P-07-16

Pulsed electric field improves the protein digestion of venison (*Cervus elaphus*) during *in vitro* gastrointestinal simulation (#292)

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Introduction

Pulsed electric field (PEF) is a novel non-thermal technology that has been studied for several applications in meat and meat products. Application of PEF has been demonstrated to affect the functional and structural properties of the proteins by affecting electrostatic interactions and causing several modifications [1, 2]. PEF processing can therefore influence the hydrolysis of proteins during gastrointestinal digestion and affect the release and bioavailability of amino acids and polypeptides from meat during digestion [1]. The objective of this study was to evaluate the effect of PEF treatment on the protein digestion of cooked venisonsubjected to *in vitro* gastrointestinal digestive simulation. Samples were analyzed for protein digestibility (%), soluble protein (%), free amino acids, protein profile (SDS-PAGE) and mineral release to evaluate if PEF treatment has any impact on protein digestibility and the release of amino acids, peptides and minerals during *in vitro* gastrointestinal digestion.

Methods

Longissimus dorsi muscle was obtained from six red deer (*Cervus elaphus*) carcasses from Lorneville plant (Alliance Group, Invercargill, New Zealand). The average hot carcass weight was 108 ± 9.8kg. The muscles were excised at 24 h post-mortem and treated with PEF. The samples were cut into blocks (13 x 8 x 5 cm) and randomly allocated to PEF treatment i.e. 10 kV, 20 Hz, 20 µs, 0.5 kV/cm plus a non-treated control. Both control and PEF treated samples were cooked to a core temperature of 75 °C and subjected to *in vitro* gastrointestinal digestion (1 h gastric phase and 2 h intestinal phase) as described previously [1]. Free amino acid analysis and mineral profile was done by using HPLC and Inductively Coupled Plasma Optical Emission Spectrophotometer, respectively. The data generated was compiled and analyzed using SPSS (version 16.0) and reported as means ± standard error. Independent samples t-test or two-way ANOVA was performed and Duncan's multiple range tests or Levene's test, at the 0.05 level of significance, were used for comparing the means to find out the effects of treatment and digestion time.

Results

PEF had a significant effect on protein digestibility (Fig. 1) and the release of soluble protein (Table 1) as the samples treated with PEF showed significantly higher values ($P<0.05$) at the end of the gastrointestinal digestion. Thegel electrophoretogram (Fig. 2) shows the differences in the bands between control and PEF treated samples. These differences, which become more prominent with the time of digestion and between gastric and intestinal phase of digestion, suggest a faster and greater rate of digestion for PEF treated samples. PEF had no significant ($P>0.05$) effect on the release of minerals during digestion.

Means with different superscripts in a row (upper case) and column (lower case) differ significantly ($P<0.05$)

Table 1: Effect of pulsed electric field on the soluble protein (%) of cooked venison Longissimus dorsi

Phase of digestion	Incubation time	Control	T_1 (10 kV)
In-vitro gastric digestion	0 Minutes	12.76 ± 0.38^{a}	13.03 ± 0.43^{a}
30 Minutes	18.89 ± 2.42^{b}	19.69 ± 2.07^{b}	
60 Minutes	19.06 ± 0.30^{b}	21.17 ± 2.00^{bc}	
In-vitro intestinal digestion	120 Minutes	22.65 ± 0.58^{bc}	24.98 ± 1.09^{cd}
180 Minutes	24.66 ± 0.99^{cA}	27.73 ± 0.28^{dB}	

Conclusion

A positive effect of PEF-processing was observed on the protein digestion of cooked venison during *in vitro* gastrointestinal digestion. Prior treatment of muscle with PEF resulted in a faster and greater digestion with a significant ($P < 0.05$) increase in *in-vitro* protein digestibility (%) and soluble protein (%). No negative impact of PEF processing was observed on the release of minerals, including Fe, Zn, Cu, Cr, Mg, K, Ni and P, from venison during simulated gastrointestinal digestion.

REFERENCES

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2. Han, Z., Cai, M. J., Cheng, J. H., & Sun, D. W. (2018). Effects of electric fields and electromagnetic wave on food protein structure and functionality: A review. *Trends in Food Science and Technology, 75*, 1-9.

Notes

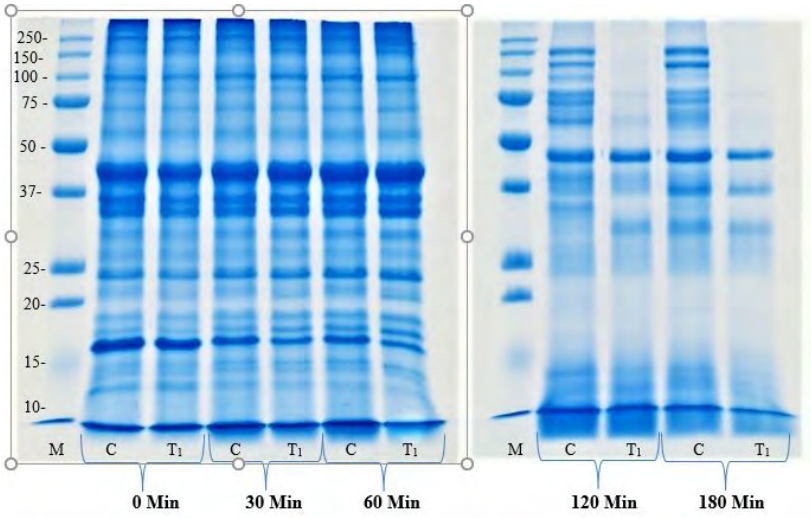

Fig. 2. Effect of PEF on the protein profile
Fig. 2. Effect of PEF on the protein profile (SDS-PAGE) of cooked venison *Longissimus dorsi* subjected to *in-vitro* gastrointestinal digestion [M = marker, C = control, T_1 = 10 kV (90 Hz)]

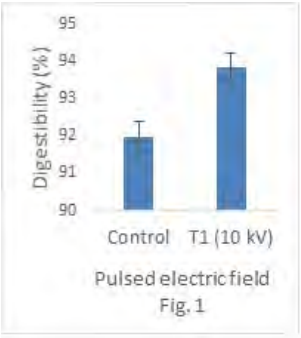

Figure 1 Effect of PEF on digestibility

Notes