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One technology does not fit all: Profiling consumers of tender and tenderised beef steaks

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ABSTRACT

New production technologies can help the beef sector to improve eating quality, in particular the tenderness, of low-value meat cuts. This paper aims at profiling potential consumers for unprocessed tenderloin *M. Psoas major*, muscle profiled *M. Infraspinatus* and marinated by injection *M. Semitendinosus* in Belgium ($n = 108$) and Norway ($n = 110$). Consumers' hedonic expectations for the three beef cuts, along with their general attitudes towards beef and food technology, were collected in central location tests. Results show that tenderloin triggers the highest hedonic expectations and best appeals to consumers profiled with high beef involvement in both countries. Consumers' expectations for steaks from novel technologies vary with consumers' attitudes towards beef, food technology and food risks and their country of residence, resulting in three additional consumer profiles. Furthermore, general attitudinal profiles of beef consumers also differ between the two countries. The results are useful for the positioning of novel beef products within the two national markets.

1. Introduction

Beef is one of the most consumed meats in Europe, with consumers in the European Union (EU-27) eating 17.2 kg per head per year on average (FAOSTAT, 2011). The European beef sector produces up to 8.2 million tonnes of beef per year, accounting for about 13.2% of the world production. Over the last decades, beef producers have diversified their market offerings from the traditional beef steak and roast to an increasing number of processed products, including ready-meals.

Beef consumers value beef mainly on its eating quality. Several studies have found that the most important intrinsic quality attributes for beef are taste (flavour), tenderness, juiciness, freshness, leanness, healthiness and nutritional value, together with brands or labels as extrinsic quality cues (Banovic, Grunert, Barriera, & Fontes, 2009; Brunsø, Bredahl, Grunert, & Scholderer, 2005; Krystallis, Chryssochoidis, & Scholderer, 2007; Verbeke, Ward, & Avermaete, 2002). Given the high variability of tenderness and tenderness-related traits among beef muscles (Rhee, Wheeler, Shackelford, & Koohmaraie, 2004) and the importance of tenderness in shaping consumer satisfaction (Huffman et al., 1996; Verbeke et al., 2010), the supply of tender beef is an important challenge for the beef industry (Eggen & Hocquette, 2004). Today a large amount of beef cuts stem from tough muscles, being sold as low-value products and used for stewing, braising or mincing. In order to achieve further market growth, opportunities for the beef industry lie, therefore, in the development of new technologies to increase the sensory quality of tough meat cuts, particularly their tenderness. In addition to directly adding value to low-quality cuts, this would also allow the industry to further develop their range of products, thus better satisfying current consumer demand and possibly reaching new consumer groups. Moreover, improving the eating quality of low-value cuts may contribute to an improved sustainability of the beef sector.

Several tenderisation treatments (such as moisture enhancement, blade tenderisation, or enzymatic tenderisation) have potentially positive impacts on beef muscle tenderness (Mueller et al., 2006; Pietrasik & Shand, 2011). Despite a clear preference for tender beef (Lusk, Fox, Schroeder, Mintert, & Koohmaraie, 2001; Shackelford et al., 2001), consumers might not always like the procedures for tenderising beef (de Barcellos et al., 2010). However, only a limited number of studies have investigated personal characteristics of consumers in relation to beef tenderness preferences. Lusk et al. (2001) studied the influence of socio-demographic variables on the probability that a consumer prefers tender steak, showing that age and education had a positive influence, while gender and income were not significantly related to tenderness preferences. Reicks et al. (2011) found that women considered tenderness more important than men in their purchasing decision of beef steaks. Furthermore, consumers over the age of 40 indicated tenderness as a more important purchasing motive than younger consumers. Other demographic variables (region, occupation, income, education, number of children in the household) did not have significant effects. Also, the behavioural (beef consumption frequency) and attitudinal variables (liking of red meat and importance in the diet) did not affect the

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importance of tenderness as a motive for purchasing beef steaks (Reicks et al., 2011).

In a recent paper, Van Wezemael et al. (2012) investigated the effect of technology information on consumer expectations and liking of beef. Based on complementary data from the same consumer experiment, the current paper investigates consumers' attitudes towards beef and food technology and profiles consumers for three tender beef cuts: unprocessed tenderloin (*M. Psoas major*), *M. Semitendinosus* tenderised by marinating by injection, and muscle profiled *M. Infraspinatus*. The objective is twofold. Firstly, this study aims at profiling beef consumers differing in their hedonic expectations for the three beef cuts. An important innovative element is the assessment of consumer expectations with respect to tender(ised) beef muscles treated with different technologies. As these beef cuts originate from a variety of muscles (high- versus low-value cuts) on which very different treatments are applied (no tenderisation, marinating by injection, or muscle profiling), differences in the cultural, attitudinal and socio-demographic profile of consumers expecting to like the different beef cuts are likely (de Barcellos et al., 2010). Knowledge about the socio-demographic and attitudinal profile of consumers in relation to beef tenderness expectations may allow the beef industry to better target tender beef products to specific consumer segments. Besides, as price is an important factor in most food choice decisions, consumers' stated price level acceptance for the three beef cuts was also investigated. A second objective of this study was to detect cross-country differences, as these may reveal the importance of the cultural context on consumer attitudes and hedonic expectations. Unlike the previously mentioned consumer studies which have been performed among American consumers, this paper will focus on two European countries: Belgium and Norway. The dissimilarity in beef consumption and production practices in the two countries (Van Wezemael et al., 2012) might be reflected in consumer attitudes and expectations for the three beef cuts. The results of the study may be useful for the positioning of novel beef products within the two national markets.

