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Relationships between sensory evaluations of beef tenderness, shear force measurements and consumer characteristics

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ABSTRACT

The supply of tender beef is an important challenge for the beef industry. Knowledge about the profile of consumers who are more optimistic or more accurate in their tenderness evaluations is important for product development and beef marketing purposes. Central location tests of beef steaks were performed in Norway and Belgium ($n = 218$). Instrumental and sensorial tenderness of three muscles from Belgian Blue and Norwegian Red cattle was reported. Consumers who are optimistically evaluating tenderness were found to be more often male, less food neophobic, more positive towards beef healthiness, and showed fewer concerns about beef safety. No clear profile emerged for consumers who assessed tenderness similar to shear force measurements, which suggests that tenderness is mainly evaluated subjectively. The results imply a window of opportunities in tenderness improvements, and allow targeting a market segment which is less critical towards beef tenderness.

1. Introduction

Tenderness is one of the most important factors in consumers' perception of meat quality, taste and satisfaction (Verbeke et al., 2010), together with flavour, juiciness, freshness, leanness, healthiness and nutritional value as intrinsic quality cues, and brands or labels referring to process characteristics or quality control as extrinsic quality cues (e.g. Banovic et al., 2009; Brunsø, Bredahl, Grunert, & Scholderer, 2005; Krystallis, Chryssochoidis, & Scholderer, 2007). Whereas before purchase, process-related characteristics, healthiness, appearance and eating quality have similar weights in the formation of quality expectations, eating quality stands out as the most decisive criterion shaping quality experience, satisfaction or dissatisfaction and future purchase (Banovic et al., 2009; Grunert, Bredahl, & Brunsø, 2004).

In order to provide consumers with a wider range of beef product choice, beef producers have diversified their market offerings from the traditional beef steak and roast to an increasing number of processed products, including marinated and tenderised beef products. Successful introduction of such new beef products in the market is, however, dependent on consumers' favourable perception and acceptance (Grunert, Verbeke, Kugler, Saeed, & Scholderer, 2011).

Given the high variability of tenderness, the supply of tender beef is an important challenge for the beef industry (Eggen & Hocquette, 2004; Hocquette et al., 2014–in this issue). The high variability in instrumentally measured tenderness of beef muscles has mainly been linked to differences between breeds and differences in the presence of tenderness-related traits among beef muscles (Hildrum et al., 2009; Rhee, Wheeler, Shackelford, & Koohmaraie, 2004), i.e. the amount and degree of cross-linking of connective tissue, the contractile state of the muscle, and the intramuscular fat content (Voges et al., 2007). Variability in sensory evaluations of beef tenderness has been linked to person- and environment-related factors such as the dining situation. Huffman et al. (1996) showed that tenderness explained most of the variation in overall palatability for consumers sampling loin steaks at a white table cloth restaurant, while flavour was more important for consumers sampling steaks at home. The results of this study also implied that consumers with higher income levels were more critical when evaluating beef tenderness (Huffman et al., 1996).

Tenderness can be assessed by sensory methods, using untrained consumers or trained expert panels, or by instrumental methods (Destefanis, Brugiapaglia, Barge, & Dal Molin, 2008; Hildrum et al., 2009). The most widely used laboratory method to measure meat tenderness instrumentally is the Warner–Bratzler (WB) shear force determination. Although several studies have illustrated consumers ability to differentiate between beef cuts with different levels of tenderness (e.g. Boleman et al., 1997), correlations between shear force measurements and sensory evaluations of beef tenderness are highly variable (Destefanis et al., 2008). As a result, shear force values have been flagged as not providing reliable information concerning product acceptability or preferences among consumers (Destefanis et al., 2008).

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The objective of this paper is twofold. Firstly, this study aims to profile untrained consumers who are relatively positive (or optimistic) in their sensory evaluations of beef tenderness. These consumers, who might thus be less critical towards beef tenderness, constitute a market segment that might be more open for new beef cuts and products with varying degrees of tenderness. Knowledge about their profile is valuable for product development and beef marketing purposes, since they can be expected to be more easily satisfied with current or new beef products because of their less-critical attitude. Alternatively, basing general product launch strategies on their evaluations entails the risk of overestimating the product's market potential.

Secondly, this study aims to profile untrained consumers whose assessment of tenderness matches best with shear force measurements. Given the often weak link between instrumental measurements and sensory evaluations of tenderness (Powell, Nicholson, Huerta-Montauti, Miller, & Savell, 2011) it is relevant to investigate whether particular untrained consumers are better at detecting tender beef than others. Consumers with a flair for beef tenderness might be a promising market segment for specific tender beef products, and knowledge about their profile would allow targeting these consumers in beef marketing campaigns or involving them in the product development process. Furthermore, consumers who are better in detecting tenderness can be expected to be less easily satisfied with the high variability of tenderness in currently available beef products, with negative consequences with respect to repeat purchasing behaviour. A tenderness guarantee system (such as Meat Standards Australia Tenderness Guarantee Scheme (Watson, Gee, Polkinghorne, & Porter, 2008)) might therefore be higher valued by this group compared to consumers who are not equally good in evaluating tenderness in line with instrumental measurements.

