Consumer Preferences For Loin and Topside Steaks From Beef Carcasses of Different Classification Criteria

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Considerable resources in the beef industry have recently been devoted to the establishment of a system of product description. A prerequisite for the success of any such system is the objective determination of consumer preferences. The trial outlined in this paper was aimed at determining consumer preferences for beef loin and topside steaks, based on selected carcass classification criteria. It was found that consumers preferred lean steaks from young, electrically stimulated carcasses.

1. Introduction

Statistics produced by the Australian Meat and Live-stock Corporation indicate that between 1976 and 1986 red meats declined in importance as a protein source for Australian consumers. Beef and veal suffered the largest decline of some 29 kg per capita. Two theories have been put forward to explain this trend. Firstly, it has been argued that, apart from adverse changes in price, less red meat is now being used due to changes in consumer lifestyles, attitudes, and perceptions (McKinna 1984). This argument implies that there have been significant changes in the structure of demand relationships for meat. The alternative theory proposes that changes in demand characteristics have had relatively minor effects on the consumption of meats (except mutton), and that the main influences have been changes in relative prices and levels of consumer income (Martin and Porter 1985, Chalfant and Alston 1987).

Irrespective of the cause of the decline in red meat consumption, this fact has led the industry to recognize the importance of product merchandising and the need to identify consumer requirements and provide a product which meets those requirements.

The characteristics of beef of most importance to consumers are generally given as appearance and the palatability attributes of tenderness, juiciness and flavour (*e.g.* Naumann *et al.* 1966, Beilken and Shorthose 1982). Among consumers, however, there is considerable variability in likes and dislikes and this can make it difficult to relate consumer preferences to objective carcass characteristics. To date, the majority of investigations have utilised laboratory measurement or trained consumer taste panels, and some doubt exists whether the general public can detect the same palatability differences. Also, because muscles within the same carcass can differ in quality characteristics, the results from studies which have examined only one muscle should be interpreted selectively.

* This research was undertaken while the author was with the Livestock and Meat Authority of Queensland. I am indebted to Dr Tony Swain for his assistance in the statistical analysis and to the Editors of the *Review* for their helpful comments. All errors remain my own.

This study aimed to overcome some of the problems associated with previous investigations.[1] The objectives of the study were:

1. to identify consumer preferences for the physical qualities of beef loin and topside steaks; and

2. to determine if consumers can detect differences in the palatability qualities of loin and topside steaks from electrically stimulated and non-stimulated beef carcasses and from animals of different dentition group, fat class, sex and breed.

2. Research Method

The trial involved the delivery of beef steaks to a sample of 192 households in each of three cities, Brisbane, Sydney and Melbourne. The steaks were delivered at approximately weekly intervals for a total of six weeks, the final delivery being made during the first week of December 1985. Households were asked to cook the steaks and to record their assessment of the physical and palatability characteristics of the steaks. Separate assessments were obtained from cooks and tasters. The treatments used in the trial are detailed in Table 1.

Table 1 : Design Treatments

Treatment	Treatment Levels
Sex	Male, Female
Breed	British, Brahman
Electrical Stimulation	Stimulated, Non-Stimulated
Fatness (Rib)	0-2mm, 3-7mm, 8-12mm, 13-23mm
Age	0-2 tooth, 3-7 tooth, 8 tooth

The breed definitions were:

British - any Bos taurus beef breed or crossbreed showing no visible signs of Bos indicus or dairy breed content.

Brahman - any Bos indicus beef breed or crossbreed showing visible characteristics of a minimum of 50 per cent Bos indicus content.

The treatment levels detailed in Table 1 represent 96 possible combinations; however, not all of these combinations were included in the design due to the difficulty in obtaining certain types of carcasses. Combinations which were not included were those comprising carcasses of young animals with a thick subcutaneous fat cover and old animals with a thin subcutaneous fat cover. In total, there were 72 treatment cells. A complete tabulation of the number of carcasses obtained in each cell of the design is provided in Table 2.

[1] Kingston *et al.* (1987) provides a more comprehensive report on the study outlined in this paper.

Table 2: Number of Carcasses Required in each Treatment Combination*

BREED/ FATNESS	AGE/SEX 0 - 2 TOOTH Male	0 - 2 TOOTH Female	3 - 7 TOOTH Male	3 - 7 TOOTH Female	8 TOOTH Male	8 TOOTH Female	TOTAL
BRITISH							
0-2 mm	8	8	-	-	-	-	16
3-7 mm	8	8	8	8	8	8	48
8-12 mm	8	8	8	8	8	8	48
13-23 mm	-	-	8	8	8	8	32
BRAHMAN							
0-2 mm	8	8	-	-	-	-	16
3-7 mm	8	8	8	8	8	8	48
8-12 mm	8	8	8	8	8	8	48
13-23 mm	-	-	8	8	8	8	32
TOTAL	48	48	48	48	48	48	288

* Half of the carcasses in each cell were electrically stimulated, the other half non-stimulated.