2. Materials and methods

2.1. Participants and procedure

Cross-sectional data were collected among adult beef consumers in Norway ($n=110$) and Belgium ($n=108$) as described by Van Wezemael et al. (2012). All participants were regular fresh beef consumers, with a consumption frequency of at least once a month. Participants were recruited from untrained panels who had given their consent to participate in consumer studies. The panels were sourced from the institutes responsible for the data collection: a subcontracted market research agency in Belgium, and the Norwegian Institute for Food, Fisheries and Aquaculture Research (Nofima) in Norway. The sample was stratified on gender (males/females: 50/50) and age 18–35 and 36–55 years, to account for possible differences in attitudes and experience between these groups. Sample characteristics from the two countries are presented in Table 1. The distributions of gender, age, household composition and occupation covered a wide range of socio-demographic profiles, though without claiming to be statistically representative for the national populations. In particular, the Norwegian sample was biased towards higher education, possibly due to the test location in a university town.

2.2. Measures

Participants were first asked to answer a few questions to establish their eligibility to participate in the study regarding their demographic profile and to what extent they consumed fresh beef. Consumers allergic to citrus, kiwi or pineapple and individuals consuming beef less than once a month were excluded. Eligible consumers were then invited to participate in a central location test (located in Ås in Norway and Deinze in Belgium). The questionnaire consisted of four parts: in the first part, participants completed a number of questions measuring attitudes to beef (Olson, Scholderer, Brunsø, & Verbeke, 2007) and involvement with beef (Zaichkowsky, 1985), perceptions of beef safety (own source) and risk issues (Hohl & Gaskell, 2008) associated with beef, issues related to food technology (Cox & Evans, 2008), general health interest (Roininen, Lähteenmäki, & Tuorila, 1999) and food neophobia (Pliner & Hobden, 1992). The questionnaire items that were used for these measures are presented in Table 2. In the second part, participants indicated their expected liking for three meat cuts: unprocessed tenderloin *M. Psoas major*, muscle profiled *M. Infraspinatus* and marinated (by injection) *M. Semitendinosus* (see Van Wezemael et al., 2012). In addition, for each beef treatment participants were asked at what price the steak would be "too cheap to expect a good quality", "cheap", "expensive" and "too expensive to be willing to buy". The price evaluations were performed on categorical scales expressed in local currencies and adjusted for local market prices. Thus, the price evaluation scales ranged from 'less than 5 EUR/kg' to 'more than 45 EUR/kg' in Belgium, and 'less than 25 NOK/kg' to 'more than 400 NOK/kg' in Norway. Eight intermediate categories were created, each with increments of 5 EUR/kg and 50 NOK/kg, respectively. The third part measured socio-demographic characteristics. In the fourth part, participants received samples of meat representing each production technology for tasting. Details and results from this sensory experiment were reported in Van Wezemael et al. (2012). Data collection was performed using EyeQuestion® software (Logic8, Netherlands) in Norway and FIZZ software (Biosystèmes, France) in Belgium.

Table 1
Sample characteristics in Norway and Belgium (in % of the national samples). Reproduced from Van Wezemael et al. (2012).

	Norway ($n=110$)	Belgium ($n=108$)
Male	46.4	46.3
Female	53.6	53.7
18–35 years old	45.5	46.3
36–55 years old	54.5	53.7
Cohabiting	91.8	91.7
Presence of children in the household (0–14 y)	50.9	31.5
Post-secondary education	69.1	44.3
Working full-time	60.9	49.1
Students	30.0	25.0

2.3. Statistical analyses

With the aim of profiling consumers with high hedonic expectations for the three beef cuts in terms of socio-demographics and attitudes, six Partial Least Squares Regression (PLSR) models (Næs, Brockhoff, & Tomic, 2010), i.e. one per country and per beef cut, were conducted. These PLSR models use the full set of questionnaire items (questionnaire parts one and three described above) as the independent variable set, and expected liking as the dependent variable. By comparing these models, differences in consumer profiles between unprocessed, muscle profiled and marinated by injection beef steaks will be highlighted, both within and across countries.

In order to study similarities and differences between the Belgian and Norwegian consumer samples in attitudes towards beef and food technology, two Partial Least Squares Discriminant Analysis (PLS-DA) models were built. These models use the questionnaire items as the independent variable set and country (1 = Norway, 2 = Belgium) as the dependent variable. One model focuses on the parts of the questionnaire specifically related to beef and detailed in Table 2, covering five themes as follows: beef consumption, attitudes to the healthiness of beef, attitudes towards eating beef as a main course, involvement with beef and attitudes towards beef safety. The other model includes

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Table 2
Consumer questionnaire items.

