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## **European Consumers' Acceptance of Beef Safety-Improving Interventions at Different Stages of the Beef Chain: Primary Production, Slaughtering, Processing and Packaging**

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### **1 Introduction**

Following the occurrence of meat safety incidents during the nineties (Verbeke et al., 1999), considerable effort has been done to improve safety in the beef chain, both by policy and beef chain actors. Nowadays, a wide array of interventions to improve beef safety is applied at different stages through the beef chain. As a result the microbiological safety risk has been significantly reduced (Koohmaraie et al., 2005). Although the benefits for the sector and the end users seem to be rather obvious, the application of interventions and technologies that are used to enhance beef safety is not always communicated to consumers. Currently, communication related to technologies and processes used in beef production and processing from the sector to consumers is often driven by legal obligations (for instance traceability) or profit seeking (for instance organic labelling). Consequently, information asymmetry between producers and consumers is the rule rather than the exception.

On the one hand, this asymmetry is maintained by the actors in the beef chain who prefer not to communicate about technical procedures that could possibly scare off consumers. Industry often fears that consumers might not fully understand all technical details about production and processing techniques. The caused confusion and uncertainty among consumers might decrease their profits. On the other hand, information asymmetry between producers and consumers is also maintained by consumers themselves. Consumers often show a considerable degree of suspicion regarding food technologies. As a result, consumer might prefer to remain ignorant about the details of food production and processing systems (de Barcellos et al., 2010). This rational ignorance has been explained by the high costs of information, and especially the high opportunity cost of processing information, in comparison with the marginal benefit from the processed information (McCluskey and Swinnen, 2004).

Although some food technologies, such as food irradiation and genetic modification, have been or are still part of an extensive public debate (Teisl et al., 2009), consumer acceptance of a large number of safety interventions remains undiscussed. Nevertheless, insight into consumer acceptance is crucial for the food industry since process characteristics are often

determining consumer preferences (Krystallis et al., 2009; Søndergaard et al., 2005). For instance, European consumers have developed a preference for 'natural' practices and organic production methods, while disliking genetic modification and excessive processing of food (de Barcellos et al., 2010).

This paper describes a study investigating consumer acceptance of a number of safety interventions that are applied at different stages of the beef supply chain to enhance the safety of beef and beef products. This study is part of the European research project ProSafeBeef, which aims at advancing beef safety and quality across Europe, and thus contribute to the beef chain in Europe to thrive and diversify (Miles and Caswell, 2008). In the framework of this research project, qualitative focus group research was conducted in 2008 to explore consumer perceptions of beef safety (Van Wezemael et al., 2010a), healthiness (Van Wezemael et al., 2010b), quality (Verbeke et al., 2010) and technologies (de Barcellos et al., 2010). The results of this exploratory research suggested that European consumers have only limited knowledge about food technologies applied in the beef chain, and limited acceptance of safety interventions at the processing stage. This paper describes the results of a European consumer survey that was conducted in 2010 and which aimed to quantify consumer acceptance of safety interventions at four key stages of the beef supply chain: 1) primary production; 2) slaughtering; 3) processing; and 4) packaging. The selection of these four stages was based on the research activities of ProSafeBeef partners. At primary production level, the modification of cattle feed was investigated. Feed adjustments might lower the number of pathogens in beef (Adam and Brülisauer, 2010). When cattle is slaughtered, harmful microorganisms that are present on cattle hide (often originating from faecal material) can contaminate beef carcasses. Washing and decontaminating cattle hide prior to slaughter can lower the amount of pathogens on the hide and thus decrease the risk of contamination of beef meat (Small et al., 2005). During processing, several techniques are used to ensure beef safety, among others high pressure and the use of preservatives. Furthermore, to prevent post-processing contamination, beef can be packaged, for instance in a vacuum packaging, or active packaging. These interventions can prolong the shelf life of foods and decrease the risk of foodborn illness (Quintavalla and Vicini, 2002).