The sample for each city comprised 16 groups of 12 households (192 households) with each group comprising four blocks of three households. Each household received six deliveries, being two each of three different dentition/fatness treatments.

The selection of households and delivery of steaks was contracted to a market research firm. Using cluster sampling, screening interviews were conducted with approximately 400 households in each city in order to obtain the required sample. Households were screened on the following basis:

* household members had to eat steak that had been grilled, fried or barbequed at least once per month;
* the household had to have a freezer which could be used for freezing meat;
* household members had to be available for the whole survey period; and
* participation was restricted to household members over 12 years of age.

Households were equally divided between two cuts (loins and topsides), two stimulation treatments, two breed types and two sexes. Half of the households received alternating stimulation treatments of the same breed type while the other half received alternating breed types of the same stimulation treatment.

Animals were selected from routine slaughter batches at three Queensland abattoirs: the Metropolitan Regional Abattoir, Ipswich Regional Abattoir and Australia Meat Holdings Pty Ltd., Beaudesert. Carcasses were not accepted where bruising was in evidence or where hide-puller damage could have resulted in uneven loin fat cover. Electrical stimulation was undertaken using an extra low voltage system (<45V) within ten minutes of slaughter.

Carcasses were boned 48 hours post-slaughter and the striploins and topsides transported to CSIRO Meat Research Laboratory (Cannon Hill, Brisbane) where they were cut into 2cm thick steaks. All subcutaneous fat was removed from the samples of topside.

Households received a tray of steaks at weekly intervals for six weeks. On the first week they were requested to select and record a cooking method to be used for the duration of the trial. They were requested not to casserole, stew or roast the steaks.

3. Results

3.1 Cooking Preparation and Cook's Perceptions

Households in Brisbane exhibited a much higher frequency of consumption with 80.8 per cent of households eating beef at least 2-3 times per week. This compares with 70.1 per cent in Sydney and 62.3 per cent in Melbourne.

The majority of cooks (89.5 per cent) cooked the samples until they were medium to well done, with 56.4 per cent cooking them until they were well done. There were no major differences between the extent of cooking of loin and topside steaks.

With regard to loin steaks (which had an intact subcutaneous fat cover), 54.9 per cent of cooks did not trim any fat. Of those who did, 69.4 per cent trimmed the fat before cooking and there was an equal distribution between those cooks who trimmed all of the fat (49.9 per cent) and those who trimmed some of the fat (50.1 per cent). It is interesting to note that, over all consumers, 22.5 per cent trimmed all of the fat from the steaks.

Table 3 provides information regarding the extent of fat trimming for each fat class. As would be expected, there was a strong positive relationship between carcass fat class and the trimming of fat from the steaks.

The majority of cooks (59.5 per cent) judged the fat colour of the loin steaks as being white and white fat was found to be more acceptable than yellow fat (Table 4). These ratings were not revealed by a comparison of different coloured fat, but simply in relation to the acceptability of the fat on a single steak. Although 80 per cent of cooks rated yellow fat as acceptable a large proportion of these could well prefer white fat to yellow fat.

A total of 54.8 per cent of cooks rated the loin steaks as not having their preferred level of fatness. Of these, 83.6 per cent identified the steaks as being too fat. Greater insight into cooks' perceptions of fatness can be gained from Table 5, which classifies cooks' ratings by

carcass fat class. Obviously, as the fat class increased, a much greater percentage of cooks rated the fatness of the steaks as deviating from their ideal. Alternatively, leanness (or over leanness) did not have a similar impact and it was steaks from carcasses in the lowest fat classes (0-2mm and 3-7mm) that offered the most appeal.

