INTRAMUSCULAR COLLAGEN CHARACTERISTICS OF DOUBLE-MUSCLED AND NORMAL JAPANESE SHORTHORN STEERS

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Introduction

Cattle displaying a heavy or extreme muscular appearance express what is known as 'double muscling' or muscular hypertrophy. This is a genetically controlled characteristic, and the manifestation of double muscling varies with the breed depending on the genetic background, environment, sex and stage of maturity. Ngapo *et al.*, (2002) indicated that double-muscled cattle have lower collagen content in muscle and higher pyridinoline cross-links in collagen than normal cattle. Mature collagen has more pyridinoline cross-links and should be less heat-labile with greater mechanical strength (Bailey, 1984). It is generally accepted that collagen is a major component in connective tissues of muscle, and the texture of meat is controlled by its quantity and quality. The Japanese Shorthorn is a breed of Japanese beef cattle and is bred mainly in the northern area of the Tohoku region of Japan. The meat has less marbling, but the number of Japanese consumers who prefer less marbling or lean meat has been increasing recently. The efficiency of lean meat production would be improved, when the merit of double-muscling could be used in the production of Japanese Shorthorn beef; but the quality of double-muscled Japanese Shorthorn beef has not been well studied. The aim of the present study was to compare the characteristics of intramuscular collagen in double-muscled Japanese Shorthorn beef cattle with normal cattle in order to evaluate the meat quality of double-muscled beef.

Materials and Methods

Three normal (22 months of age, average body weight 695.2kg) and 3 double-muscled (22 months of age, average body weight 686.8kg) castrated male Japanese Shorthorn steers were used. Steers were slaughtered and samples of *m. longissimus dorsi* (LD muscle) and *m. biceps femoris* (BF muscle) were excised. Some muscle pieces were used to prepare intramuscular connective tissue (IMCT) and the remaining samples were frozen at -20°C until analysis. IMCT samples were prepared by the method of Nishimura *et al.* (1998). The shear force value of IMCT preparations embedded in acrylamide gels was measured using a rheometer (RT-3010D-CW, RHEOTECH, Tokyo, Japan) with a shearing wire and a crosshead speed of 30cm/minute. For chemical analysis, meat samples were thawed at 4°C and trimmed of external fat and epimysial connective tissue. The muscle samples were minced and prepared to determine moisture, fat and protein contents (%), total and soluble collagen contents (mg/g of muscle) and pyridinoline contents (moles/mole of collagen). Soluble collagen was extracted from samples by heating for 70 min at 77°C in 0.25-strength Ringer's solution, using a water bath (Hill, 1966). The supernatant samples and minced meat samples used to measure the total amount of collagen in each muscle were hydrolyzed in 6 N HCl for 12 hours at 121°C. The hydroxyproline concentration of each hydrolyzate was determined by a colorimetric method (Bergman and Loxley, 1963). The collagen content was calculated using conversion factors of 7.25 (total collagen) and 7.52 (soluble collagen), respectively (Cross *et al.*, 1973). Collagen solubility was expressed as the percentage soluble collagen of the total collagen content. Pyridinoline was purified by ion-exchanged cellulose according to the method of Skinner (1982), and was determined by the liquid chromatographic procedure of Arakawa *et al.*, (1992). Pyridinoline concentration was determined by monitoring fluorescence intensity using excitation and emission wavelengths of 295 and 395 nm, respectively and compared with the intensity of an external standard purchased from Wako (Osaka, Japan).

Results and Discussion

In LD and BF muscle, moisture and protein contents were higher while fat content was lower in double-muscled cattle than in normal cattle and double-muscled cattle had a lower content of total, soluble and insoluble collagen than normal cattle. But collagen solubility and pyridinoline in collagen did not show clear differences (Table 1). These results indicate that the muscles of double-muscled cattle had lower intramuscular collagen content from the dilution of collagen with other proteins and moisture, but the solubility and pyridinoline cross-links of collagen were not different. The shear force value of IMCT preparations from double–muscled cattle was lower than that from normal cattle (Figure 1). This may be attributed to different collagen proportions.

Table 1: Chemical composition and collagen characteristics of muscles of normal and double-muscled cattle.

Cattle	*M. longissimus dorsi*						*M. biceps femoris*		
	Normal			Double-muscled			Normal	Double-muscled	
	1	2	3	1	2	3	3	1	2
Moisture (%)	65.1	66.7	67.2	72.0	71.1	72.3	69.1	73.0	72.8
Fat (%)	14.2	11.3	10.9	4.6	4.3	4.3	8.5	2.1	3.7
Protein (%)	19.6	20.9	20.6	21.6	22.4	22.1	20.7	22.6	22.1
Total collagen (mg/g)	3.26	3.10	2.77	2.46	1.86	3.17	5.21	3.32	3.39
Soluble collagen (mg/g)	0.39	0.54	0.43	0.27	0.22	0.51	0.45	0.41	0.38
Insoluble collagen (mg/g)	2.86	2.56	2.34	2.19	1.64	2.66	4.76	2.91	3.01
Collagen solubility (%)	12.1	17.5	15.7	11.0	12.0	16.0	8.6	12.4	11.3
Pyridinoline (moles/mole of collagen)	0.16	0.14	0.16	0.11	0.14	0.17	0.16	0.16	0.15

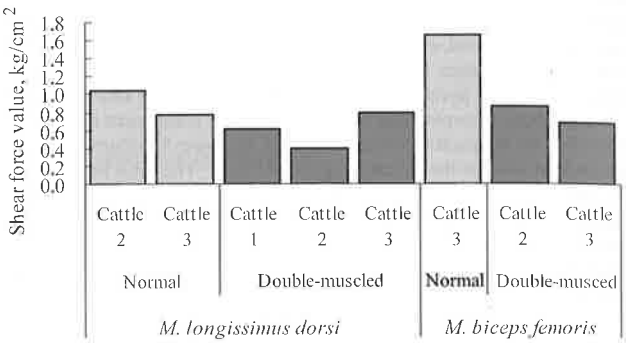

Figure 1: The shear force value of IMCT preparations embedded in acrylamide gels of muscles of normal and double-muscled cattle.

Conclusions

Muscle from double-muscled Japanese Shorthorn beef cattle had a high protein and low collagen content and low shear force value of IMCT, but collagen solubility and pyridinoline cross-links did not differ from normal cattle. From these results, it seems that double-muscling of Japanese Shorthorn is efficient to produce tender beef.

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