Variable/construct	Items	Response scale
Beef consumption frequency	Frequencies of consumption in the last 14 days: beef steak, roast beef, beef burger, minced beef, ready meal with beef	Numerical
Attitudes towards the healthiness of beef	Eating beef is healthy Eating beef is necessary for obtaining beneficial nutrients Beef contains important nutrients Beef is good for general health Beef is an important part of a healthy diet	1 (completely disagree) to 7 (completely agree)
Feelings when eating beef	Positive–negative Delightful–terrible Exciting–dull Pleasant–unpleasant Satisfied–unsatisfied Good–bad	1 (positive feeling) to 7 (negative feeling)
Involvement with beef	Beef means a lot to me in my daily diet Beef is very important for my well-being Beef means a lot to me for my nutrition I like the taste of beef very much	1 (completely disagree) to 7 (completely agree)
Feelings when thinking about beef safety	Optimistic–pessimistic Confident–unconfident Satisfied–unsatisfied Comfortable–uncomfortable Trustful–suspicious At ease–worrying	1 (positive feeling) to 7 (negative feeling)
Food risk perception	Residues of medicines in meat Genetic modification of food Pesticides in fruit or vegetables Pollutants in foods, e.g. mercury Additives New viruses such as avian flu BSE (the mad cow disease) Bacteria, e.g. salmonella Chemicals formed during food preparation, e.g. frying Welfare of farmed animals Lack of hygiene outside home Develop an allergy Lack of hygiene in the home Put on weight	1 (not at all worried) to 4 (very worried)
Attitudes to new food technologies	The benefits of new food technologies are often grossly overstated There are plenty of tasty foods around so we do not need to use new food technologies to produce more New food technologies decrease the natural quality of food New food technologies may have long term negative environmental effects It can be risky to switch to new food technologies too quickly Society should not depend heavily on new food technologies to solve its food problems There is no sense trying out high-tech food products because the ones I eat are already good enough	1 (completely disagree) to 7 (completely agree)
General interest in the healthiness of foods	The healthiness of food has little impact on my food choices. I am very particular about the healthiness of the food I eat. I eat what I like and I do not worry much about the healthiness of food. It is important to me that my diet is low in fat. I always follow a healthy and balanced diet. The healthiness of snacks has little impact on my food choices. I do not avoid foods, even if they may raise my blood cholesterol levels. It is important to me that my daily diet contains a lot of vitamins and minerals.	1 (completely disagree) to 7 (completely agree)
Food neophobia	I am constantly sampling new and different foods. I do not trust new foods. If I do not know what is in food, I won't try it. I like foods from different countries. Ethnic food looks too weird to eat. At dinner parties, I will try a new food. I am afraid to eat things I have never had before. I am very particular about the foods I will eat. I will eat almost anything. I like to try new ethnic restaurants.	1 (completely disagree) to 7 (completely agree)
Heard/talked about food safety	In the last two weeks, have you – read or heard anything around food safety incidents in the media? – talked about or discussed food safety issues?	Yes/no

the parts of the questionnaire related to food in general, covering five themes as follows: concerns about food risks, attitudes to new food production technologies, interest in the healthiness of foods, food neophobia and awareness of food safety incidents (Table 2). In addition to single question items, aggregated scores corresponding to each construct in the questionnaire were included in the models.

All PLSR and PLS-DA models were run on standardised variables, using cross-validation on 10 random segments and performing a Jack-knife uncertainty test with 95% confidence interval for the detection of significant variables (Martens & Martens, 2001). Calculations were performed in The Unscrambler X 10.1 (Camo Software AS, Oslo).

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3. Results and discussion

3.1. Hedonic expectations

In the Norwegian sample, tenderloin obtained a very high and stable mean with a liking score of 8.4 (standard deviation (S.D.) = 0.9) on a scale from 1 to 9 (Table 3). This is 41% higher than the mean expected liking for muscle profiled (6.0) and marinated (6.1) beef steaks and reflects a high positive image of this meat cut, which is reputed to be particularly tender. Also, perceived healthiness (nutritional value and safety) might have played a role in shaping these differences in expectations, as processed beef products are generally perceived as less healthy and less safe than unprocessed beef (Van Wezemael, Verbeke, de Barcellos, Scholderer, & Perez-Cueto, 2010; Van Wezemael, Verbeke, Kügler, de Barcellos, & Grunert, 2010). The fact that non-invasive muscle profiling and highly-invasive marinating by injection received equivalent mean hedonic expectations can be related to the low level of concern for food risks in Norway. Furthermore, Norwegian consumers express a high level of trust and confidence in food authorities (Berg, 2005) and show a high open-mindedness for new food technology (see Section 3.4.). Table 3 also reports consumers' expected preferences between the three beef cuts based on a comparison of expected liking scores. This table provides insight on potential segment sizes for the three beef cuts. About 84% of participants expect to like tenderloin more than muscle profiled or marinated steaks, while about 16% expect to like these novel steaks at least as much as tenderloin. Each of the novel technologies (muscle profiling and marinating by injection) is preferred to the other one by roughly the same number of consumers, corresponding to 38.2% of the sample for muscle profiled beef and 34.5% for marinated beef (Table 3).

In the Belgian sample, tenderloin obtained a mean expected liking score of 7.4 (S.D. = 1.7) on a scale from 1 to 9. This is 25% higher than the mean expected liking for muscle profiled beef (5.9) and 37% higher than the mean expected liking for marinated beef (5.4). In terms of consumer preferences, about 73.1% of the Belgian participants expect to like tenderloin more than muscle profiled or marinated steaks, while 26.9% expect to like these novel steaks at least as much as tenderloin (Table 3). Further, 45.4% of the Belgian participants show an expected preference for marinated steak compared to muscle profiled steak, against 34.3% with opposite expected preferences.

Consumers in the Belgian sample had significantly higher liking expectations towards both muscle profiled and marinated by injection beef in relation to tenderloin, as compared to consumers in the Norwegian sample. This is related to the smaller differences in expected mean liking between products in the Belgian sample.

3.2. Profiles of consumers with high expectations for the three beef cuts

The profiles of consumers who have the highest expectations for tenderloin, muscle profiled and marinated beef were obtained by PLSR modelling as described in Section 2.3. The results are presented for both Norwegian and Belgian consumer samples in Table 4. Note that only statistically significant items are displayed in the table. For instance, demographics are not reported in the table because they did not differ across consumer profiles corresponding to the different meat cuts.

The PLSR models carry limited to moderate amounts of explained variance for expected liking (from 10.6% to 33.7% explained variance), indicating that other parameters than just the set of questions included in the present study influence consumers' expectations. In particular, previous beef consumption experiences (all recruited consumers were regular fresh beef eaters) may have a greater impact on expected liking than the consumers' attitudinal and socio-demographic data. Several questionnaire items were nonetheless statistically significant in the models (Table 4).