## **2 Material and methods**

During February and March 2010, a consumer survey was conducted among 2520 beef consumers in five European countries: France, Germany, Spain, Poland and the United Kingdom. In each country, 504 beef consumers completed the online questionnaire. Participant recruitment was performed by a professional market agency. Consumers were selected for participation if they consumed beef steak or beef burger at least several times per year. Consumers were asked to rate their level of acceptance of safety interventions at the four above-mentioned stages in the beef chain. Furthermore, consumers' acceptance of the specific processes used for these interventions were included in the questionnaire: one particular process for adjusting the cattle feed (adding protective bacteria to the feed); three hide decontamination processes (washing with a kind of soap, fixating harmful organisms on the hide using a fixating fluid, and removing the hair); four processing technologies (high pressure treatment, high temperature treatment, the addition of natural ingredients, and the addition of protective bacteria during processing); and five packaging technologies (modified atmosphere packaging, vacuum packaging, the addition of natural agents to the packaging, the addition of protective bacteria to the packaging, and the use of packaging

releasing preservative additives). Consumers' acceptance levels were measured using a five-point scale from 1 ("completely unacceptable") to 5 ("completely acceptable").

In addition, consumers were asked about their consumption behaviour, background attitudes and socio-demographic characteristics. Consumers were asked how many times they had consumed beef steak and beef burger during the previous two weeks. Consumers' confidence in beef was measured on a five-point scale ranging from 1 ("very confident") to 5 ("not at all confident"). Food safety concern was measured with a scale used by McCarthy et al. (2003), for which Cronbach's Alpha obtained a value of 0.8 for the three items. General health interest was measured with a scale developed by Roininen et al. (1999), as well obtaining a Cronbach's Alpha value of 0.8. Registered socio-demographic characteristics related to gender, age, household composition, socio-economic status, and place of residence.

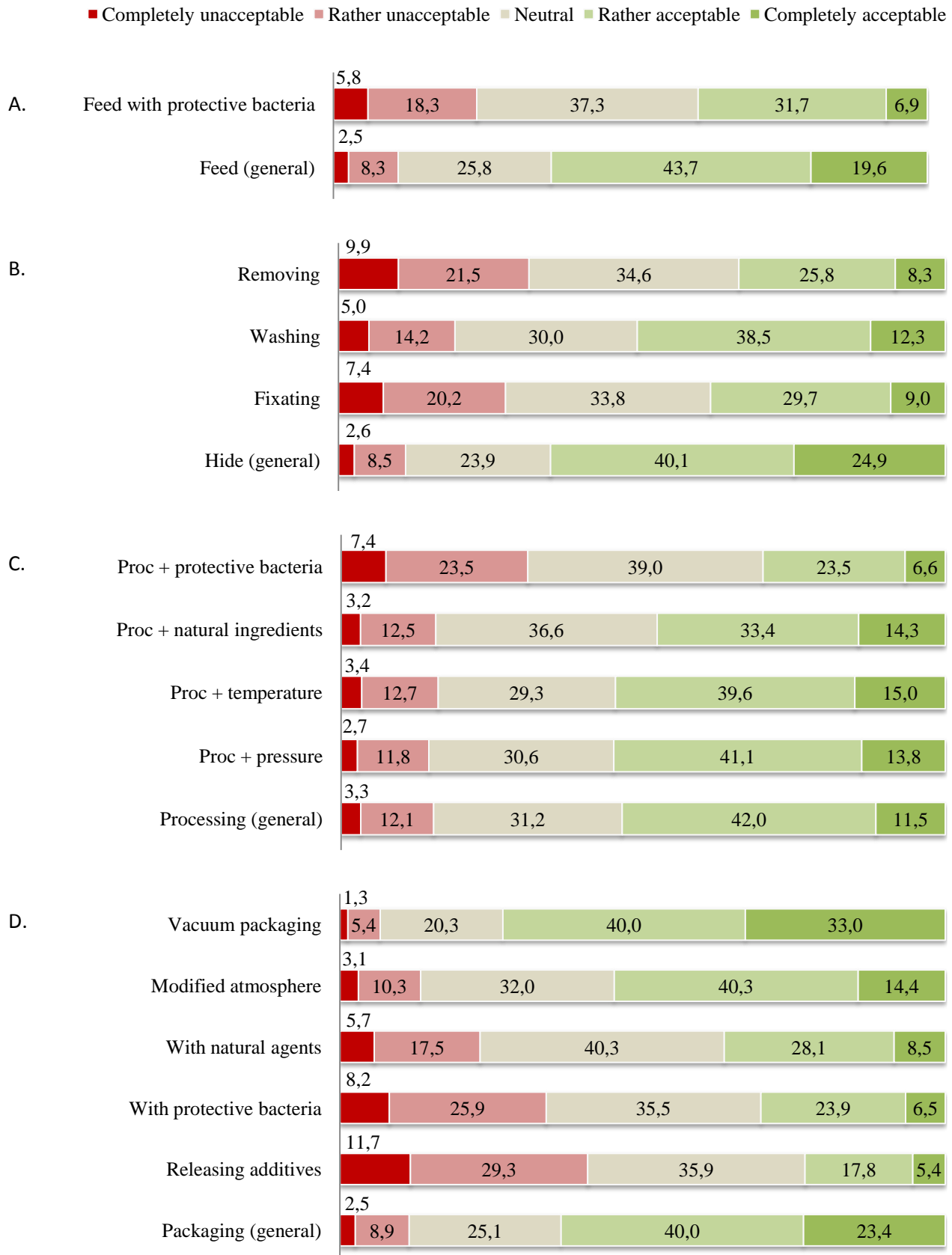
Principal-component factor analysis was performed in SPSS 15 on all safety interventions, using varimax rotation and Kaiser normalization. The resulting factors were used as input for a consumer segmentation analysis, in which a hierarchical clustering method was followed by a K-means clustering. Ward's method was applied as cluster method. Consumer segments were characterized using one-way ANOVA F-tests and  $\chi^2$  tests.

