



Relationships between the assessment of “grain of meat” and meat tenderness of Charolais cattle

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ABSTRACT

Beef industry operators often use a “grain of meat” assessment to aid in selecting carcasses according to their tenderness potential.

The first aim of this study was to formalise this empirical notion by building a scoring scale for grain of meat. Two experts, regular users of this notion, were called upon to build the assessment grade. A group of 16 criteria was identified on the carcass as being effective in predicting an overall “grain of meat” score.

The second aim of this study was to establish the relationship between the meat grain score estimated on the carcass and the tenderness of the *longissimus thoracis* muscle estimated by sensory evaluations. Some individual criteria such as “nerve presence”, “marbling”, and “touch of muscles” appeared to be linked to muscular characteristics such as collagen content, lipid content and shear force. No significant relationship was identified between grain of meat and either tenderness (initial: $p=0.58$; overall: $p=0.50$), shear force ($p=0.33$), or collagen content and collagen solubility ($p=0.23$; $p=0.33$).

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1. Introduction

For the consumer, from a sensory point of view, the most important quality trait is tenderness. Increasing tenderness appears to increase the enjoyment while eating (Ristic & Miscevic, 2012). Beef is known to have a poor quality/price ratio compared to white meats, with the main criticism being irregularity in tenderness (Dransfield, 1994; Leroy et al., 2003; Warriss, 2004). This has a significant effect on consumer choice. This has been exacerbated by successive BSE crises or excessive nutritional criticisms that often target red meat. Depending on the country, some different ways were used to develop a commercial system that gives the insurance of a high quality meat to the consumer. For example, in Australia, the Meat Standards Australia eating quality grading system was developed and recent researches have also been made in Korea, Ireland, USA, Japan, and South Africa (Polkinghorne & Thompson, 2010).

Previous result indicated that most consumer prefer more tender meat and are ready to pay a premium for tender versus tough meat (Boleman et al., 1997; Lusk, Fox, Schroeder, Mintert, & Koohmaraie, 2001; Polkinghorne & Thompson, 2010; Prieto, Andrés, Giráldez, Mantecón, & Lavín, 2008a,b). Moreover, it appears that French consumers are willing to pay more for well-reared animals (feeding, welfare, ...) and farm-specific source verification (Tonsor, Schroeder,

Fox, & Biere, 2005). Thus, to achieve market segmentation, the producers and the beef industry have developed official quality labels based on animal breeds and livestock rearing methods (pre and post-slaughter). Indeed, it is well known that even when post-slaughter conditions are fixed, there are still wide variations in meat quality traits that may be linked to pre-slaughter factors and that it is possible to increase meat quality traits by selecting some breeding factors (Oury et al., 2007). Then, it is relevant to be able to control, as early as possible, the higher quality of carcasses and meat samples.

The beef industry is currently attempting to make a distinction, mainly based on tenderness rather than on flavour and taste, between standard and high-quality beef products sold both by supermarkets and by butchers. This is partly based on the assumption that butchers possess a know-how that is founded on subjective criteria in addition to the relationship between “grain of meat” and tenderness and taste. Previous works also indicated this link between muscle “grain” size and tenderness such as Purslow (2005). Moreover, the “graininess” descriptor is used in the USDA grading scheme for beef for many decade, fine grain being a requirement for the top grades. Nevertheless, much of the work cited in the literature on muscle grain and meat texture is 40–70 years old, and so does not appear in modern databases.

The assessment of grain of meat is also a subjective judgement, established by wholesalers at the time of primary carcass cuts, in order to select and guide the carcasses according to their tenderness potential. This evaluation, used by some wholesale and retail butchers,

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is based on both visual and tactile features and enables an empirical assessment of the tenderness of a carcass (Delavigne, 2008a,b).

This assessment of grain of meat, currently used by retailers and butchers, appears to be an outdated expression, not used in recent studies where the term “texture” is generally preferred. Nevertheless, it was previously indicated that the meat grain concept represents the network that may be observable on a transverse muscle section. The division of muscles into fascicles by the perimysium can also easily be discriminated by eye. The muscle grain is synonymous with muscle fibre bundle diameter. The differences in primary bundle size, the thickness of the perimysium and the degree of adipose tissue associated with the perimysium can be explained by the grain size (Purslow, 2005). The grain is thus identifiable both visually and by touch (Lepetit & Culioli, 1994; Taylor, 1998).

With regard to knowledge and know-how, an in-depth analysis of beef retailer and butcher discourses on grain of meat expression was realised as preliminary work (Delavigne, 2008a), and lead to define this term and identify some “meat markers” that can be used to estimate grain of meat on the carcass and after cutting.

The primary aim of this research was to formalise some of these “markers” identified in the ethnological analysis, and then to balance them in a meaningful way for the experts' scoring scale. The second aim was to establish the relationships between grain of meat and meat quality traits especially tenderness as assessed by sensory evaluations.