3.2.1. Consumer profiles in Norway

The consumer profiles corresponding to the three beef treatments show similarities and differences (Table 4). Common to all three categories of beef, Norwegian consumers with high hedonic expectations like the taste of beef, feel good and satisfied when consuming beef, consider that beef is healthy/good for health, and feel comfortable and trustful about beef safety. Furthermore, Norwegian consumers who typically show the highest expectations towards tenderloin are also characterised by a relatively high consumption of beef burgers, a positive attitude to beef and healthiness of beef, positive feelings when eating beef, a high level of involvement with beef, positive feelings about beef safety, and very little worries about additives in food and lack of hygiene at home. Interestingly, almost the same profile of consumers shows high expectations for muscle profiled beef, despite a lower average expected liking score for this beef type (Table 3). This may indicate that muscle profiling is rightfully perceived as a natural technology to these consumers, somewhat comparable to unprocessed tenderloin cuts.

Finally, marinated beef generates the same mean hedonic expectations as muscle profiled beef, a slightly higher actual liking and attracts a different profile of consumers as compared to tenderloin: consumers with lower involvement with beef, more neutral attitudes and feelings towards beef and a tendency to lower food neophobia. Marinated beef may therefore best appeal to consumers who are not primarily fond of unprocessed beef and who expect to value the changes in texture and taste resulting from marinating by injection, without objecting to a certain decrease in naturalness. In other words, although this marinating technology may not satisfy the most enthusiastic and involved beef eaters, it may attract a different consumer segment. This may be worth investigating among non-regular beef consumers (i.e. people consuming beef less than monthly).

3.2.2. Consumer profiles in Belgium

The consumer profiles corresponding to the three beef treatments in Belgium show clearer differences than in Norway (Table 4). Firstly, the consumers with the highest expectations for tenderloin are characterised by a positive attitude to the healthiness of beef, a high involvement with beef and positive feelings towards beef and beef safety. Secondly, the consumers with the highest expectations for muscle profiled beef share this involvement and these positive feelings, however the healthiness of beef does not have a significant influence on their hedonic expectations for this treatment. In addition, these consumers show low worries regarding chemicals formed

Table 3
Average expected liking results and consumers' expected preferences among the three beef cuts (in % of the national samples) based on a comparison of expected liking scores.

	Norway (n = 110)			Belgium (n = 108)		
	Tenderloin	Muscle profiled	Marinated by injection	Tenderloin	Muscle profiled	Marinated by injection
Expected liking (S.D.)	8.4 (0.9)	6.0 (2.1)	6.1 (1.7)	7.4 (1.7)	5.9 (2.0)	5.4 (2.3)
Tenderloin is at least as good as (*better than*)…	100 (*0*)	97.3 (*84.5*)	99.1 (*83.6*)	100 (*0*)	87 (*73.1*)	87 (*73.1*)
Muscle profiled beef is at least as good as (*better than*)…	15.5 (*2.7*)	100 (*0*)	65.5 (*38.2*)	26.9 (*13.0*)	100 (*0*)	65.7 (*45.4*)
Beef marinated by injection is at least as good as (*better than*)…	16.4 (*1.8*)	61.8 (*34.5*)	100 (*0*)	26.9 (*13.0*)	54.6 (*34.3*)	100 (*0*)

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Table 4
Consumer attitudes related to expected liking for the three beef cuts in the Norwegian and Belgian (significant items only) consumer samples. + indicates a positive effect of the attitudinal item on hedonic expectations, − indicates a negative effect, the absence of a symbol indicates non-significance.

	Norway[a] ($n=110$)			Belgium[b] ($n=108$)		
	Tenderloin	Muscle profiling	Marinating by injection	Tenderloin	Muscle profiling	Marinating by injection
Beef consumption						
Beef burger	+					
Healthiness of beef						
Healthy	+	+	+	+		+
Necessary for nutrients	+					
Contains important nutrients		+		+		+
Good for health	+	+	+			+
Important in a healthy diet	+	+		+		
Aggregated	+	+		+		
Feelings when eating beef						
Bad–good	+	+	+	+	+	
Unsatisfied–satisfied	+	+	+	+	+	
Unpleasant–pleasant	+			+	+	
Dull–exciting		+				
Terrible–delightful	+					
Negative–positive	+	+		+	+	
Aggregated	+	+	+	+	+	
Involvement						
Means a lot in my daily diet	+	+				
Important for my well-being	+	+		+	+	
Means a lot for my nutrition	+			+	+	
Like the taste of beef	+	+	+		+	+
Aggregated	+	+		+	+	
Positive feelings about beef safety						
Optimistic (pessimistic)	+	+		+	+	
Confident (unconfident)	+	+		+		+
Satisfied (unsatisfied)	+	+			+	
Comfortable (uncomfortable)	+	+	+	+		
Trustful (suspicious)	+	+	+		+	+
At ease (worrying)		+			+	
Aggregated	+	+		+	+	
Worry about food risks						
Residues of medicines in meat						−
Genetic modification						−
Pollutants						−
Additives	−					−
Chemicals					−	−
Lack of hygiene in home	−					
New food technology						
NFT decrease the natural quality					−	
NFT have negative environmental effects					−	
Healthiness of foods (HoF)						
Very careful about the HoF I eat					−	
I do not worry about the HoF					+	
Low in fat diet important					−	
Follow a healthy diet					−	−
Aggregated					−	−
Food neophobia						
If I do not know what is in food, I won't try it					−	−
I am afraid to eat things I have never had before					−	
I am very particular about the foods I will eat					−	
I will eat almost anything		+	+			