Table 3 : Percentage of Cooks Trimming Fat by Fat Class of Carcass

Fat Class	Trimmed			Did Not Trim
	All Fat	Some Fat	Total	
0 - 2 mm	11.7	16.2	27.9	72.1
3 - 7 mm	20.1	18.5	38.6	61.4
8 - 12 mm	24.7	23.0	47.7	52.2
13 - 23 mm	28.3	31.7	60.0	40.0

Table 4 : Cooks' Perceptions of the Fat Colour of Loin Steaks

	White Fat (%)	Yellow Fat (%)
Acceptable	94.7	80.0
Unacceptable	5.3	20.0

Table 5 : Cooks' Perceptions of the Amount of Fat on Loin Steaks

	Carcass Fat Class (%)			
	0-2mm	3-7mm	8-12mm	13-23mm
Too Fat	20.7	31.0	53.3	69.6
Just Right	64.1	57.0	38.9	27.4
Too Lean	15.2	11.9	7.8	3.0
Mean Rating *	3.95	3.75	3.20	2.69

* 1 = Much too fat, 4 = Just right, 7 = Much too lean.

3.2 Tasters' Perceptions

Analysis of variance was used to examine differences between mean taster ratings of juiciness, tenderness and flavour. Separate analyses were conducted for each of these dependent variables. Initially, cut (loin vs. topside) was examined as a treatment (Table 6). Separate analyses were then conducted for loin and topside steaks (Tables 7 and 9), with the same dependent variables.

Due to the unavailablility of younger animals with a high fat cover and older animals with a low fat cover, it was necessary to modify the treatments outlined in Table 1 in order to maintain a balanced factorial design. Fat cover was classed as low, medium or high, depending on the age category of the animal. That is, for 0-2 tooth animals the three fat classes ranged from 0-2 mm (low) to 8-12 mm (high), while for 3-7 and 8 tooth animals the fat classes ranged from 3-7 mm (low) to 13-23 mm (high). Also, due to the type of experimental design and statistical software limitations, sex of the animal (a dichotomous variable) was analyzed as a covariate rather than as a factor.

Other variables introduced as covariates included pH, carcass weight, degree of cooking, and abattoir where the animal was slaughtered. Although the last two variables were not strictly continuous, the variable degree of cooking comprised a 5 point graduated scale from rare to well done and this was reduced to a dichotomous scale comprising medium to rare and well done. Abattoir where the animal was slaughtered was introduced as two separate variables, each in dummy variable form. The first variable was the smaller abattoir (Ipswich Regional Abattoir) versus the others. The second variable was the two larger abattoirs versus each other.

The covariate degree of cooking was retained in the analysis because it significantly affected ($p < .05$) the juiciness of loin steaks, and the juiciness, tenderness and flavour of topside steaks. Given the preference for well-done steaks, these results indicate either that consumers are unaware of the effect their cooking preferences have on meat palatability or that visual characteristics are more important (i.e. consumers do not like their cooked meat to have a red or pink colour).

Mean taster ratings for loin and topside steaks are shown in Table 6. The ratings show that loin steaks were perceived, at very high levels of significance, to be juicer, more tender and of a better flavour. This is consistent with the design of the trial, in that two cuts were selected which were considered to possess different characteristics.

3.2.1 Tasters' Perceptions of the Palatability of Loin Steaks

Analysis of variance results for loin steaks are summarized in Table 7. The juiciness of the steaks was significantly affected by stimulation treatment, age of the animal and degree of cooking. Steaks from carcasses which had been electrically stimulated were rated as 3.6 per cent juicer than those which were non-stimulated, while steaks from 0-2 and 3-7 tooth animals were rated as 5.0 per cent juicer than those from 8 tooth animals. Steaks which were cooked well done were rated as 5.4 per cent less juicy than those which were cooked medium to rare.

Factors having a significant effect on the tenderness of the loin steaks were the main effects of breed, stimulation treatment and age, the two-factor interactions of breed by stimulation

Table 6 : Mean Taster Ratings for Loin and Topside Steaks*

	Juiciness	Tenderness	Flavour	Overall Satisfaction
Loin	3.78[a]	3.80[a]	3.27[a]	3.77[a]
Topside	4.20[b]	4.21[b]	3.57[b]	4.32[b]

* Means that differ in superscript are significantly different ($p < .01$)

Juiciness :	1 = extremely juicy	7 = extremely dry
Tenderness :	1 = extremely tender	7 = extremely tough
Flavour :	1 = excellent	7 = poor
Satisfaction:	1 = extremely satisfied	7 = extremely dissatisfied

