Meat - Marketing

CONSUMER PREFERENCES FOR BEEF STEAKS

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DEPARTMENT OF AGRICULTURAL MARKETING

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Contents

CHAPTER I

INTRODUCTION

This is the second of a series of interim reports dealing with the five year programme of research undertaken by the Department of Agricultural Marketing in the University of Newcastle upon Tyne into meat marketing. The work is sponsored by F.M.C. (Meat) Limited and the Agricultural Market Development Executive Committee.

A primary objective of the research is to attempt some description of the types of beef the changing meat trade is demanding. Nevertheless it was early recognised that it would not be possible to single out three or four main types of beef carcase which at the same time were both in good supply and considered to yield meat which was generally acceptable to consumers. There were thus no obvious and universally acceptable main categories of beef carcase for which consumer acceptability ought to be tested. Therefore it was necessary to establish which characteristics of quality in beef were most important to consumers and to examine both their relative influences on satisfaction and what were mass requirements in respect of each characteristic.

Preliminary investigation suggested tenderness, leanness and flavour as being the main criteria by which consumers judge the quality of beef. Retailers' opinions of the importance of these and other criteria were examined in a survey already reported*. Butchers made leanness of first importance, tenderness second and flavour third. Other possible characteristics such as marbling and ageing were almost completely disregarded.

The following analysis, therefore, deals with consumers' attitudes to tenderness, leanness and flavour. From it inferences can be drawn about the relative importance of each of these criteria and the acceptability of different levels of tenderness, leanness and flavour.

The method of investigation was by product tests in five cities—Birmingham, Glasgow, Liverpool, London and Newcastle upon Tyne. These took place during the period from September 1964 to February 1965. No testing was undertaken during the Christmas period.

As far as possible normal purchase and consumption were simulated in each test. The consumer panels were therefore enlisted from the customers of particular butchers' shops. First separate areas of one square mile were distinguished in each city in which either high or low incomes predominated, then two high and two low income districts were selected at random. In each of these the co-operation of one butcher was obtained in order to facilitate distribution of the test meat. Prior to testing, some fifty customers at each shop were asked to co-operate by visiting the shop on a particular day to buy steak. At the same time information was obtained to

* G. H. Brayshaw, E. M. Carpenter and R. A. Phillips, Butchers and Their Customers, University of Newcastle upon Tyne, Department of Agricultural Marketing, Report No. 1. April, 1965. 15s.

ensure that the co-operating consumers lived in the selected areas and to provide the basis for socio-economic classification. Together with husbands or some other male member of the family this provided in each city some four hundred co-operators who were asked to and in general did take part in testing for each of the three characteristics—tenderness, leanness and flavour.

Three separate tests were carried out. For the tenderness and flavour tests frying steaks were cut from the round and for leanness from the sirloin. A pair of similar steaks, together with two separate questionnaires were prepackaged. A male member of the family was asked to eat the larger of the two steaks and, to avoid collusion, it was not admitted that the two should have been the same. Inspection of the data strongly suggests that collusion was rare. Each co-operator then purchased a pair of steaks from her butcher at approximately half the current retail price and questionnaires for each steak were completed when they were eaten. (Appendix II).

Considerable difficulty was experienced in offering steaks of several degrees of tenderness. A laboratory experiment suggested a technique of selection depending on age of the live animal and different hanging periods. (Table 1).

TABLE 1.

	Hung 3 days	Hung 6 days	Hung 9 days	Hung 12 days	Hung 15 days
BARLEY BEEF					
Topside	23.0	24.9	14.7	14.7	
Rump	14.8	19.8	13.1	12.7	
Fore Chine	—	15.2	15.2	17.9	
Chuck	20.5	14.0	13.0	11.9	
2 YEAR OLD					
Topside	29.5	22.4	21.3	22.2	19.3
Rump	15.2	14.2	14.2	14.1	18.5
Fore Chine	20.4	18.6	17.6	18.4	17.2
Chuck	27.1	18.4	15.7	12.2	18.5
2½ YEAR OLD					
Topside	34.5	34.7	22.3	19.6	26.9
Rump	18.0	18.1	14.7	14.6	14.0
Fore Chine	18.3	17.3	16.9	19.3	11.1
Chuck	20.3	20.4	16.7	13.5	19.8

In practice, however, these results were by no means regularly repeated, as is shown in Chapter 4. Different proportions of fat to lean were more easily offered by visual inspection and trimming. In the absence of any better basis for predicting flavour, barley beef and mature beef were used.

CHAPTER II

CONSUMER ATTITUDES TO FLAVOUR

In the following analyses an examination is made of questionnaire returns completed on opinions of nearly two thousand frying and grilling steaks, derived from the topsides of different types of beast, by almost one thousand co-operating households in five major cities.

Each of two thousand co-operators were asked to state, using a five-point scale on a prepared questionnaire, his or her opinion of the strength or intensity of flavour possessed by a sample steak. Using two nine-point scales, each consumer was also requested to state how satisfactory was that degree of flavour, and how enjoyable was the sample steak in an overall sense taking other factors besides flavour into account. Other supplementary questions were asked relating to factors such as cooking methods in order to preserve some measure of control over the experiment as a whole.

