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HAL Id: hal-02742422
https://hal.inrae.fr/hal-02742422

Submitted on 3 Jun 2020

DEMOGRAPHIC FACTORS HAVE ONLY MINOR EFFECTS ON A CONSUMER'S PERCEPTION OF THE EATING QUALITY OF BEEF

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Abstract – The beef industry must respond to the changing market place and consumer demands. An essential part of this is quantifying consumer perception of beef quality across a broad range of demographics. Over 19,000 consumers from four European countries tasted seven beef samples and scored them for tenderness, juiciness, flavour liking and overall liking. Consumers also answered a short demographic questionnaire. The four sensory scores were analysed as dependent variables in linear mixed effects models. A fifth model was also established using a weighted combination of the four sensory scores termed the MQ4 score (0.3*tenderness, 0.1*juiciness, 0.3*flavour liking and 0.3*overall liking). The answers to the demographic questionnaire were analysed as fixed effects in the models. Consumer, session, country, serve order and the quality of the previous sample were controlled for in the analysis. Overall, there were only small differences in a consumer's perception of beef eating quality between demographic groups. This indicates that a single quality descriptor could reliably predict eating quality for the entire market, providing a basis for a widespread, eating quality based, beef grading system in Europe.

Key Words – Consumer testing, Europe, Sensory testing.

I. INTRODUCTION

Quantifying consumer responses to beef across a broad range of demographics is essential for the beef industry to become more consumer focused. There is interest in using the principles of the Meat Standards Australia (MSA) model, which uses untrained consumers for the prediction of eating quality, to reduce the variability of European beef [1-4]. Consumer demographics are well established as factors that influence purchasing decisions [5]. Therefore, such an approach requires a sound understanding of the effect of demographics on consumer sensory scores in order to properly design the taste panel experiments [6] to ensure they aren't arbitrarily biased by the presence of large demographic effects. Furthermore, the use of a single quality descriptor for all consumers would be validated in the absence of large demographic effects.

Previous work on Australian and Korean consumers identified only very minor demographic effects on sensory scores of beef and lamb [6,7]. The main response was that consumers who considered beef to be a more important part of their diet scored lamb more favourably [6]. Using the same experimental protocols as this study, Thompson, *et al.* [6] found males scored beef 2 points out of 100 lower than females. In contrast, Kubberød, *et al.* [8] found that males scored beef more favourably than females and Huffman, *et al.* [9] found no differences between the sexes. A consumer's preferred level of cooking doneness

was also found to have a small effect on consumer scores [6], where consumers who preferred their beef medium-well to well-done scored beef 1-2 points higher out of 100 when testing beef cooked to a medium degree of doneness.

We hypothesise that there will be only small demographic effects, limited to a positive relationship with the importance of beef in a consumer's diet, and consumers who prefer beef cooked well-done will rate beef more favourably than consumers who prefer beef cooked rare. We also expect that males will score beef more favourably than females.

II.   MATERIALS AND METHODS

The meat used for this experiment was sourced from standard commercial carcasses from all participating countries. They are described in detail by Bonny, *et al.* [4] and Legrand, *et al.* [10]. Meat was cooked by one of four cooking methods: grill, roast, slow cook and Korean BBQ (barbeque), to a rare, medium or well-done cooking doneness according to the protocols for MSA testing by personnel trained in MSA testing procedures [11,12].

Table 1 Percentage of consumers in each category

	Doneness[1]	Importance[2]	Gender[3]	Country[4]
0[5]	0.68	1.33	0.71	0
1	6.51	29.33	44.88	7.70
2	34.84	36.09	54.41	8.93
3	31.59	22.56	-	46.1
4	26.37	10.69	-	37.3

[1]1=blue/rare. 2=medium. 3=medium-well. 4=well done; [2]1=Red meat is important in my diet. 2=Red meat is a regular part of my diet. 3=Red meat is part of my diet. 4=I rarely/never eat red meat; [3]1=Male, 2=Female; [4] 1=France, 2=Ireland, 3=Northern Ireland, 4=Poland; [5]0=unrecorded.

A total of 19 492 consumers were sourced through both commercial consumer testing organisations and local clubs and charities. Consumers scored meat from their country of origin and scored samples for tenderness (tn), juiciness (ju), flavour liking (fl) and overall liking (ov), by making a mark on a 100 mm line scale, with the low end of the scale representing a negative response and the high end of the scale representing a positive response. For a more detailed description of the testing procedures and the questionnaire, see [11]. In addition to scoring beef samples, consumers answered a short demographic questionnaire in their native language (Table 1). The English version of this questionnaire is detailed elsewhere [11].

The effect of demographic factors on the sensory scores (tn, ju, fl, ov) was investigated using linear mixed effects models with the HPMIXED procedure in SAS [13]. A model was established using a weighted combination of the four sensory scores termed the MQ4 score (0.3*tn, 0.1*ju, 0.3*fl and 0.3*ov) as calculated by [14]. Consumer, session, country, serve order and the quality of the previous sample were controlled for in the analysis. All factors in the model were interacted with country and the score of the previous sample was also interacted with sample serve order. Non-significant terms ($P>0.05$) were then removed in a step-wise fashion to arrive at the final model. The predicted means for demographic effects were compared using the least significant differences, generated using the PDIFF function in SAS [13].