2. Material and methods

2.1. Part one

2.1.1. Development of a “grain of meat” assessment scale

According to the ethnological study (Delavigne, 2008a,b), the “grain of meat” could be evaluated both on the entire carcass and after the separation of fore and hindquarters. To this end, the experts combine an association of senses such as touch or sight and pay attention to the “texture” (Fig. 1).

A detailed analysis of the ethnological study identified a significant number of criteria that were recorded in a preliminary assessment scale.

Two experts, regular users of the “grain of meat” concept, were called upon. The first expert was a butcher used to choosing carcasses in the slaughterhouse according to these criteria. The second expert was a wholesale butcher using the “grain of meat” concept to direct carcasses according to customer expectations. They were asked to select and prioritise the identified criteria. Only criteria which made consensus were kept.

For every relevant criterion, the observation method was described as precisely as possible. The extreme modalities and the modality considered most favourable to the “grain of meat” were determined. The explanations given by each expert were summarised in a temporary scale in which all the modalities for every criterion were transcribed in checkboxes according to the experts' indications. Each criterion was illustrated in a picture board and specified in a definition list proposed alongside the assessment scale.

2.1.1.1. Testing the scale. Forty representative carcasses covering the whole “grain of meat” range were sampled in 8 different sessions at the commercial slaughterhouse ‘Charollais Viande’ located in Paray-Le-Monial (France).

In order to obtain a representative population of the whole “grain of meat” range, carcasses were sampled on various types of animals (heifers, steers, and cows) and various ranges of EUROP carcass grading.

For this step, a jury of 4 members, regular users of the “grain of meat” concept, was set up.

The “grain of meat” criteria were scored 48 h post mortem. During 8 successive sessions, 5 Charolais carcasses were scored independently by each of the experts, the 4 members of the jury were separated

from one another so as to ensure they were not influenced during the scoring process.

2.1.1.2. Statistical analysis. The statistical test “Kendall's coefficient of concordance” was used to estimate the reproducibility of the grid and the relative advantages of each criterion in estimating the “grain of meat”.

This test recognised how often carcasses were scored in the same order either fully or partially between jury members (taken two-by-two or all together) and between each criterion and the “grain of meat”. This test gives a coefficient of between 0 and 1.

A coefficient equal to 1 is representative of total concordance [a coefficient of 0 is representative of total discordance] 1) in the first case between the different members of the jury or, 2) in the second case between the score of a criterion and the “grain of meat” (Statistica Kernel, 2000).

2.2. Part two

2.2.1. Relationships between “grain of meat” and meat tenderness

2.2.1.1. Animals. A total of 31 Charolais cattle with a carcass weight of between 350 and 450 kg and a medium EUROP grading (R= to U=) were selected according to their “grain of meat” score. The population was constituted by 31 young females (9 young cows and 22 heifers) from 30 to 72 months of age, with a carcass weight located between 350 and 450 kg. The young cows were older (54 vs. 35 months; $P < 0.001$) but not significantly heavier (391 vs. 380 kg; $P = 0.1329$) than heifers.

All slaughters were performed in the same industrial slaughterhouse in order to standardise slaughtering, chilling and storing procedures. After slaughter, carcasses were weighed and carcass conformation was scored according to the EUROP classification with three levels per class (+, =, and –). The fattening carcass score was scored between 1 and 5 according to the European classification (EU no. 1234/2007; FranceAgriMer, 2010).

Carcasses were graded at the slaughterhouse, 24 h post mortem, by experts familiar with the meat grain concept. Assessments were made at the first cutting up of carcass according to the scale established in the first part of the study. Each scale item was scored between 1 and 5 depending on whether the modality was favourable or unfavourable to the “grain of meat”. At this stage, animals with an extreme “grain of meat” score (coarse with a score of 2 or less, called “large”; fine with a score of 4 or more, called “fine”) were isolated. The objective was to obtain an average of 15 carcasses in each of the two groups.

The 5th, 6th and 7th ribs of each right half-carcass were removed 24 h post mortem. The *longissimus thoracis* muscle was removed from the ribs, and then vacuum-packed for ageing for 10 days at 4 °C. The 10 day length of ageing was chosen, as it is currently done in French beef ‘Label Rouge’ specifications (see the French Institut National de l'Origine et de la Qualité – INAO).

After ageing, the *longissimus thoracis* muscles were cut into uniform steaks (thickness of 1.5 cm). The one cut at the 5th rib level was kept for muscular analysis and the other for meat quality evaluations. Then, all the steaks were frozen at –20 °C until the measurements.

2.2.1.2. Sample collection and analysis

2.2.1.2.1. Total and soluble collagen content. The collagen content was determined by measuring hydroxyproline content (Collagen = $7.5 \times$ hydroxyproline) using the Bergman and Loxley (1963). The collagen in the insoluble part was established according to a procedure given by Bonnet and Kopp (1992).

2.2.1.2.2. Dry matter and intramuscular fat content. The dry matter content was measured on 10 g of ground meat, by oven drying at 103 °C for 48 h. The intramuscular fat content was determined after

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