### 3 Results

Comparing the application stages, interventions at processing level were the least accepted (Figure 1). Consumer acceptance of safety-improving interventions during processing (53% accepting this type of interventions) was lower than acceptance at the other application stages (cattle feed 63%; hide decontamination 65%; packaging 63%). Hide decontamination yielded the highest percentage of completely accepting consumers (25%). When more detailed information about the concrete processes was presented, consumers were generally less inclined to accept the intervention (Figure 1). However, acceptance was higher for the processes that consumers were most familiar with, especially related to the processing (high pressure and high temperature treatments) and packaging stage (vacuum packaging). The least accepted processes related to the addition of protective bacteria, especially during processing and packaging.

Factor analysis of the process statements yielded three types of safety interventions, namely additives, familiar treatments and hide decontamination processes (Table 1). Consumers' acceptance levels on these three distinct factors differed significantly between countries (Figure 2). Especially Poland was characterized by a low acceptance level of hide decontamination techniques compared to the other European countries in this study.

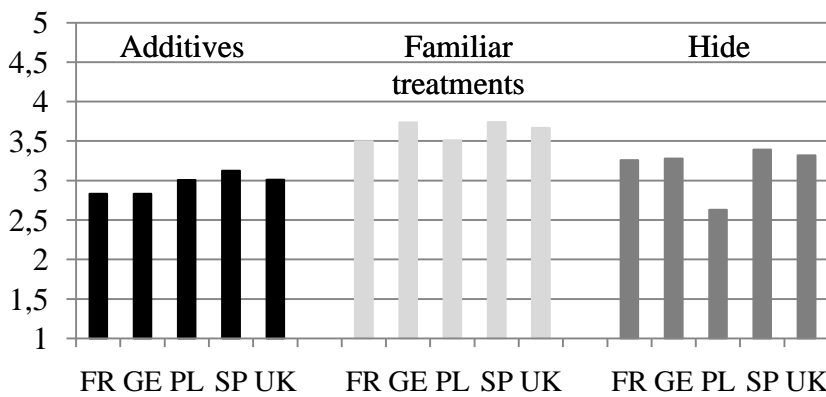
Cluster analysis based on consumer acceptance of the three factor analytically derived types of safety interventions revealed four consumer segments: the enthusiast, consumers feeling OK, sceptic consumers and rejecting consumers (Figure 3). These segments were profiled based on their consumption behaviour and background attitudes (Table 2), and socio-demographic characteristics.



