TEXTURE PROPERTIES OF TEN BEEF MUSCLES TO BE MARKETED AS STEAKS

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Background and Objective: A challenge for future beef production will be to meet contemporary consumer attitude towards more convenient food of high quality. Developing new steak cuts suitable for grilling or panfrying might be an approach to expand the supply of products which are fast and easy to prepare. As collagen content is higher in most of the muscles other than common steak muscles such *as psoas major*, *longissimus dorsi*, or *glutaeus medius* texture problems will be the first limiting factor.

The objective of this study was to examine texture properties of various promising muscles of intensively fattened young bulls which were expected to provide beef relatively low in mature cross-links in collagen. Additionally, the influence of age and genetic origin on potential utilization of these new cuts was evaluated.

Material and Methods: Young bulls of defined genetic origin (Blonde d'Aquitaine x Brown Swiss (BAX, n=16), Limousin x Friesian (LiX, n=8), and purebred Friesian (Fr, n=16)) were assigned to two representative age groups and slaughtered at an age of 13 or 15.5 months. They provided average carcass weights of 273/333 kg (BAX), 265/310 kg (LiX), and 243/287 kg (Fr), respectively. Electrical stimulation was conducted directly after stunning while animals were bleeding out. Carcasses were deboned four to five days after slaughter. The individual muscles *biceps femoris* (BF), *glutaeus medius* (GM), *longissimus dorsi* (LD), *rectus femoris* (RF), *semimembranosus* (SM), *supra spinatus* (SS), *semitendinosus* (ST), *serratus ventralis* (SV), *triceps brachii* (TB), and *vastus lateralis* (VL) were separated, vacuum-sealed in PE-bags, and aged until 14 days p.m.. Then 2.5 cm slices were cut according to a standardized procedure and kept frozen until later use.

For mechanical texture analysis the assigned slice was grilled to an internal temperature of 72°C. When cooled to room temperature, 6 to 10 cores of 1.27 cm diameter were taken and Warner-Bratzler shear (WBS) attachment mounted on Instron 4301 was used to shear cores perpendicular to muscle fibres. Maximum shear force, extension (from the starting point 20 mm above the slot to occurence of max. shear force), and total energy as well as energy from an extension of 15 mm (the point were myofibriliar strength is assumed to be broken) to the end of shear process were recorded.

Sensory analysis was performed to investigate differences between muscles and also between age groups and genetic origin. In the first run, all muscles of one animal were offered in one session whereby four animals of each age group and genetic origin were included, resulting in a total of 24 sessions. In the second run the same muscles from two animals of each age group and genetic origin were presented in one session resulting in a total of 16 sessions. Due to the limited number of samples to be handled per session only BAX and Fr were included in the second run.

Steaks were browned in a teflon coated pan on both sides for 1.5 min, transferred to a 'Cyclo-Jet' (Tec Tronic Industries Co. Ltd, Hong Kong), and cooked in hot air circulating with 500 m/min at 200°C under control of internal temperature. For half of the sessions in the first run internal temperature was set to 70°C. At all remaining sessions internal temperature was raised to 77°C, in order to evaluate texture properties under unfavourable conditions as may occur during household preparation. After removing the edges of the steaks, 2 x 2 cm cubes were cut, and immediatly offered to trained panelists. Panelists had to score the following attributes in the given order: initial firmness, initial juiciness, tenderness, beef flavor intensity, hedonic flavor, sustainable juiciness, durable toughness, and overal acceptance on an 8-point scale (1 = extremely dry, firm, tough, no resp. unacceptable flavor or acceptance; 8 = extremely juicy, soft, tender, intense, resp. desirable flavor or acceptance).

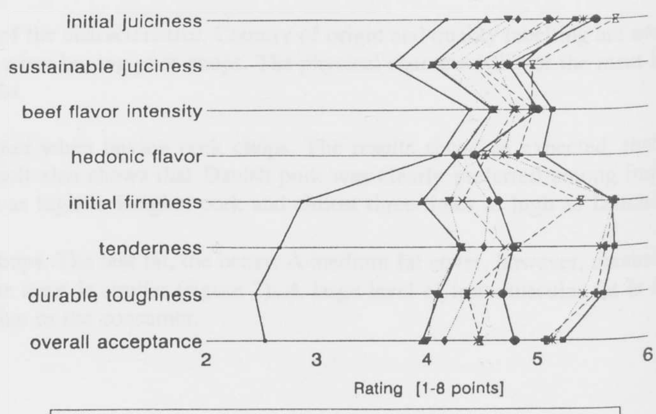

Fig. 1: Sensory texture profile of different beef muscles

Results and Discussion: Sensory profile shows individual characteristics and significant differences among the muscles examined in the first run (Fig. 1). The conventional steak-muscles LD and GM may serve as a reference. RF shows a similar profile and is even slightly more tender. TB is clearly not as tender as these muscles, but its acceptance ranks between the reference muscles and the medium range, possibly due to its favorable juiciness and flavor. A very special profile is shown by SV. The initial texture impression is very soft but becomes tougher during the chewing process. Its juiciness is the highest of all muscles, obviously due to its high, even visible fat content. On the other hand, its flavor is not very intense and favorable. These findings are in accordance with the results of Carmack et al. (1994) indicating that flavor is not only dependent on the amount of intramuscular fat. BF is - when prepared as steak - clearly too tough. Its low ranking in flavor in this study is in contrast to the findings of Carmack et al. (1994) and may be partly due to a correlated impression with the undesirable overall palatability, especially as the panelists were not specifically trained for evaluation of flavor traits. Raising internal temperature resulted in lower juiciness and flavor, but improved tenderness and reduced durable toughness (Data not shown). This indicates that no hazardous effects on tenderness of these unconventional steaks are to be expected even when they are prepared to a well done state.

