

Relationship of postmortem troponin-T degradation and meat tenderness of beef *Longissimus dorsi* from different production systems in Thailand

J. Sethakul¹, Y. Opatpatanakit³, R. Limsupavanich^{2*}, L. Srisuwan¹ & K. Jirajaroenrat¹

¹Department of Animal Production Technology, Faculty of Agricultural Technology, King Mongkut's Institute of Technology Ladkrabang, Ladkrabang, Bangkok 10520, Thailand.

²Department of Agricultural Education, Faculty of Industrial Education, King Mongkut's Institute of Technology Ladkrabang, Bangkok 10520, Thailand.

³ Department of Animal Technology, Faculty of Agricultural Production, Maejo University, Chiang Mai 50290, Thailand.

Abstract

Troponin-T degradation in relationship to tenderness of beef *Longissimus dorsi* (LD) from four different production systems had been observed. LD muscles from natural grass grazed native Thai cattle (N, 100%, *Bos indicus*, n=10), straw and grass-fed with 3-mo concentrate finish Brahman crossbred (BG, 100% *Bos indicus*, n=10), pineapple by product-fed with 6-mo concentrate finished Brahman crossbred (BP, 100% *Bos indicus*, n=10), and at least 50% *Bos taurus* of Charolais crossbred steers with 12 to 18-mo concentrate finishing (C, n=5), were vacuum aged (4°C) over aging period of 1, 7 and 14 days. The 30 kDa band (SDS–PAGE) corresponding to the troponin-T degradation were detectable and increased in intensity with increasing ageing period, with the most intense BP, followed by N, BG and C, respectively. However, the 37 kDa band was not found in C group compared to the indicus cattle at 14 days of ageing. The average means of WB shear force values were 3.96, 13.61, 9.52 and 13.76 kg in C, BG, BP and N beef, respectively.

Introduction

It is well known that the tenderness of meat depends on several factors such as breed, production systems, feed, storage of carcasses, connective tissue content and myofibrillar protein degradation, etc. Thai beef has a great difference in meat quality especially tenderness. More than 95% of beef in Thailand are from indicus cattle which had not been aged prior to sale. Storage of carcasses at refrigerated temperature has been reported to improve the tenderness by increasing myofibrillar protein degradation (Koochmarai and Shackelford, 1991). The degradation of myofibrillar proteins such as titin, desmin and troponin-T (Tn-T) have shown to play a role in the development in meat tenderness (Huff-Lonergan *et al.*, 1996). One of the most common symptoms of protein degradation during aging is appearance of Tn-T degradation products having molecular weight about 30-kDa (Joo *et al.*, 1999). A 30-kDa polypeptide was detected in several bovine muscles postmortem at the same time that Tn-T was decreasing (Ho *et al.*, 1997) and Steen *et al.* (1997) found 80% of Tn-T degradation between day 1 and 8. The objectives of this study were to investigate Tn-T degradation products (30-kDa) of beef LD muscle from different breeds and production systems during 1, 7 and 14-days postmortem in cold storage and to determine tenderness of meat (Warner-Bratzler shear force) during ageing period and relate to the intensity of 30-kDa polypeptide.

Materials and methods

Beef LD muscle from four production systems in Thailand, natural grass grazed native Thai cattle (N; 100% *Bos indicus*, 214-kg, n=10), straw and grass-fed with 3-mo concentrate finished Brahman crossbred (BG; 100% *Bos indicus*, 487-kg, n=10), pineapple byproducts-fed with 6-mo concentrate finished Brahman crossbred (BP; 100% *Bos indicus*, 497-kg, n=10), and at least 50% Charolais crossbred steers, with 12 to 18-mo concentrate finishing (C, 664-kg, n=5). Samples were taken from the 6th to the 12th ribs of the abdominal region at 24 hours postmortem. Steaks of 2.5cm thickness were vacuum-packaged and aged at 4°C for 1, 7 and 14 days. The pH, Warner-Bratzler shear force (WBSF) and SDS-PAGE analysis were determined. The pH value was measured at 24 hr postmortem 7 and 14 days by pH Meter model WTW (Germany) and Electrode-WTW pH-sentix^{sp}. The WBSF values was measured by Instron Warner-Bratzler Model 1011 with 50 kg compression load cell and speed 500 mm/min (Devine *et al.*, 1999), the. Myofibrillar protein extraction and SDS-PAGE analysis were performed using the method reported by Claves *et al.* (1995). SeeBlue® Plus2 Pre-Stained Standard (Invitrogen) was used as protein molecular weight marker. Bovine serum albumin (BSA) was used as an internal control for relative quantitative measurement of Tn-T and 30 kDa protein band. The data of pH, WBSF and 30-kDa were statistically determined according to 4x3 factorial arrangement in completely randomized design which factor A was 4 different breeds and production systems and factor B was 3 different ageing periods.

Results and discussion

From SDS-PAGE analysis (Figure 1), the results showed that intensity of the 37-kDa band corresponding to Tn-T in C beef started to disappear at 7 days and disappeared at 14 days of ageing whereas the same band in other beefs was clearly detected from 1 day to 14 days of ageing. The intensities of the 39 kDa band in beef from all groups were observed at each ageing period, however, that of C beef markedly decreased as ageing period became longer. In addition, BP beef had the highest intensity of Tn-T degradation product (30-kDa) over the 14 days of ageing. Interestingly, the 30-kDa band appeared with a high intensity from day 1 and only slightly increased at 7 and 14 days of ageing. This observation indicated that the Tn-T in BP beef may be dramatically digested by a kind of calpain-like enzyme at day 1 of ageing, following which further digestion continued by calpain activity as in other beefs. Such enzyme might be related to the feeding of beef with pineapple. This would be a topic for further investigation.

