EFFECTS OF INJECTION TIME AND POST-MORTEM STORAGE TIME ON TEXTURE PROPERTIES OF BEEF TOPSIDE TREATED WITH PLANT PROTEASES

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I. INTRODUCTION

Meat tenderization by using exogenous proteases can be achieved at varying levels of success [1], however over-tenderization have been often reported with plant proteases and a commercial method has yet to be optimized. The downfall of many of the plant proteases investigated is the lack of specificity toward connective tissue and myofibrillar protein [1, 2]. The resultant mushy texture, bitterness and off flavour generated with extensive hydrolysis are not desirable attributes to the consumer, therefore the plant proteases currently have little commercial application in fresh meat. The use of plant proteases that have mild tenderizing activity (such as actinidin and zingibain) is more promising than harsh proteases such as papain and bromelain [1, 3] in meat tenderization. Another important aspect that is not investigated before is the impact of the treatment on meat of various post-mortem times and whether treatment followed by ageing will be better option than ageing followed by treatment with proteases. The objective of this study is to investigate the effect of treatment with kiwifruit or ginger juices as source of actinidin and zingibain proteases, respectively, before or after ageing storage on the textural properties of the meat.

II. MATERIALS AND METHODS

A total of 12 animals were slaughtered in export certified slaughterhouse (Alliance Group Ltd) and 24 topsides were excised and chilled at 4°C overnight to reach 24hrs post-mortem before being separated and the right side was used for immediate (before) and the left side was used for post-mortem (after) injection with proteases. The topsides were sliced in half and the halves were randomly assigned to one of the following treatments; control, water-injected, actinidin-injected or zingibain. Each slice was cut into 3 block of meat that were randomly allocated to either 2, 7 or 20 days of post-treatment storage at 4°C. The samples that were injected using a 68 needle meat injector (Brine Injector ZS1-80, YC Mechanism, Shijiazhuang, Hebei, China) to approximately 10% of the original weight. The actinidin and zingibain solutions were prepared from fresh fruits and rhizomes, respectively on the day of the treatment and stabilizing compounds were added to preserve the activity. The proteolytic activities (BODIPY-FL casein proteolysis assay) of the preparations were adjusted to 0.3×10^6 and 2.6×10^6 (Δfluorescence min^{-1} mg^{-1} protein) based on previous studies [3, 4]. The shear force and the texture profile analysis were determined as described by Bekhit et al. [5]. Data were analysed using the REML routine in GenStat (GenStat Release 16.1), and the significance of treatment terms and their interactions was determined by Wald tests. Data were analyzed as a split-split-plot design, with infusion treatment as the whole plot, injection time (before aging and after aging) as the subplot, and postmortem time (2, 7 and 20 days of vacuum-packing) as sub-subplot. Each infusion treatment assigned to meat section was treated as a completely randomized block design. The model included infusion treatment, injection time and postmortem time as fixed factors, whereas animals, topside section and location within each section were set as random factors. Model terms were sequentially added to the fixed model to test for fixed effects.

III. RESULTS AND DISCUSSION

The hardness of the topsides was affected by the protease treatment ($p < 0.05$) but not by the post-treatment storage time or the treatment time (i.e. before ageing or after ageing) ($p > 0.05$) (Figure 1).

Overall, the hardness of water and control treated samples were not different ($p > 0.05$) and were higher than actinidin and zingibain treated samples ($p < 0.05$). The hardness of actinidin treated topsides was significantly lower than zingibain treated samples. The shear force of the topsides was affected by treatment and treatment time ($p < 0.05$), but not by the post-treatment storage time (Figure 1). Both actinidin and zingibain treated meat samples had significantly lower shear force values than water treated samples. Cohesiveness had similar trends as hardness .The shear force of control and actinidin treated samples were not different. Overall, samples injected before storage at 4°C had lower shear force values than the samples injected after storage. Only adhesiveness of water was higher than the actinidin treated samples. Chewiness and gumminess of water and control were not different ($p > 0.05$). These properties were lower in zingibain and actinidin compared to control (Table 1) and actinidin samples were lower that zingibain treated samples.

Table 1. Effect of injection with water, actinidin, zingibain preparations on the texture properties of beef topsides either injected and stored for 2, 7 and 20 days post-treatment or injected after comparable storage time vaccum packed.

Treatment	Post-treatment storage time	Adhesivness	Chewiness	Cohesivness	Gumminess	Resilience	Springness
Control	2	0.19	1.23^{abc}	0.46^{a}	33.34^{ab}	0.09^{a}	0.007^{bc}
	7	-0.01	1.41^{ab}	0.44^{ab}	35.83^{ab}	0.08^{abc}	0.008^{ab}
	20	-0.79	1.71^{a}	0.44^{ab}	38.51^{a}	0.08^{a}	0.009^{a}
Water	2	0.52	1.26^{abcde}	0.44^{abc}	32.41^{abc}	0.08^{abcd}	0.008^{abc}
	7	-0.02	1.29^{abcde}	0.43^{abcdef}	32.71^{abc}	0.08^{abcd}	0.008^{abc}
	20	0.09	1.82^{a}	0.44^{abcde}	38.23^{ab}	0.08^{abcd}	0.009^{a}
Actinidin	2	-1.06	0.51^{f}	0.37^{cdef}	15.03^{e}	0.06^{de}	0.006^{c}
	7	-0.98	0.69^{def}	0.37^{def}	18.75^{de}	0.06^{cde}	0.007^{bc}
	20	-0.99	0.60^{f}	0.36^{f}	15.96^{e}	0.06^{e}	0.007^{bc}
Zingibain	2	-0.15	0.98^{bcdef}	0.44^{ab}	28.44^{bcd}	0.08^{ab}	0.007^{bc}
	7	-0.56	0.74^{ef}	0.40^{bcdef}	19.69^{de}	0.07^{cde}	0.007^{bc}
	20	-1.24	0.92^{cdef}	0.39^{bcdef}	23.73^{cde}	0.07^{cde}	0.007^{bc}
SEM		0.44	0.12	0.01	1.93	0.003	0.0003

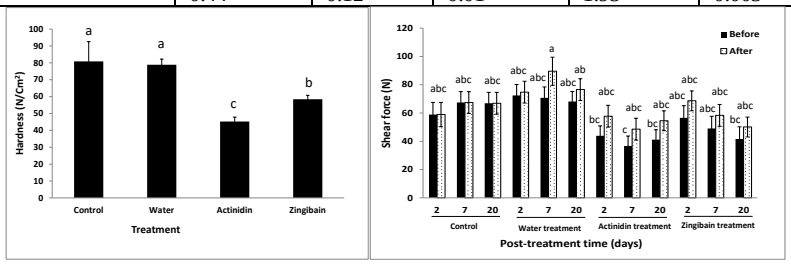

Figure 1. Effect of injection with water, actinidin, zingibain preparations on the hardness and shear force of beef topsides either injected and stored for 2, 7 and 20 days post-treatment or injected after comparable storage time vaccum packed.

IV. CONCLUSION

This study confirms earlier work suggesting fresh kiwifruit juice, as source of actinidin is very effective meat tenderizing preparation. Ginger juice preparation as source of zingibain was exhibited milder tenderizing effect despite its higher proteolytic activity as measured by caseinolytic activity. The injection of proteases prior to further storage appears to be more beneficial in improving the meat tenderness.

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