[a] PLSR explained Y-variances (%calibration; %validation) in Norway: tenderloin (33.7; 21.8), muscle profiled (16.9; 6.0), marinated (17.1;1.6).
[b] PLSR explained Y-variances (%calibration; %validation) in Belgium: tenderloin (17.3; 0), muscle profiled (22.3; 12), marinated (10.6; 3.1).

during food preparation, have a higher acceptance for new food technologies, are less interested in the healthiness of the food they eat and show signs of low food neophobia. Thirdly, consumers with the highest expectations for marinated beef have a positive attitude to the healthiness of beef, like the taste of beef, neither show particularly high positive feelings when eating beef nor a high level of involvement, do not have strong positive feelings about beef safety other than confidence and trust, are very little concerned about food risks and are less interested in the healthiness of food.

Based on these results, it appears that tenderloin consumers in the Norwegian and Belgian samples share the same attitudinal profiles. The main differences between the two countries lie in the profile of consumers with high expectations towards the lower-value beef cuts. For instance, in the Norwegian sample consumers with a highly

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positive image of the healthiness of beef have high expectations for both tenderloin and muscle profiled beef, while in the Belgian sample similar consumers have high expectations for tenderloin especially, and marinated beef to some extent (Table 4). It seems that muscle profiling in the Norwegian consumer sample is perceived as a natural process which appeals to the same consumers as tenderloin steak, while in the Belgian consumer sample it is perceived as a technological process which appeals to consumers with high openness to food technology and low food neophobia. Finally, no significant demographic effects were detected in either country.

3.3. Price acceptance for the different beef cuts

In order to investigate acceptable price levels for the three beef cuts, consumers were asked to indicate their personal thresholds for too cheap, cheap, expensive and too expensive prices for the three beef cuts. Average retailer prices for each beef cut were provided as a reference point, and category scales were utilised for the measure. Fig. 1 reports frequency distributions of consumers for the two countries. For the Norwegian sample, the reference retailer price for tenderloin (NOK 399≈€50 per kg) is predominantly considered as "so expensive that [I am] not willing to buy". Thus, current prices in Norway are positioned too high for the consumers in the sample to be willing to purchase beef tenderloin, despite high hedonic expectations for this meat cut. According to Fig. 1, a price reduction by about 40% would be necessary to reverse this trend towards a perception of "cheap" prices, i.e. at a level under 250 NOK per kg (≈ €30 per kg). The too high perceived prices for tenderloin may explain the higher consumption of minced beef compared to beef steaks in this country. Moreover, the price barrier may explain why the Norwegian consumer profile for tenderloin is linked to a high consumption of beef burgers (Table 4) and not beef steaks as would be expected. This finding confirms a real market demand for cheaper alternatives for beef steaks with good eating quality in Norway. As described above, the profile of consumers showing the highest expectations for muscle profiled beef follows that of tenderloin, indicating that this beef cut may be a valid alternative for consumers interested in tenderloin. However, based on data from the same study, Van Wezemael et al. (2012) reported that actual liking for muscle profiled beef is still lower than for tenderloin. It seems therefore important for the potential success of muscle profiled beef that the price should compensate for the lower sensory quality: offering a significantly lower price for muscle profiled beef steaks may help consumers adjust sensory expectations to a lower level and avoid a negative disconfirmation of expectations (Deliza & MacFie, 1996).

In the Belgian sample, the reference retailer price for tenderloin (€30 per kg) balances between "expensive" and "too expensive" perceptions. A price reduction of about 15% would reverse this trend towards a perception of "cheap" or "too cheap" prices. Based on the respective consumer samples, it seems therefore that the current price of tenderloin in Belgium is better adapted to the market demand than in Norway.

In the cases of muscle profiled and marinated beef cuts, retailer reference prices are positioned at the border of "cheap" and "expensive" prices, in both countries. Thus, Belgian consumers attach the same value to the two tenderised beef cuts even though their expected liking for marinated beef is on average lower than for muscle profiled beef (Table 3). It is possible that consumers relied to some extent on the given reference prices when answering these questions. The results for tenderloin in the Norwegian sample testify however that this was not the case when the given reference price was deemed unacceptable.

3.4. Norwegian and Belgian attitudes to beef and food technology

Figs. 2 and 3 present the key differences between Norwegian and Belgian consumers' attitudes to beef and food technology in the form of weighted regression coefficients plots from PLS-DA models (Section 2.3 Statistical Analyses). Fig. 2 focuses on beef-related attitudes while Fig. 3 covers attitudes to general food issues. In these models, variables showing positive regression coefficients are more typical of Belgian consumers than Norwegian consumers, while variables showing negative regression coefficients are more typical of Norwegian consumers than Belgian consumers. On the figures, only questionnaire items with statistically significant differences between the two countries are shown (Jack-knife uncertainty test with 95% confidence interval). Both models showed a high explained Y-variance (68.0% and 69.6%, respectively) and a model validation at nearly 64% with three factors. This indicates that there are clear national differences between the Belgian and the Norwegian samples.

3.4.1. Attitudes to beef

In terms of beef consumption, Belgian consumers more typically report a high recent consumption of beef steaks and beef burgers compared to Norwegian consumers, who more typically report a high consumption of minced beef and ready-meals with beef compared to Belgian consumers (Fig. 2). It is to be noted that translations of beef burger ("hamburger van rundvlees" in Dutch and "hamburger av storfekjøtt" in Norwegian) refer exclusively to hamburgers from beef. Translations of minced beef ("gehakt van rundvlees" in Dutch and "kjøttdeigprodukter" in Norwegian) refer to beef that has been minced, including beef products that can be prepared from it. It is possible that consumers transform minced beef into beef burgers or patties while preparing meals at home. However, since beef burger was included as a specific category in the questionnaire, differences in reported beef burger and minced beef consumption patterns between the two countries are assumed to reflect real product consumption differences. Furthermore, no significant difference was found in the total frequency of beef consumption between the two countries, in accordance with the similarity in reported beef consumption volumes (19.4 and 20.5 kg per capita yearly in Belgium and Norway, respectively) (FAOSTAT, 2011).