Table 7: Treatment Effects on Loin Steaks

		Dependent Variable					
		Juiciness		Tenderness		Flavour	
Source of Variation	df	ms	fa	ms	fa	ms	fa
Breed	1	2.28	2.72	5.36	4.47*	0.02	0.04
Stimulation	1	4.16	4.97*	50.62	42.14**	5.44	9.47**
Age	2	4.77	5.70**	24.39	20.31**	1.43	2.50
Fat	2	1.50	1.79	2.27	1.89	1.37	2.39
Breed x Stimulation	1	1.97	2.35	8.34	6.94**	0.46	0.81
Breed x Age	2	1.37	1.64	2.76	2.30	2.15	3.75*
Stimulation x Age	2	1.91	2.28	1.40	1.17	4.27	7.44**
Breed x Fat	2	1.07	1.28	2.75	2.29	0.55	0.96
Stimulation x Fat	2	0.30	0.36	2.26	1.88	0.03	0.07
Age x Fat	4	1.81	2.16	3.97	3.30*	1.24	2.15
Breed x Stimulation x Age	2	0.30	0.36	3.56	2.96	0.63	1.10
Breed x Stimulation x Fat	2	0.49	0.58	0.67	0.56	0.03	0.06
Breed x Age x Fat	4	0.48	0.57	0.24	0.20	0.66	1.15
Stimulation x Age x Fat	4	1.42	1.70	4.11	3.43**	1.38	2.41*
Covariates:							
Sex	1	0.86	1.02	1.40	1.16	1.20	2.09
Cooking Extent	1	3.41	4.06*	1.75	1.46	0.04	0.08

a * Significant at the 5 per cent level
** Significant at the 1 per cent level

treatment and age by fat, and the three-factor interaction, stimulation treatment by age by fat.

Electrical stimulation led to a 14.2 per cent improvement in the tenderness of steaks from British breeds and a 7.7 per cent improvement in the steaks from Brahman breeds. Because electrical stimulation had a greater effect on the steaks from British breeds, steaks from electrically stimulated British carcasses were rated as 7.3 per cent juicier than those from equivalent Brahman carcasses. When carcasses were not stimulated there was no significant difference between breeds.

Electrical stimulation also significantly improved the tenderness of steaks from animals of all age and fat classes, except for those from 3-7 tooth, low fat animals. The percentage improvement in tenderness in each age and fat class is shown in Table 8.

For each fat class, steaks from 8 tooth animals were rated as the least tender and for the low and high fat classes, steaks from 0-2 tooth animals were rated as significantly more tender than those from 3-7 tooth animals. On average, moving from 0-2 tooth to 3-7 tooth and from 3-7 tooth to 8 tooth animals, involved a decrease in tenderness of 5.4 per cent and 6.3 per cent respectively.

Electrical stimulation led to an improvement in the flavour of loin steaks from 0-2 tooth and 8 tooth animals of 9.8 per cent and 6.0 per cent respectively. Steaks from 3-7 tooth animals were not significantly affected.

For British breeds, steaks from 8 tooth animals were rated as having less flavour than those from 0-2 tooth and 3-7 tooth animals, however there was no significant difference between the age groups of Brahman cattle.

Table 8 : Percentage Improvement in the Tenderness of Loin Steaks from Electrically Stimulated Carcasses of Different Age and Fat Classes

	Fat Class[a]		
Age Class	Low	Average	High
0-2 tooth	11.5	6.9	20.1
3-7 tooth	-	10.6	14.9
8 tooth	17.2	9.0	9.0

a For 0-2 tooth animals the fat classes were 0-2 mm (low), 3-7 mm (average) and 8-12 mm (high). For 3-7 tooth and 8 tooth animals the fat classes were 3-7 mm (low), 8-12 mm (average) and 13-23 mm (high).

3.2.2 Tasters' Perceptions of the Palatability of Topside Steaks

Analysis of variance results for topside steaks are summarised in Table 9. The covariate degree of cooking had a significant effect on each dependent variable. In comparison to a medium to rare steak, a well done steak exhibited a loss in juiciness, tenderness and flavour of 14.2 per cent, 7.8 per cent and 5.9 per cent respectively. Age was the only significant main effect with regard to consumer ratings of juiciness, however there were significant interaction effects of breed by fat and age by fat.

Across all fat classes, steaks from 0-2 tooth animals were rated as the most juicy. For carcasses with a low or average fat cover, 3-7 tooth animals were rated as having the least amount of juiciness, however for high fat carcasses 8 tooth animals were rated as inferior. Moving from the most preferred to the least preferred age category involved a decrease in juiciness of 2.8 per cent, 3.4 per cent and 10.3 per cent for the low, average and high fat classes respectively.

The breed by fat interaction indicated that, for British breeds, the juiciness of the steaks increased as fat cover increased, however for Brahman breeds this effect was reversed. For British breeds, low fat animals were rated as 3.0 per cent less juicy than high fat animals, while for Brahman breeds high fat animals were rated as 4.6 per cent less juicy than low fat animals.