The toughness of BF is well reflected by the mechanical WBS measure (Tab. 1). The large extension and the high energy especially in the last part of the shear process indicate the predominant influence of the connective tissue in this muscle. Max. shear force is also highest for BF but no significant difference can be noticed among the other muscles. According to the results of Huffman et al. (1996),

Tab. 1: Warner-Bratzler shear measures of different beef muscles from intensively fattened young bulls.

	BF	GM	LD	RF	SM	SS	ST	SV	TB	VL
max. shear force [N]	57,0^{a}	42,4^{b}	42,8^{b}	41,8^{b}	47,7^{ab}	47,8^{ab}	45,4^{b}	42,4^{b}	43,0^{b}	49,2^{ab}
extension [mm]	19,2^{a}	15,4^{bcd}	14,7^{d}	15,2^{cd}	16,4^{bc}	16,9^{b}	14,7^{d}	16,5^{bc}	15,5^{bcd}	16,6^{bc}
total energy [mJ]	664^{a}	484^{b}	477^{b}	486^{b}	583^{ab}	551^{ab}	519^{b}	536^{b}	487^{b}	586^{ab}
energy from 15 mm [mJ]	510^{a}	283^{bcd}	268^{d}	279^{cd}	368^{b}	360^{bc}	288^{bcd}	351^{bcd}	285^{bcd}	366^{b}

LS-means within the same row lacking a common superscript differ significantly (Scheffé, $p < 0.05$)

WBS force should not exceed 4.1 kg (~40.2 N) to guarantee consumer satisfaction. On average GM, LD, RF, SV, and TB are showing max. shear force only slightly above this limit but differ significantly in sensory tenderness. Extension and energy values might give more evidence for differences in texture properties when different muscles are compared. So, SV shows high extension and energy reflecting the sustainable component of toughness found in the sensory evaluation, despite of relatively low max. shear force. TB shows smaller extension and energy values and is ranking higher in sensory acceptance. TB as well as RF are stretched in a conventionally hung carcass, thus, sarcomere length may also contribute to the tenderness in both muscles. Comparison among genetic origin and age groups shows higher scores for Fr in all juiciness and texture traits, resulting in a higher overall acceptance (Fig. 2). Within genetic origin younger animals were scored significantly better in juiciness, texture and therefore acceptance. This emphasizes the effect of age on the connective tissue component of tenderness. No conclusive explanation can be elucidated for the unexpected low acceptance for LD in this part of the evaluation.

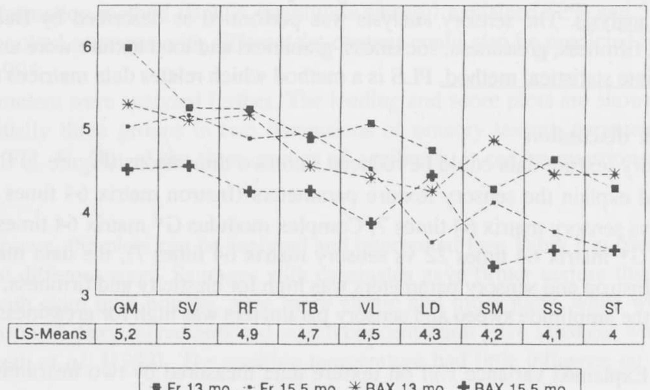

Fig. 2: Sensory acceptance of different muscles from young bulls differing in age and genetic origin

Conclusions: Mechanical texture measurement as well as sensory evaluation indicate that additional steaks can be cut from RF and TB. Second choice steaks may be obtained from SM, SV, ST, and VL. To assure satisfactory acceptance of those new steak cuts, bulls have to be slaughtered very young and, as differences among genetic origins were found, some restriction on genetic origin may be useful. Finally, economical calculations and customer acceptance have to show whether new, unconventional steak-cuts can be successfully commercialized.

Pertinent Literature:

Carmack, C.F., C.L. Kastner, M.E. Dikeman, J.R. Schwenke, and C.M. Garcia Zepeda 1994: Sensory evaluation of Beef-Flavor-Intensity, Tenderness, and Juiciness among Major Muscles. Meat Science 39, 143 - 147

Huffman, K.L., M.F. Miller, L.C. Hoover, C.K. Wu, H.C. Brittin, and C.B. Ramsey 1996: Effect of Beef Tenderness on Consumer Satisfaction with Steaks Consumed in the Home and Restaurant. Journal of Animal Science 74:91-97

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