**Figure 1.** Consumer acceptance levels of beef safety-improving interventions and processes

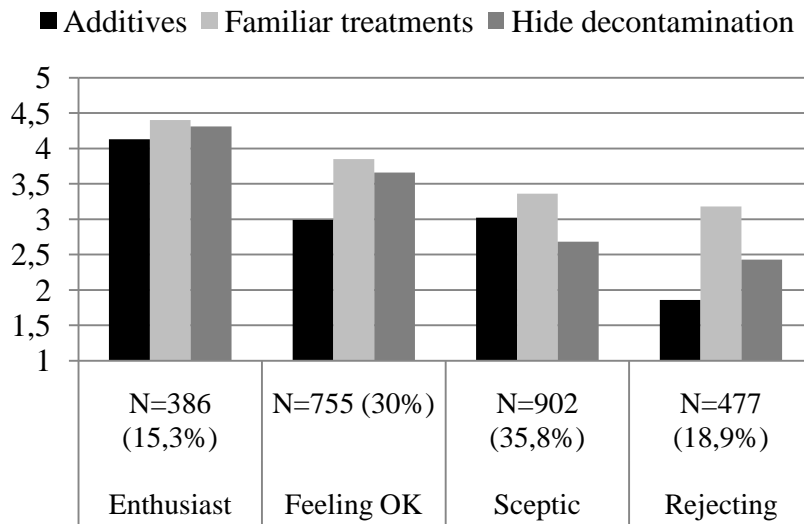
**Table 1.** Factor analytically derived types of interventions and their factor loadings

	Additives	Familiar treatments	Hide decontamination
Feed - protective bacteria	0,63	0,18	0,24
Proc - protective bacteria	0,83	0,15	0,13
Pack - protective bacteria	0,81	0,19	0,14
Pack - releasing additives	0,75	0,08	0,19
Proc - high pressure	0,20	0,67	0,28
Proc - high temperature	0,25	0,60	0,21
Pack - modified atmosphere	0,29	0,67	0,12
Pack - vacuum	-0,01	0,83	0,08
Hide - fixating	0,22	0,17	0,83
Hide - washing	0,07	0,30	0,81
Hide - removing hair	0,32	0,10	0,72
<i>Proc - natural ingredients</i>	<i>0,47</i>	<i>0,49</i>	<i>0,15</i>
<i>Pack - lactic acid</i>	<i>0,61</i>	<i>0,38</i>	<i>0,12</i>



FR = France; GE = Germany; PL = Poland; SP = Spain, UK = United Kingdom

**Figure 2.** National differences between consumer acceptance of the factor analytically derived types of safety interventions (Mean acceptance scores on the Y-axis)



**Figure 3.** Consumer segments based on consumer acceptance of the three intervention types (Mean acceptance scores on the Y-axis)

**Table 2.** Characterisation of the four consumer segments based on consumption behaviour and attitudes

	Enthusiast	Feeling OK	Sceptic	Rejecting
Beef steak consumption	2.34 <sup>a</sup>	1.92 <sup>b</sup>	1.77 <sup>b</sup>	1.66 <sup>b</sup>
Beef burger consumption	2.16 <sup>a</sup>	1.53 <sup>b</sup>	1.52 <sup>b</sup>	1.35 <sup>b</sup>
General health interest	4.72 <sup>a</sup>	4.87 <sup>a</sup>	4.55 <sup>b</sup>	4.74 <sup>a</sup>
Food safety concern	5.73 <sup>a</sup>	5.54 <sup>b</sup>	5.28 <sup>c</sup>	5.47 <sup>b</sup>
Confidence in beef	3.98 <sup>a</sup>	3.77 <sup>b</sup>	3.42 <sup>c</sup>	3.46 <sup>c</sup>

<sup>a,b,c,d</sup> Scores in a row with different superscripts are significantly different ( $p < 0.05$ ).

Significant differences using one-way ANOVA and Bonferroni and Hochberg GT2 multiple comparison tests

Enthusiast beef consumers had high acceptance levels on the three types of safety interventions. They reported significantly higher consumption of beef steaks and burgers, high food safety concern and high confidence in beef and beef products. The enthusiast consumers were often better-off consumers (with a netto monthly household income over €3000), employed in a managerial position, or without paid employment. They were often co-habiting, and living in Spain.

At the other side of the spectrum were beef consumers who rejected each of the three types of safety interventions. This consumer segments also reported significantly lower confidence in beef and beef products. Consumers rejecting the safety interventions were more often

self-employed, between 31 and 45 years old, and living alone. They were more likely to live in Germany, and in rural areas. They were more often in the age category 31-45.

