EFFECT OF INJECTING KIWI JUICE ON THE TENDERNESS OF BEEF BICEPS FEMORIS.

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I. INTRODUCTION

Specific muscles of animals can have a substantial toughness, which is caused by the strength of the connective tissues and/or insufficient endogenous proteolytic enzymes capacity to tenderise the meat post mortem [1]. Extended ageing of these muscles does not produce tender meat and the tenderness can be greatly improved by the use of exogenous enzymes [2]. Several plant proteases have been used to accelerate meat tenderisation through injection, marination or infusion; with papain being the most studied. However, the negative effects of papain on over-tenderisation of the meat, has been described as causing an undesirable “mushy “texture [3]. Kiwifruit juice contains actinidin, a cysteine protease that when injected into meat, can contribute to meat tenderness post mortem [3]. Studies that have investigated the effect of kiwifruit extract injections on shear force of lamb [4], pork [5] and beef [6] have demonstrated a reduced shear force compered to no injection (NI). This study aims to evaluate the effectiveness of kiwifruit juice injection on the tenderness and water holding capacity of beef. More specifically, this study will investigate the implication of cooking temperature on the kiwifruit proteases ability to hydrolyse myofibrillar and connective tissue proteins.

II. MATERIALS AND METHODS

Six bovine Biceps femoris muscles were obtained from six beef carcasses (0 permanent incisor), 48h after slaughter across two collection days. Kiwifruit juice was extracted using a published protocol from kiwifruit obtained commercially [4]. The proteolytic activity of kiwifruit juice was quantified using a colourimetric assay with casein as substrate [2]. Muscles were cut into ten portions (278 $\pm$ 20.9 g) within five positions along the length of the muscle. Each portion was randomly allocated to an injection treatment; being no injection (NI) or injection with diluted kiwifruit juice 0, 0.5, 1.0 or 5.0 % (v/v) (diluted with water) and cooking temperature (55 or 75°C). Meat portions were injected to 110% of initial weight and then stored at 2°C for 24h. Subsequently, the samples were cooked in a water bath (Julabo, 738, John Morris Scientific) to internal temperature of 55°C or 75°C. Warner Bratzler peak shear force (WBPSF) and texture profile analysis (TPA) were performed and hardness and compression were calculated from TPA data [7]. Myofibrillar fragmentation index (MFI) was performed on uncooked samples which were frozen at -80°C prior to analysis [8]. Data was analysed using the restricted maximum likelihood estimation (REML) in GenStat (16th Edition, VSN, international Ltd, UK). Random terms in the model included collection day, carcass and position.

III. RESULTS AND DISCUSSION

The proteolytic activity of the kiwifruit juice was 2.036 $\pm$ 0.554 x 10^{-3} U.mL^{-1}. Preliminary tests injected kiwifruit juice concentrations (11-100%) produced undesirable mushy texture (data not shown), similar to previous studies using papain [3]. Therefore, lower concentrations (up to 5% v/v) were injected. The interaction between cooking temperature and injection treatment was significant ($p < 0.05$) or tended towards significant ($p < 0.10$) for all texture and cook loss traits, demonstrating kiwifruit juice to be a promising meat tenderiser. For compression, samples cooked at 55°C had similar values ($p > 0.05$) whereas for samples cooked at 75°C, samples injected with 0.5-5% kiwi juice had lower values than control NI and 0% kiwifruit juice. Injection concentration influenced WBPSF; at 55°C, the WBPSF was quite similar ($p > 0.05$), whereas at 75°C, 0.5 & 1.0% (v/v) had a lower WBPSF then NI, 0 & 5% (v/v).

Table 1. Effects of kiwifruit juice injection (INJ; NI = No injection vs 0, 0.5, 1.0 & 5.0% v/v) and cooking temperature (CT; 55°C vs 75°) on quality traits of beef Biceps femoris. Values are least squares means.

		Injection treatment						*P-values*		
		NI	***0***	***0.5***	***1.0***	***5.0***	***S.E.D[1]***	***CT***	***INJ***	***CT*INJ***
Hardness (N)	$T_{55°C}$	36.10	44.27	42.25	40.23	34.18	2.34	< 0.001	0.027	0.081
	$T_{75°C}$	45.33	51.66	45.87	41.08	37.47				
Compression (kg)	$T_{55°C}$	18.01	21.63	21.02	19.25	15.40	2.08	0.353	0.460	0.005
	$T_{75°C}$	24.58	20.95	17.23	18.42	18.59				
WBPSF (N)	$T_{55°C}$	54.72	47.00	56.55	51.44	51.12	3.68	0.795	< 0.001	0.041
	$T_{75°C}$	48.30	49.29	42.98	42.95	48.11				
Cook Loss (%)	$T_{55°C}$	10.91	11.10	13.17	14.78	22.99	1.57	< 0.001	0.075	0.091
	$T_{75°C}$	29.13	30.84	34.63	28.36	24.84				
MFI	-	18.91	15.13	16.75	13.75	27.44	4.36	-	0.015	-

[1] S.E.D = Standard Error of the Difference for cooking temperature*Injection

Cooking temperature was shown to affect ($p < 0.001$) Hardness (Table 1). More specifically, the cooking temperature of 75°C gave higher values for hardness compared to 55°C, at all injection concentrations. Furthermore, with increasing injection concentration ($p < 0.05$) the hardness was decreased i.e. produced a more tender piece of meat, at both cooking temperatures. An injection concentration of 5% gave higher MFI values compared to the NI control, showing the injection effected the fragmentation of myofibrils. The treatment interaction (cooking temperature x injection) influenced the compression measurement ($p = 0.005$) (Table 1). This measurement has proven to be a good indicator of connective tissue or "background" toughness [6 & 7]. The increasing concentration of kiwifruit juice has reduced the impact collagen has on texture (toughness) of beef Biceps femoris.

IV. CONCLUSION

This study demonstrated that injection of kiwifruit juice into beef Biceps femoris results in reduced WBPSF, hardness and compression values and thus can be used to tenderise tough muscles. The results have indicated the injection of kiwifruit juice combined with cooking at higher temperatures is able to reduce background toughness (due to collagen). Muscles with high connective tissue content will benefit from combining injection and cooking temperature to improve their tenderness. More specifically, an injection rate of 5% (v/v) when cooking at grilling or roasting temperatures (75°C) will be considered for future studies.

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