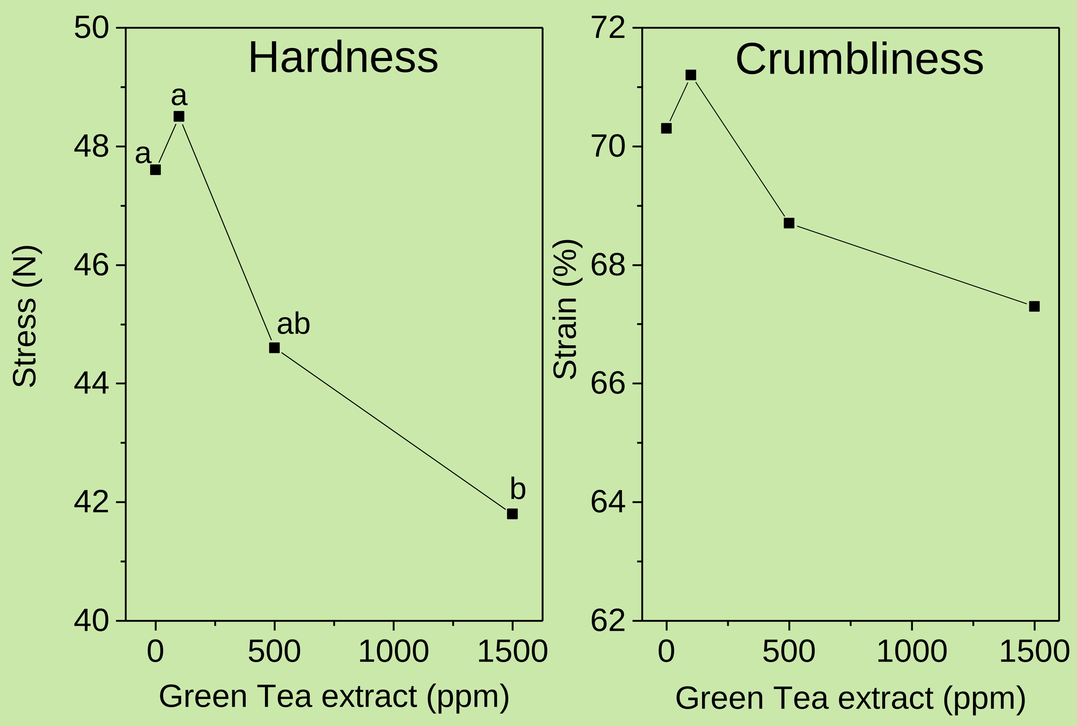


Figure 2.
Hardness (Stress (N)) and **Crumbliness** (Strain (%)) of meat emulsions added 0 (Control), 100, 500, or 1500 ppm green tea extract (GT) stored at 5 °C for 1 day (n=3).

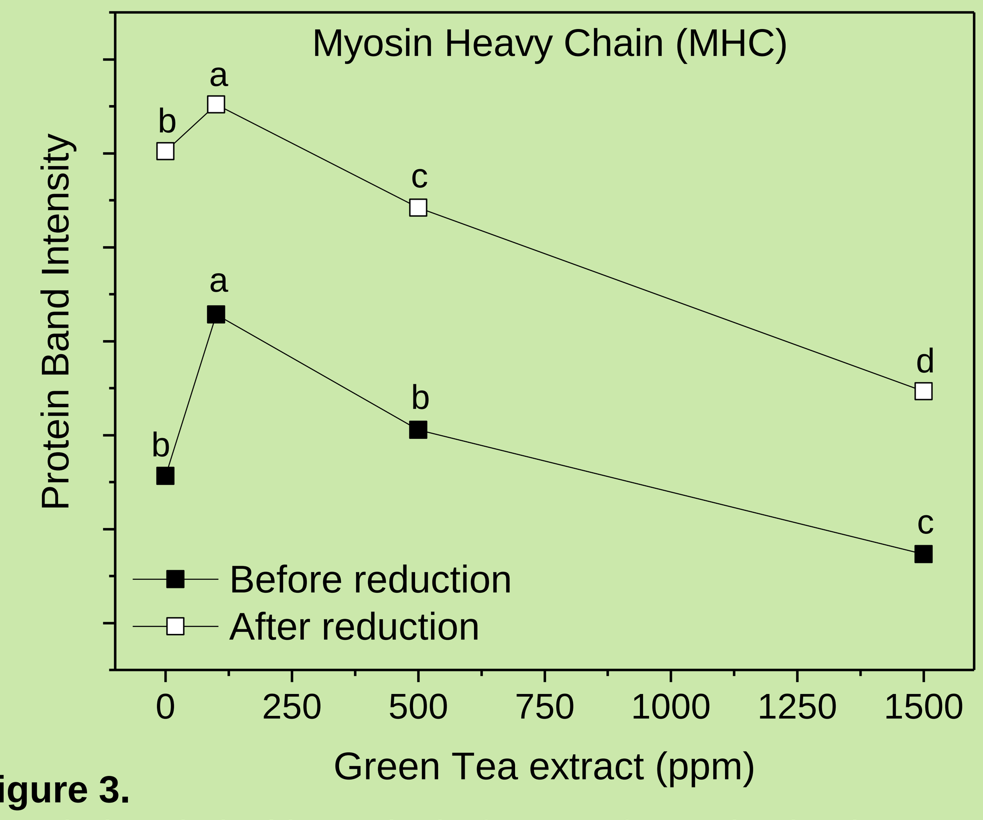
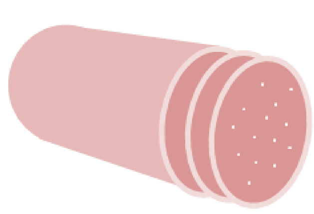


Figure 3.
Protein band pixel intensity before or after reduction by dithiotreitol (DTT) of myosin heavy chain (MHC) from meat emulsions added 0 (Control), 100, 500, or 1500 ppm green tea extract (GT) stored at 5 °C for 1 day (n=3).

Methods and Materials

Recipe of meat emulsions
275 g porcine LD
12.5 g NaCl
100 g crushed ice
100 g canola oil
0, 0.05, 0.25, or 0.75 g Green Tea extract (GT20M, DuPont, Denmark)



Procedure
Tubes filled with batter, centrifugation 3000 rpm, 10 min.
Heated in water bath (80 °C) until a center temperature of 70 °C (~15 min).
Cooled on ice – hereafter cooking loss analysis.
Kept at 5 °C for 1 day – hereafter remaining analyses.

Analyses
Emulsion stability evaluated by cooking loss
Cooking loss was determination directly after heat treatment and centrifugation at 2700 g for 3 min by weighing the supernatant:
Supernatant (g) / meat batter (g)) · 100 % = Cooking loss (%, w/w).
Textural properties evaluated by shear force
Samples were cut into 2-3 cylindrical cores and placed on a platform and each sample compressed to 30 % of its original height (strain) using an Instron Material Testing Machine (Instron 4301, Instron, Bucks, UK).
Lipid oxidation evaluated by TBARS analysis
Conducted according to Vyncke *(7)* and Sørensen & Jørgensen *(8)*.
Protein cross-linking evaluated by gel electrophoresis
The myofibrillar proteins were separated by SDS-PAGE as described by Nieto, et al. *(9)*.

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