Both sceptic consumers and consumers feeling OK reported mean acceptance levels around the neutral point of the scale. Sceptic consumers distinguished themselves by their lower acceptance of hide decontamination techniques and their lower general health interest, food safety concern and confidence in beef. The sceptic consumers were less well-off (netto monthly household income below €1000), living in Poland and were younger (18-30). Consumers feeling OK about the safety interventions were living in Spain and had an income in the middle categories (€1000-3000 netto monthly household income). They were often employed in a non-managerial position or retired, and somewhat older (age categories 46-64 and 65-85).

#### 4 Discussion

In general, intervention statements related to the application stages were accepted relatively well. For all four stages of the beef supply chain, 50 to 65% of the participants considered the safety interventions acceptable. The lowest acceptance level regarding the application stages of the interventions was found at the processing stage. This result confirms earlier qualitative research results suggesting that consumers express some reserve towards safety interventions during processing (de Barcellos et al., 2010; Van Wezemael et al., 2010a). Nevertheless, even during processing the majority of the participants considered this intervention acceptable, suggesting that public acceptance might be higher than expected based on exploratory studies.

The acceptance levels of the statements regarding the applied processes were generally lower than the acceptance levels of the statements regarding the application stages. Previous research has shown that more detailed information regarding processes and technologies can decline consumer liking (Cardello, 2003). Furthermore, as indicated in the introduction, consumers have indicated themselves not to be too keen to receive too much detailed information about food technologies (de Barcellos et al., 2004). This preference for incomplete information has been referred to as 'rational ignorance' by McCluskey and Swinnen (2004) and a 'conscious lack of knowledge' by de Barcellos et al. (2010). As consumers will not spend the time to become well informed about the advantages of food safety interventions, they will remain imperfectly informed.

A clear example of the lower acceptance of the applied processes compared to the application stage was found in the hide decontamination statements. While the decontamination of cattle hides seemed unacceptable for only 10% of the sample, 20 to 30% of the participants rejected the applied processes for hide decontamination. Consumers especially disliked chemical dehairing and microbial fixation, compared to washing the hide. This finding converges with the other research results that suggest that more familiar processes were accepted more easily. The highest acceptance levels were found for vacuum packaging; high pressure and high temperature treatments during beef processing; and washing cattle hides with a kind of soap, which might be the most straightforward way to clean cattle hides in the eyes of consumers. Familiarity has been shown to be an important determinant of consumer acceptance in previous research (de Barcellos et al., 2010; Søndergaard et al., 2005).



Our factor analysis yielded three distinct types of safety interventions. Two of these (additives and familiar treatments) combined processes from different application stages, indicating that the nature of the process might be more important than the stage of application. The consumer segmentation based on consumer acceptance of the three factor analytically derived types of safety interventions revealed four consumer segment with divergent profiles. The enthusiast consumers were regular to heavy beef consumers with a high confidence in beef. Their relatively high food safety concern can partly explain the high acceptance levels of interventions that specifically aim to enhance beef safety. Also higher a priori confidence in beef and beef products was associated with higher acceptance levels. Communication on safety interventions can be expected to be relatively well accepted by this segment of well-off consumers, as they will attach importance to issues related to their favourable beef and its food safety. The consumer segment with sceptic consumers appeared to be somewhat younger, and less well-off. This profile matches with the fact that hide decontamination processes were less easily accepted in Poland, where the sample comprised more younger people and where the average income was lower than in the other countries under study. The reason for the lower acceptance level of hide decontamination processes among Polish respondents remains unclear. Future research could investigate reasons for national differences in acceptance, and underlying arguments for accepting or rejecting specific safety intervention processes.

## 5 Conclusion

Although safety interventions are used at different stages of the beef chain, consumer research about much of the applied beef safety-enhancing interventions is scarce. However, information about consumer acceptance of diverging safety interventions is valuable for the industry as process characteristics are increasingly influencing product preferences. This paper has assessed consumer acceptance of processes that are applied along the beef supply chain and that aim to enhance beef safety. The results show that acceptance levels differ between countries, stages of application, type of processes, amount of information provided, and consumer groups. As a result, it is unlikely that one standard way of communicating about beef safety improvements will be most successful. Strategies in which consumers can access information they require, and can be reassured that safety is taken care of using the best possible technologies stand a higher likelihood of success.

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