Belgian consumers seem to eat beef more out of a nutritional motive ("Eating beef is necessary for obtaining beneficial nutrients", "Beef means a lot to me for my nutrition") and report that consuming beef as a main course is dull (as opposed to exciting). Norwegian consumers show less involvement with the nutritional benefits of beef than Belgian consumers, possibly due to their lower consumption of whole beef meat. Moreover, they show a positive attitude to the healthiness of beef ("Eating beef is healthy", "Beef is good for general health"), yet more typically report, in comparison to Belgian consumers, that consuming beef as a main course yields negative feelings.

Belgian consumers have previously been reported to have a strong involvement with fresh meat (Verbeke & Vackier, 2004). This is confirmed in the present study as they show a higher involvement with beef than Norwegian consumers, which is signalled by a significant aggregated variable for involvement and significant effects for two specific involvement items ("Beef is very important for my well-being", "Beef means a lot to me for my nutrition"). As mentioned above, Norwegian consumers show less nutritive involvement but possibly more hedonic involvement than Belgian consumers ("Beef means a lot to me in my daily diet").

Furthermore, Belgian consumers showed more negative feelings about beef safety compared to Norwegian consumers, as they more typically indicated feeling "unconfident", "uncomfortable" and "suspicious" about beef safety. On the contrary, Norwegian consumers more typically scored high for feeling "satisfied" and "at-ease" about beef safety. This finding is in line with previous studies indicating that Belgian consumers remain vigilant towards beef safety after consecutive meat safety incidents (Verbeke, 2005), and illustrates at the same time the particularly high confidence in beef safety in Norway. This is in accordance with the Norwegians' high trust in governmental food controls and food safety in this country (Almli, Verbeke, Vanhonacker, Næs, & Hersleth, 2011; Berg, 2005).

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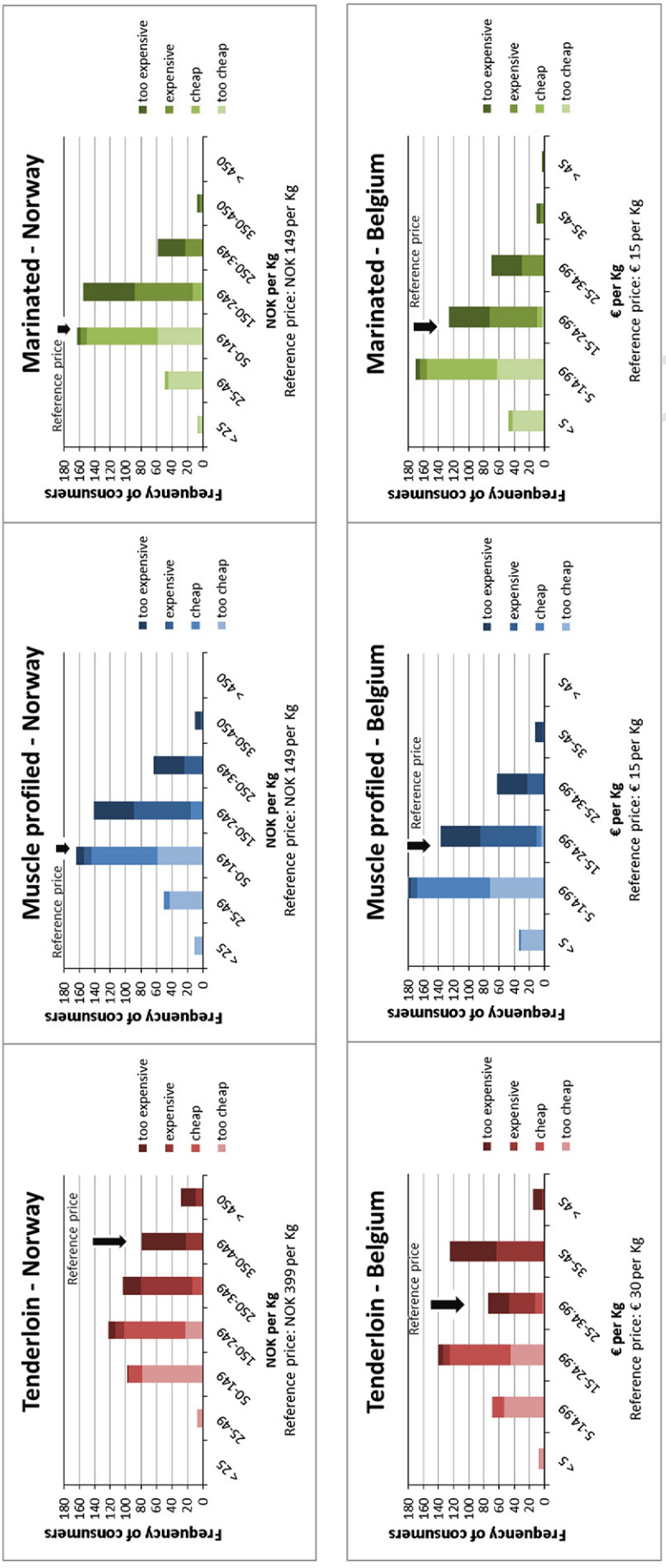

Fig. 1. Price level acceptance for the three beef cuts in the Norwegian sample ($n = 110$; prices in NOK per kg) and in the Belgian sample ($n = 108$; prices in EUR per kg).