2. Materials and methods

2.1. Meat samples

Beef muscles were obtained from Norwegian Red (NR) and double-muscled Belgian Blue (BB) young bulls (18–24 months old) for preparation and presentations in Norway and Belgium, respectively. Muscles were selected from ten animals in Norway, and from four animals in Belgium. Three beef cuts were selected for this study: *M. Psoas major*, *M. Infraspinatus*, and marinated *M. Semitendinosus*. Muscles were cut from the carcasses two days post mortem and vacuum aged at 4 °C until cooking 14 days after slaughter. Preparation methods for the different beef muscles including content and application method of the marinade have been described in Van Wezemael et al. (2012). Briefly, samples were cooked in a dry oven set at 175 °C. The samples were taken out when the core temperature reached 70 °C for *M. Psoas Major, M. Infraspinatus* and 72 °C for *M. Semitendinosus*, corresponding to medium (71 °C) to well done (77 °C) steaks (National Cattlemen's Beef Association, 1998).

2.2. Sensory evaluation of beef tenderness

Central location tests of beef steaks were organised with adult beef consumers in Ås, Norway ($n = 110$) and Deinze, Belgium ($n = 108$) during selected weekdays of January and February 2011. All participants consumed fresh beef at least once a month, and were recruited from untrained panels in the two countries. The samples were stratified on gender (50% females and 50% males) and age (50% aged 18–35 years and 50% aged 36–55 years) to account for possible differences in attitudes and experience between these groups. Before tasting, participants completed a questionnaire regarding their socio-demographic characteristics (gender, age, household composition, education, and occupation) and expectations regarding the three presented beef steaks. Detailed sample characteristics are reported in Van Wezemael et al. (2012). Furthermore, participants completed a number of questions related to: attitudes towards beef (Olsen, Scholderen, Brunsø, & Verbeke, 2007), involvement with beef (Zaichkowsky, 1985), attitudes towards beef safety and beef healthiness (Almli, Van Wezemael, Verbeke, & Ueland, 2013), interest in the healthiness of food (Roininen, Lähteenmäki, & Tuorila, 1999), food neophobia (Pliner & Hobden, 1992), and food technology neophobia (Cox & Evans, 2008). These attitudes to food and beef were selected because they might associate with consumers' ability to assess beef quality and their evaluation of beef tenderness. Also consumption frequency of different beef products (beef steak, roast beef, beef burger, minced beef, and ready-meal with beef) during the 14 days preceding the survey was recorded. After completing the questionnaires on computers at the central testing location, three beef steak samples were served in balanced order. After tasting each sample, participants reported their sensory evaluation of the tenderness of the three beef steaks on a 9-point rating scale ranging from 1 (not at all tender) to 9 (very tender).

2.3. Warner–Bratzler shear force analysis

WB shear force has been assessed using samples taken after preparation from the same muscles as tasted during the sensory evaluation. After preparation, the BB samples were vacuum packed and frozen until analysis. The NR samples were stored for 1–2 days at 2 °C. The samples were allowed to reach room temperature before WB measurements. From all samples, cores were removed parallel to the muscle fibre orientation. The maximum force (N) needed to shear each core was recorded, and was averaged to yield the WB shear force value per sample. In Belgium, 4 WB shear force values for each of the three types of muscles were obtained (equal to the number of animals in the sample), while in Norway 8 measures were recorded for *M. Psoas major*, 17 for *M. Infraspinatus*, and 6 for *M. Semitendinosus*.

2.4. Data processing

In order to profile consumers who are evaluating samples as more tender than the average value given by the total sample of consumers, a separate measure was developed. This measure compares individual sensory evaluations with the mean sensory evaluation value for each beef sample. Therefore, for each of the three muscles the mean sensory tenderness for each tasted sample was calculated, which was subtracted from each individual sensory evaluation value. Sensory evaluations deviating more than one unit from the zero mean (negatively or positively) were labelled as pessimistic or optimistic tenderness evaluations, respectively. Participants who evaluated at least two of the three tasted samples positively were defined as optimistic tenderness evaluators, while participants evaluating at least two samples negatively were labelled as pessimistic tenderness evaluators. Average evaluators evaluated two or three samples similar to the average tenderness evaluations, and participants evaluating the three samples all in a different way (pessimistically, average, and optimistically) were labelled as capricious evaluators.

To profile consumers with a flair for assessing tenderness in line with WB shear force values, it was necessary to first define 'correct tenderness assessments', and to identify participants who made such correct assessments. Therefore, WB shear force values were categorised into five WB shear force categories (WB5) covering the complete range of WB shear force values of the Norwegian beef samples. Since the range of WB shear force values among the BB samples was too limited to discriminate between very tender and very tough samples, only data from the Norwegian participants was used as input for the profiling part of this paper. As research has shown that consumers can discriminate tenderness levels with a difference of at least 1 kg (9.81 N) (Miller et al., 1995), all WB5 categories had a range of 11 N (cut-off points 19-30-41-52-63-74 N). These cut-off points corresponded with threshold values reported in previous studies, where 31.38 and 38.25 N were used as cut-off values for very tender and tender beef respectively (Belew, Brooks, McKenna, & Savell, 2003; Sullivan & Calkins, 2011).