Table 9 : Treatment Effects on Topside Steaks

		Dependent Variable					
		Juiciness		Tenderness		Flavour	
Source of Variation	df	ms	fa	ms	fa	ms	fa
Breed	1	0.04	0.04	4.00	4.00*	0.04	0.09
Stimulation	1	2.88	3.18	0.28	0.28	0.00	0.00
Age	2	3.01	3.32*	29.97	29.96**	2.71	5.84**
Fat	2	0.11	0.13	1.11	1.11	0.82	1.77
Breed x Stimulation	1	0.42	0.46	4.91	4.91*	0.00	0.00
Breed x Age	2	0.69	0.74	2.96	2.96	1.01	2.17
Stimulation x Age	2	0.03	0.03	0.16	0.16	0.09	0.20
Breed x Fat	2	3.15	3.48*	0.24	0.24	1.43	3.08*
Stimulation x Fat	2	2.34	2.58	1.37	1.37	0.76	1.64
Age x Fat	4	2.51	2.77*	3.10	3.10*	0.69	1.49
Breed x Stimulation x Age	2	0.04	0.04	0.02	0.02	0.10	0.22
Breed x Stimulation x Fat	2	0.20	0.22	0.04	0.04	0.33	0.70
Breed x Age x Fat	4	0.40	0.44	1.72	1.72	0.39	0.85
Stimulation x Age x Fat	4	1.01	1.12	2.02	2.02	0.55	1.18
Covariates:							
Sex	1	1.86	2.05	3.44	3.44	2.30	4.96*
Cooking Extent	1	25.09	27.69**	10.35	10.35**	3.34	7.19**

a * Significant at the 5 per cent level
** Significant at the 1 per cent level

Factors having a significant effect on the tenderness of the topside steaks were the main effects of breed and age, and the interaction effects of breed by stimulation treatment and age by fat.

When carcasses were not electrically stimulated, there was no significant difference between the mean tenderness ratings for steaks from different breed types. However following electrical stimulation, steaks from Brahman breeds were rated as 5.3 per cent less tender than steaks from British breeds. This difference resulted because electrical stimulation significantly improved the tenderness of steaks from British breeds, but not those from Brahman breeds. Such an effect is surprising and is different to what was found with loin steaks, where electrical stimulation improved the tenderness of both breed types.

The age by fat interaction was similar to that found for the juiciness of the steaks. That is, across all fat classes, steaks from 0-2 tooth animals were rated as the most tender. Steaks from 3-7 tooth animals were rated as inferior for carcasses with a low to average fat cover, while for those carcasses with a high fat cover, steaks from 8 tooth animals were rated as inferior. Moving from the most preferred (0-2 tooth) to least preferred age category involved a decrease of 13.3 per cent, 7.3 per cent and 16.5 per cent for the low, average and high fat classes respectively.

The main effect of age and the breed by fat interaction effect were significant in determining consumer ratings of the flavour of the topside steaks. In comparison to steaks from 0-2 tooth animals, those from 3-7 and 8 tooth animals were rated, respectively, as having 4.4 per cent and 3.8 per cent less flavour. There was no significant difference between the flavour of steaks from British breeds of different fat classes, however steaks from low fat Brahman animals were rated as having 4.4 per cent and 5.2 per cent more flavour than those from average and high fat Brahmans, respectively. For the first time the sex of the animal had a significant effect, with the steaks from females being rated as having 11.4 per cent less flavour than those from steers.

4. Conclusion

The study reported in this paper has shown that consumers, on average, can perceive differences in quality traits between steaks from carcasses of different classification criteria. These findings have important implications for the development of an objective product description system and in the promotion of beef to the consumer. Specifically, it is possible to identify objectively those carcasses yielding meat of the most preferred quality and accordingly, to promote this quality product to the consumer.

Consumers exhibited a dislike for fat and as fat cover increased, a higher proportion of cooks trimmed some, or all, of the fat from the loin steaks. Across all fat classes, almost one-quarter (22.5 per cent) of cooks trimmed all of the fat from the steaks.

In determining consumers' ratings of palatability, the factors which exhibited statistical significance most frequently and which also had the greatest impact, were age and stimulation treatment. Preference was shown for steaks from young (0-2 tooth), electrically stimulated carcasses. Electrical stimulation had a much greater effect on the palatability of loin steaks than topside steaks.

The actions of consumers also can influence palatability characteristics. It was found that a greater degree of cooking (rare to well-done) resulted in a steak of lesser quality. The majority of steaks were cooked well-done, however, and therefore consumers are either unaware of the effect of their cooking preferences or other considerations are of more importance.

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