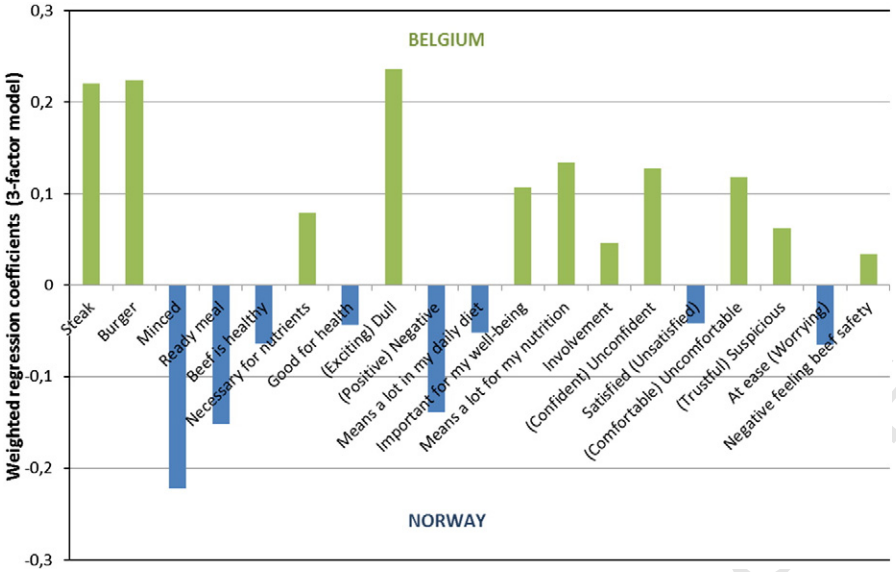

Fig. 2. Comparison of consumption habits and attitudes towards beef in Belgium and Norway, by PLS-DA. Attitudes significantly more typical of Belgian consumers are represented by positive coefficients and attitudes significantly more typical of Norwegian consumers are represented by negative coefficients. Non-significantly different attitudes between the two countries are not shown.

3.4.2. Attitudes to food technology

Corroborating negative feelings towards beef safety, Belgian consumers generally show more concern about food risks than Norwegian consumers. Consumers in the Belgian sample are more strongly concerned about residues of medicines in meat, new viruses such as the avian flu, BSE (Bovine Spongiform Encephalopathy, or "mad-cow" disease), lack of hygiene outside and inside of home, risk of developing an allergy and possibility of putting on weight (Fig. 3). On the other hand, consumers in the Norwegian sample are significantly more concerned than consumers in the Belgian sample about risks related to pesticide residues in fruit or vegetables and additives in food. Such concerns may reflect past experiences with food safety issues in the two countries. Belgium was affected by the BSE scandal, a national dioxin scandal on poultry and pork at the end of the 1990s, and a swine fever outbreak at the end of the 1990s (Berg, 2004; Verbeke, 2001). However, the international nature of these incidents and the related media attention could possibly also have an impact in Norway, that was not spared from food safety incidents itself (e.g. E. coli O103 incident in 2006) (van Kleef et al., 2009). Furthermore, these differences in food risk perceptions might reflect different areas of focus for food risks in the respective national media. Norwegian consumers did not indicate having heard or read about food safety issues in the media more than Belgian consumers. However, Norwegian consumers (32%) more often indicated having recently talked about food safety issues than Belgian consumers (21%).

When it comes to new food production technologies, Belgian consumers are found to be more conservative and traditional than Norwegian consumers, adhering more strongly to statements "the benefits of new food technologies are often grossly overstated" and "there is no sense in trying out high-tech food products because the ones I eat are already good enough". This corroborates earlier findings regarding scepticism towards agro-food processing technologies in Belgium (Verbeke, 2011).

It is interesting to note that consumers of beef show contradictory attitudes regarding dietary choices both in Norwegian and Belgian samples. Consumers in the Belgian sample scored high on "the healthiness

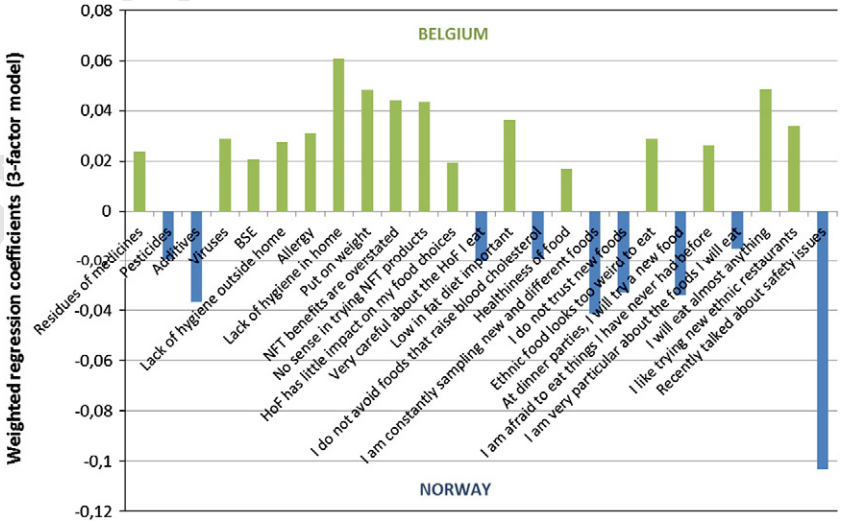

Fig. 3. Comparison of attitudes towards food risks, new food technology and healthiness of food in Belgium and Norway, by PLS-DA. Attitudes significantly more typical of Belgian consumers are represented by positive coefficients and attitudes significantly more typical of Norwegian consumers are represented by negative coefficients. Non-significantly different attitudes between the two countries are not shown. NFT: new food technologies. HoF: healthiness of food.

