EFFECT OF INJECTING GINGER PROTEASE ON IMPROVING TENDERNESS IN *M. BICEPS FEMORIS* FROM CULLED DAIRY COWS

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I. OBJECTIVES

Muscles of culled/old animals exhibit substantial toughness due to the strength developed in the connective tissues and/or insufficient endogenous proteolytic enzyme capacity to tenderize the meat postmortem. Marination of muscles with exogenous proteases acquired from plants, bacteria, fungi, and their commercially available products have shown tenderizing effects on tough beef meat. Zingibain or ginger protease is a cysteine protease found in ginger rhizome, and its proteolytic activity appears to have manifold effects on collagen compared with actomyosin, and the combined proteolysis of these 2 muscle proteins could result in improved beef tenderness. The study was designed to investigate the tenderization of low-valued meat using commercially available ginger powder containing proteolytic enzymes including zingibain.

II. MATERIALS AND METHODS

This study used *biceps femoris* (n = 30) acquired from Angus/Angus cross culled cows of similar age (6–7 y old). Each *biceps femoris* was cut into 4 portions and injected with 1 or 2 gL^{-1} ginger powder solution, control was with water only, and another had no injection. Each portion was cut into 3 blocks, vacuum packed, and cooked for 1 h, 8 h, and 18 h in temperature-equilibrated water baths at 65°C and 75°C, and internal temperature was monitored by thermocouples attached to a Grant data logger. Warner Bratzler shear force (WBSF), cooking loss, collagen content, and myofibrillar fragmentation index (MFI) were measured to assess change in meat tenderness. The data were analyzed using a linear mixed effect model fitted by REML in R version 3.5.2 (with packages “nlme” and “emmeans”; R Core Team, 2018).

III. RESULTS

Results revealed significant (all $P < 0.005$) interactions between enzyme treatment, cooking temperature, and time on WBSF. WBSF in low-valued meat reduced with injecting ginger powder solution and cooking duration (Table 1). Cooking loss increased with increasing cooking temperature and time ($P \leq 0.0001$) (Table 2). Results of collagen content and MFI are presented in Table 3. Collagen solubility increased by injecting ginger powder solution (P = 0.0045) and cooking time (P = 0.0001) but was not impacted by cooking temperature (P = 0.38). MFI increased with increasing concentration of enzyme (P = 0.029). The results have indicated weakening of myofibrillar proteins and connective tissue contribute to denaturation of proteins and solubilization of collagen.

Table 1.

Effect of zingibain treatment and cooking time on the Warner-Bratzler shear force (WBSR N) of *biceps femoris.* Superscripts (letters a-g) refer to the significant differences ($P < 0.05$) in mean WBSF values.

		Injection treatment			
	Time	**No injection**	**Only water**	**1 gL^{-1} GP**	**2 gL^{-1} GP**
	1 h	48.8^{ab}	49.9^{a}	37.9^{cd}	27.3^{f}
WBSF (N)	8h	42.9^{abc}	42.8^{bc}	27.9^{ef}	24.7^{f}
	18 h	36.0^{d}	32.7^{de}	20.2^{g}	20.4^{g}

Table 2.

Effect of cooking temperature (65°C, 75°C) and cooking time (1 h, S h; 18 h) on cooking loss (%) of *biceps femoris*. Superscripts (letters a-e) refer to the significant differences ($P < 0.05$) in mean values.

Temperature	**65°C**			**75°C**		
Time	**l h**	**8 h**	**18 h**	**1 h**	**8h**	**18 h**
Cooking loss	32.3^{a}	39.3^{c}	41.3^{e}	43.0^{b}	47.0^{d}	47.3^{d}

Table 3.

Effect of zingibain treatment on soluble collagen (mg.g^{-1} meat) and myofibrillar fragmentation index (MFI) of of *biceps femoris*. Superscripts (letters a-c) refer to the significant differences ($P < 0.05$) in mean soluble collagen and MFI values.

	Injection treatment			
	No injection	**Only water**	**1gL^{-1}GP**	**2 gL^{-1} GP**
Soluble collagen	0.21^{a}	0.28^{ab}	0.41^{c}	0.39^{bc}
MFI	139.6^{b}	147.1^{ab}	150.2^{a}	153.7^{a}

IV. CONCLUSION

Injecting zingibain improved tenderness of *bicep femoris*, therefore ginger protease has potential to add value to low-valued muscle from older cows with reduced cooking duration.

Keywords: ginger protease, tenderness, beef, older cows, collagen solubility