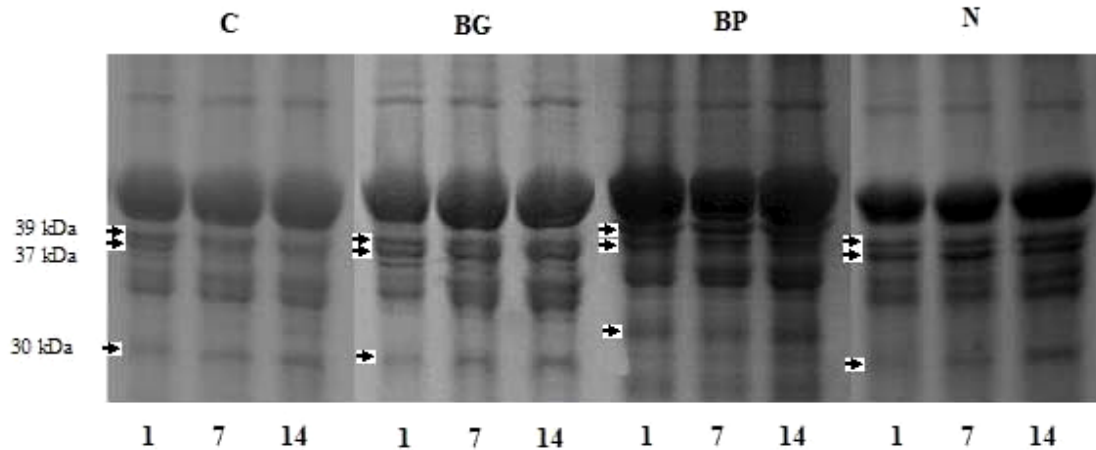


Figure 1. SDS-PAGE of myofibrillar proteins after ageing for 1, 7 and 14 days postmortem. Bovine serum albumin (BSA) was an internal control for relative quantitative.

The WBSF results showed that beef from indicus cattle, N and BG, had a similar WBSF but were significantly higher than those of BP and C. The average means of WBSF values were 3.96, 13.61, 9.52 and 13.76 kg in C, BG, BP and N beef, respectively. The intensities of 30-kDa band from C, BG and N beef samples were approximated 3.04, 3.28 and 4.02 μ g BSA-equivalent, respectively whereas those of BP group, fed pineapple waste as a roughage, was the highest, 5.42 μ g BSA-equivalent (Table 1). The negative correlations between WBSF value and 30-kDa intensity were 0.91, 0.88, 0.84 and 0.78 in beef from C, BG, N and BP groups, respectively (data not shown). It indicated that myofibrillar protein degradation play a more important role on tenderness in taurus than in indicus crossbred cattle. This result is similar to those reported by Wheeler *et al.* (1990), who stated that increasing of proteolysis in Hereford breed (taurus group) was due to a higher calpain-dependent of protease I (CDP) activity or lower CDP inhibitor activity.

From this study, beef from N group with only grazed natural grass showed a higher pH value. This was due to an extensive feeding system causing less accumulation of fat covering, leading to acceleration of temperature reduction in meat during chilling. It could retard anaerobic glycolysis, resulting in slowdown of the pH reduction (Smith *et al.* 1976). Higher pH in beef enhanced activity of calpain dependent protease which could affect meat tenderness, as stated by Neath *et al.* (2007) who reported that buffalo meat had a slower pH decline than beef, which increased the tenderness of buffalo meat. Moreover, Steen *et al.* (1997) found that pH in beef at 3 hr postmortem is negatively related to Tn-T concentration but is positively related to intensity of 30-kDa band. In agreement with this study, the younger N beef (2 yr) had a higher pH and more intense 30- kDa band than the other age (> 3 yr). In addition, Kolezak *et al* (2003) reported that Tn-T degradation was higher in younger cattle (calf) than those in older cattle such as heifer and cow.

Table 1. The pH value, WB shear force and 30 kDa intensity of beef samples from different breeds and production systems at various ageing periods

	pH				WBSF (kg)				30 kDa band (μ g BSA-eq)			
	1d	7d	14d	Breed mean	1d	7d	14d	Breed mean	1d	7d	14d	Breed mean
C	5.56	5.42	5.52	5.50^a	6.29	3.48	2.71	3.96^a	2.04	3.10	3.99	3.04^a
BG	5.56	5.53	5.57	5.55^{ab}	18.01	12.08	9.43	13.61^c	2.42	3.59	3.84	3.28^a
BP	5.58	5.59	5.57	5.58^b	12.67	8.32	6.85	9.52^b	5.07	5.19	6.00	5.42^c
N	5.65	5.57	5.55	5.59^b	17.22	14.94	11.56	13.76^c	3.11	4.00	4.94	4.02^b
Ageing mean	5.54	5.56	5.58		12.91^d	10.58^e	9.03^f		3.92^a	4.09^b	4.79^c	

^{abc} means with different superscript in the same column differ due to effect of breeds and production systems ($p < 0.05$).

^{def} means with different superscript in the same row differ due to effect of ageing period ($p < 0.05$).

Conclusions

Indicus beef had higher WBSF, even after 14 days of ageing while taurus crossbred beef had more tender (lower WBSF) after 7 days of ageing. It could be confirmed that myofibrillar protein degradation, indicating by intensity of 30-kDa protein, was not only factor affecting tenderness of indicus beef. More associated factors which influence tenderness such as higher insoluble collagen content, pineapple byproducts as a feed, should be considered in further studies.

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