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of food has little impact on my food choices", but also on "it is important to me that my diet is low in fat". Consumers in the Norwegian sample scored high on "I am very particular about the healthiness of the food I eat", but also on "I do not avoid foods that raise blood cholesterol". Furthermore, note that the aggregated variable for healthiness of foods is significantly more associated to Belgian than Norwegian consumers, indicating a relatively stronger involvement with healthy food in the Belgian sample.

Finally, no clear pattern emerges in terms of food neophobia between the two countries, as both countries are characterised significantly by some items typical for a higher food neophobia (in Belgium: "Ethnic food looks too weird to eat" and "I am afraid to eat things I have never had before"; in Norway: "I do not trust new foods" and "I am very particular about the foods I will eat") and some items typical for a lower food neophobia (in Belgium: "I will eat almost anything", "I like trying new ethnic restaurants"; in Norway: "I am constantly sampling new and different foods", "At dinner parties I will try a new food"). Moreover, the aggregated variable shows no significant difference between the two countries, indicating comparable national samples in terms of food neophobia.

4. Summary and conclusions

This paper investigated beef consumers' attitudes to beef and food technology, as well as their hedonic expectations for three beef cuts subjected to different levels of processing: unprocessed tenderloin *M. Psoas major*, muscle profiled *M. Infraspinatus* and marinated by injection *M. Semitendinosus*. The present study has a number of limitations that should be taken into account when interpreting the findings and the contributions of this study. The use of consumer samples that are not fully representative for the Belgian and Norwegian populations imposes constraints on possible generalisation of the results. Furthermore, the limited sample size limits the possibilities for segmentation and attitude-based modelling. Further research with larger and more representative samples is needed to verify whether the consumer profiles that were identified may correspond to actual consumer segments in the national beef markets.

Results indicate that Norwegian consumers show lower involvement with nutritional value and higher hedonic involvement with beef than Belgian consumers, while Belgian consumers show higher involvement in the healthiness of food and more concern about beef safety, food risks and new food technologies than Norwegian consumers. Regarding hedonic expectations, it was revealed that tenderloin is preferred to the novel beef cuts by the majority of consumers in both samples. However, 16% of the Norwegian and 27% of the Belgian consumer samples expect to like novel beef cuts at least as much as tenderloin. Among the regular beef consumers in this project, four attitudinal profiles could be identified. A summary of these profiles is presented in Table 5. Consumers with high expectations for tenderloin may be qualified as "Enthusiastic beef eaters" as they show a high beef involvement, positive attitudes to the healthiness of beef, and positive feelings when eating beef and about beef safety (Table 5). This profile is found in both countries. Analysis of consumers' price acceptance indicated that current prices in Norway are too high for consumers in the sample to be willing to purchase beef tenderloin despite high hedonic expectations. This finding confirms a market demand for cheaper alternatives for beef of good eating quality in Norway. Consumers with high expectations for muscle profiled beef in Norway also match the "Enthusiastic beef eaters" profile (although attenuated, Table 4). This beef cut is perceived to be priced at an acceptable level; it may therefore represent a valid alternative to tenderloin in the market. Belgian consumers with high expectations for muscle profiled beef share a similar profile as in the Norwegian sample, but are less interested in the healthiness of foods (including beef), are very open to new food technologies and report a low food neophobia. They may therefore be qualified as "Open-minded beef eaters". Finally, consumers with high expectations for beef marinated by injection in the Norwegian sample are qualified as "Indifferent beef eaters" as they are quite indifferent to the healthiness of beef or beef safety, despite expressing positive feelings when eating beef. Belgian consumers with high expectations for marinating beef are qualified as "Carefree beef eaters", being characterised by a low concern for food risks and healthiness of foods.

Table 5
Summary of the four consumer profiles for tender and tenderised beef cuts. The number of consumers who scored higher than average for the consumer sample per product and per country is indicated in brackets.

	Norway (total sample $n=110$)	Belgium (total sample $n=108$)
Tenderloin	*Enthusiastic beef eaters* ($n=69$) High involvement with beef Positive feelings when eating beef Positive feelings about beef safety Beef is healthy.	*Enthusiastic beef eaters* ($n=89$) High involvement with beef Positive feelings when eating beef Positive feelings about beef safety Beef is healthy.
Muscle profiled	*Enthusiastic beef eaters* ($n=57$) High involvement with beef Positive feelings when eating beef Positive feelings about beef safety Beef is healthy.	*Open-minded beef eaters* ($n=71$) High involvement with beef Positive feelings when eating beef Positive feelings about beef safety Healthiness of food is not important. High acceptance for new food technologies Low food neophobia
Marinated by injection	*Indifferent beef eaters* ($n=46$) Positive feelings when eating beef	*Carefree beef eaters* ($n=60$) Do not worry about food risks. Healthiness of food is not important.

In conclusion, the four profiles of beef consumers that were identified indicate that tenderloin and tender(ised) low-value beef cuts may be complementary and satisfy a broader market demand. Muscle profiled beef in particular has market potential as it generates good hedonic expectations, is perceived to have an acceptable price and is expected to be preferred to marinated steak by 38.2 and 45.4% of the Norwegian and Belgian samples, respectively. New production technologies improving the tenderness of low-value meat cuts, such as the ones investigated in this study, may therefore be key to new market opportunities for the beef sector.

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