EFFECT OF COMMERCIAL PROTEASES AND IN-HOUSE PREPARATIONS OF ASPARAGUS AND KIWIFRUIT EXTRACTS ON THE EATING AND KEEPING QUALITIES OF HOT-BONED BEEF

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I. INTRODUCTION

Biological variation in muscle biochemistry due to physiological and anatomical differences between different animals and muscle type/meat cut can present a major challenge to achieve uniform tenderisation even with extended ageing times. Meat tenderness is largely regulated by post-mortem protein degradation via the actions of endogenous proteases in meat. Several studies have suggested the use of exogenous proteases to improve the tenderization process [1, 2]. Several proteases from plant, microbial and animal sources have been investigated for meat tenderization with varying levels of success [1, 2]. The objective of the current study was to investigate the tenderizing effect of 5 commercial food grade proteases of microbial and plant origin and in-house kiwifruit or asparagus preparations in beef topsides. Furthermore, the effect of post-treatment ageing time and the cooking style (fast vs slow) on the texture of treated samples were investigated.

II. MATERIALS AND METHODS

Hot-boned topsides from dairy cows (>5 years old) were randomly selected on the day of slaughter (approximately 2-3 hours following slaughter) from Alliance Group Ltd (Pukeuri Plant, Oamaru). For logistical reasons, topsides from both sides of 22 carcasses (44 topsides in total) were collected over 3 consecutive days. The carcasses had a mean hot carcass weight of 183 ± 35.6 kg and the topsides had a mean weight of 6.7 ± 1.5 kg. The topsides were transported to the University of Otago within 1.5-2 h of boning and sample treatment was performed 2-3 h after arrival at the laboratory. Topsides were halved and cut into steaks (mean weight ± SD was 305 ± 58.8 g) that were assigned to 1 day post-mortem (PM) treatment, and meat blocks of about 9x9x20 cm (mean weight ± SD was 1678 ± 488.5 g) that were aged (2°C) vacuum packed for 21 days. All of the samples (steaks and blocks) were subjected to needle injection with seven commercial protease solutions (papain, bromelain, zingibain, actinidin, bacterial protease G, fungal 31K and fungal 60K) (to 10% of the original weight) according to the manufacturers' recommendations or experimental level determined for the two in-house extracts prepared as described earlier [3] as well as a water injection control. The sources of the proteases and their proteolytic activities were reported earlier [3, 4]. The samples were tested for pH, cooking loss, shear force and compression force [5]. Fast cooking (10-14 min of cooking in a bag to 75°C core temperature), or slow cooking (1.5-2 h roasting at 180°C) were used for the steaks and meat blocks, respectively. Sample position for the different analyses was randomized within each sample block. Data were analysed using the REML routine in GenStat (GenStat Release 12.2), and the significance of treatment terms and their interactions was determined by Wald tests. In the REML analysis, treatment was set as a fixed factor, whereas animal and slaughter day, side, cut and slice were set as random factors using the VCOMPONENTS directive. Model terms

were sequentially added to the fixed model to test for fixed effects. Means and SEM were those estimated by the REML routine.

III. RESULTS AND DISCUSSION

There was no effect of treatments on the pH or on weight gain compared to controls after 21 days of PM storage (Table 1). Shear force was of meat samples treated with the in-house kiwifruit juice preparation exhibited the lowest shear force and compression values (Table 1). Some of the meat samples from this treatment had extensive breakdown of their structure, indicating the need to apply a less concentrated kiwifruit preparation. Interestingly, there was no tenderising effect by the commercial proteases. Similarly, the compression values indicate a clear tenderising effect for the in-house kiwifruit preparation. Fast cooking, or slow cooking did not have a significant effect on the shear and compression forces, with the exception of increased compression values of kiwifruit treated samples with slow cooking.

Table 1 Effect of treatment of hot boned beef topsides with enzyme tenderisers on % change in weight, pH, cooking loss (%), shear force and compression values of cooked (fast cooking vs roasted (slow cooking)) beef at 21 days post-mortem.

Treatments	Change in weight due to treatment (%)	Cooking loss (%)	Fast-cooking Shear force (N)	Fast-cooking Compression (N)	Roast Shear force (N)	Roast Compression (N)
Control	-2.6^{bc}	33.9	83.4^{abcd}	135.0^{a}	75.3^{ab}	138.8^{abc}
Water	-1.2^{ab}	36.5	68.9^{cde}	136.1^{a}	73.8^{ab}	147.9^{abc}
Papain	1.3^{a}	36.7	71.4^{bcd}	122.0^{a}	75.9^{ab}	127.5^{abc}
Bromelain	-0.7^{ab}	36.9	84.0^{ab}	138.7^{a}	70.2^{bc}	119.2^{cd}
Actinidin	-2.7^{bc}	33.6	67.9^{de}	124.2^{a}	74.9^{ab}	117.1^{cd}
Zingibain	-1.2^{ab}	36.1	79.6^{abcd}	126.5^{a}	74.1^{ab}	122.0^{bcd}
Fungal 31K	-0.9^{ab}	36.0	85.5^{ab}	142.9^{a}	81.4^{ab}	156.6^{a}
Fungal 60K	-2.8^{bc}	37.5	87.9^{a}	144.2^{a}	82.1^{ab}	151.9^{ab}
Protease G	-4.0^{c}	37.1	84.1^{ab}	136.1^{a}	87.6^{a}	153.5^{ab}
Kiwifruit juice	-0.7^{ab}	34.8	58.1^{e}	76.0^{b}	58.6^{c}	94.2^{d}
Asparagus juice	-4.0^{c}	33.3	87.3^{ab}	150.7^{a}	84.6^{a}	144.8^{abc}
SED	1.35	2.4	8.9	13.0	7.1	16.1

IV. CONCLUSION

Meat samples injected with fresh kiwifruit juice were found to have the best potential for tenderizing tough beef topsides.

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REFERENCES

1. Bekhit, et al. (2017). Manipulation of meat structure: use of exogenous proteases. In: Advances in meat science and processing. Bekhit, Ed. CRC Press, pp 65-120.
2. Bekhit, et al. (2014). Exogenous proteases for meat tenderization. Critical Reviews in Food Science and Nutrition. 54, 1012-1031.
3. Ha, et al. (2012). Characterization of commercial papain, bromelain, actinidin and zingibain protease preparations and their activities toward meat proteins. Food Chemistry, 134, 95–105.
4. Ha, et al. (2013). Characterization of kiwifruit and asparagus enzyme extracts, and their activities toward meat proteins. Food Chemistry, 136, 989–998.
5. Bekhit, et al. (2013). Effect of Kiwifruit and flaxseed flours on the texture of salami. In: Proceedings of 59th ICoMST, 18-23rd,August 2013, Izmir, Turkey.