III.   RESULTS AND DISCUSSION

The effect of a consumer's preferred cooking doneness varied by country (Table 2). Confirming our hypothesis, consumers from Northern Ireland, who preferred their beef cooked well-done or medium-well, scored beef samples approximately 4 points higher ($P<0.05$) than consumers who preferred their beef cooked blue/rare and slightly higher than those who preferred medium (Table 3). This result is similar for the Irish consumers and supported by Hwang et al. (2008) and Thompson et al. (2005) who found a similar trend in Australian consumers. In contrast, the Polish consumers exhibited the opposite relationship, with consumers who preferred beef cooked medium-well or well-done scoring samples less favourably. This may be explained by variations in the different degrees of cooking doneness used in this study, as consumers' rate beef cooked to their preferred cooking doneness higher (Cox et al., 1997). More Northern Irish and Polish consumers preferred beef cooked

medium-well to well-done than any other category. There was no effect of preferred cooking doneness for the French consumers.

Table 2 The F values for the linear mixed effects model, predicting MQ4[1] for beef samples

Variables	NDF[Λ]	MQ4[1]
Country	3	28.06***
Order[2]	5	163.04***
Gender	2	9.17***
Importance[3]	3	8.05***
Level[4]	3	2.16
Carry-over[5]	1	89***
Carry-over[5]*Carry-over[5]	1	103.66***
Order[2]*Country	15	4.34***
Carry-over[5]*Country	3	15.2***
Carry-over[5]*Order[2]	5	108.42***
Importance3[5]*Country	9	2.13*
Level[4]*Country	9	9.31***

[Λ]Numerator degrees of freedom; Denominator degrees of freedom is 111000; [1]MQ4= a weighted combination of consumer scores; [2]The order in which the product was served to the consumer; [3]The importance of beef in their diet; [4]The preferred degree of cooking doneness of the consumer; [5]The sensory score of the previously tasted sample

Aligning with our hypothesis, the more importance consumers placed red meat in their diet, the more favourably ($P<0.01$) they scored beef (Table 2) in Poland, France, and Northern Ireland, but not by those tested in Ireland. The magnitude of the effect in Poland and Northern Ireland is similar to the findings of Thompson, et al. [6] who used the same technique with Australian consumers tasting lamb. However, this effect was the most pronounced for the French consumers, with a change by over 17 points out of 100 ($P<0.05$) (Table 3). This result should be treated with caution due to the poor spread of French consumers over the four possible responses, with only 0.13 % in the least important category. In contrast, the Polish data had between 20 to 30 % of consumers in each category. Further investigation with a more balanced distribution of consumers is required to fully quantify the effect of the importance of meat in the diet for French consumers on their perception of the eating quality of beef.
Supporting our hypothesis, Males (53.1±0.60) scored beef samples higher than females (52.3±0.60) by about 1 point. This result is also

supported by Gregory [15] and Kubberød, et al. [8] who also found that males scored meat more favourably than females.

Table 3 Predicted means (± standard error) of beef samples

	Preferred cooking doneness			
	Rare	Medium	Med-well	Well-done
All	51.5±0.85[a]	52.6±0.73[ab]	53.0±0.79[ab]	53.1±0.91[ab]
Fr[1]	51.8±2.65	51.9±2.29	51.9±2.59	54.4±3.16
Ir[2]	52.4±1.27[a]	54.3±0.95[ab]	55.7±0.99[b]	55.0±0.94[b]
NI[3]	47.7±0.82[a]	50.6±0.54[b]	51.5±0.55[c]	51.9±0.52[c]
Pl[4]	54.0±0.75[ab]	53.8±0.53[a]	53.1±0.51[b]	51.1±0.61[c]
	Importance of beef in the diet			
	Important[5]	Regular[6]	Part[7]	Rarely[8]
All	54.7±0.53[a]	54.0±0.52[b]	52.8±0.61[c]	48.7±2.19[c]
Fr[1]	58.7±1.23[a]	57.2±1.13[ac]	54.7±1.60[bc]	39.4±8.33[b]
Ir[2]	54.4±0.80	53.7±0.81	54.1±0.98	55.1±2.10
NI[3]	51.9±0.52[a]	51.5±0.52[a]	49.8±0.56[b]	48.5±0.89[b]
Pl[4]	53.9±0.58[a]	53.5±0.57[a]	52.8±0.55[b]	51.9±0.57[c]

[1]France; [2]Ireland; [3]Northern Ireland; [4]Poland; [5]Red meat is important in my diet; [6] Red meat is a regular part of my diet; [7] Red meat is part of my diet; [8] I rarely/never eat red meat; [a,b] Values within a row with different superscripts differ significantly at $P<0.05$.

IV. CONCLUSION

The way consumers score beef eating quality is remarkably consistent between different demographic groups. Where demographic groups differed, these differences were small, less than 4%. As consumers from different demographic groups have a similar appreciation of beef, this indicates that a single descriptor of eating quality will likely be applicable to different European countries. Having a reliable definition of eating quality will enable the European beef industry to develop an eating quality based grading system for beef. This would enable consumers to select beef of a desired quality when purchasing, and provide a price signal in the market, encouraging the production of quality beef.

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