The major aims of the survey are therefore three-fold. Firstly, an attempt is made to determine whether or not the general public is able to discern differences in the flavours of steaks from various sources. Secondly, the questions permit conclusions to be reached on whether or not consumers in general prefer steaks which possess a strong beef flavour rather than less flavour. And, finally, an analysis is made of the importance of flavour and other factors, principally tenderness, in determining the overall eating quality of steaks in the opinion of the mass market.

Types and Characteristics of Sample Steaks

A basic constraint on the scope of a survey of attitudes to meat flavour is the difficulty of measuring either the type or intensity of the flavour characteristic in a meaningful quantitative way. Consequently, if untrained panels are asked to state the strength of flavour of two types of beefsteak their responses may be identical because their palates are unable to detect a difference which in fact exists. Or, alternatively, there may have been no real difference or perhaps only a negligible difference in the actual, but unmeasurable, flavours of the two meat types.

Typically the role of tasting for flavour is the prerogative of specialists with palates trained to detect slight differences of flavour and undoubtedly it would have been possible to use expert panels to assess the qualities of the meat used in this survey. Such procedures are, indeed, vital in those sectors of the food industry mass-producing highly processed, branded goods for which consistency of flavour may be an indispensable part of marketing strategy. There is a difference, however, between the need to replicate consistently through time a flavour for which an existing preference is known to exist and, on the other hand, the establishment of the preference in the first place. In this survey we are attempting to establish the preferences of the shopping public, and this can only be done satisfactorily if the general public are asked their opinions.

In these circumstances, it was hoped that beasts of various breed and age, produced by widely differing systems of management and feeding, would actually yield meat with different intensities of flavour. Also, it was hoped that the envisaged

differences in flavour would be recognised by the consumer panels, even though the steaks offered for testing were to be eaten in the normal way; that is, as part of a meal consisting of other items besides the meat. For, logically, it is only if variations in flavour are recognisable that a preference for one degree or another of flavour can rationally be established.

For consumer testing the survey team attempted to procure, through normal wholesale channels, carcases of intensively fed barley beef and of mature grass-finished animals of various pure and cross breeds for distribution in each city. In practise it was not possible for the supplier to specify exactly the origins, age and feeding regimes of all beasts from which topside steaks were cut; but it was feasible to distinguish on the one hand young intensively fed animals of less than fifteen months at slaughter and those on the other hand which were at least two years of age at slaughter. In the subsequent analysis these are generally referred to for convenience as barley beef and mature beef respectively.

Of approximately four hundred steaks distributed in each city, two hundred were barley beefsteaks and the other half were from mature beasts. The barley beef were divided, approximately evenly, into two groups, designated A and B throughout the analysis, using different beasts in each sub-group, and similarly, the mature beef-steaks consisted of two groups, labelled C and D in the following analyses.

Representative samples from each of the four steak groups (A, B, C and D) were retained for laboratory evaluation, on the same day that consumer samples were eaten, enabling an assessment to be made of the degree of tenderness of each group. No attempts were made to measure fatness or leanness of steaks used in this particular survey, but during the cutting and packing operation visual efforts were made to achieve uniformity of leanness and so eliminate this particular variable from the analysis. The basic characteristics of each steak group for each of the five cities are recorded in Table 2.

TABLE 2. **Characteristics of Steaks used in Flavour Survey**

City	Steak Group	Description	Av. degree of tenderness (shear)
Liverpool	A	Barley Beef	21.2
	B	Barley Beef	19.3
	C	Mature 2½ year	21.2
	D	Mature 2½ year	23.9
Glasgow	A	Barley Beef	18.7
	B	Barley Beef	19.3
	C	Mature 2 year	25.0
	D	Mature 2 year	27.7
Birmingham	A	Barley Beef	20.5
	B	Barley Beef	24.0
	C	Mature 2/2½ year	31.4
	D	Mature 2/2½ year	28.6
Newcastle	A	Barley Beef	22.5
	B	Barley Beef	24.2
	C	Mature 2½ year	25.6
	D	Mature 2½ year	29.0
London	A	Barley Beef	25.0
	B	Barley Beef	22.4
	C	Mature 2/2½ year	33.0
	D	Mature 2/2½ year	31.3

The main aim in differentiating each meat type into two groups according to carcase was to achieve some difference in tenderness between the two groups in each city. In practise, however, it was not always possible to obtain statistically different degrees of tenderness between groups A and B or between steak groups C and D. Thus, in parts of the following analysis questionnaires relating to A and B have been pooled; and similarly data on C and D have been aggregated for some purposes. It will be noted that in Table 2 none of the ten groups of barley beef distributed had a mean shear value of more than 25.0, as measured on the Warner Bratzler instrument, whilst only two of the mature beef groups were rated at less than 25.0 on the tenderness inedx. It is therefore not considered possible to assess the relative importance of flavour and tenderness in all individual cities with any precision in the following parts of this report although some inferences can realistically be drawn from the whole body of data.

CONSUMER RECOGNITION OF FLAVOUR

All consumer panels were asked to score the intensity of the flavour they believed the sample steak possessed on eating it according to the following five-point schedule:

Extremely strong beef flavour	5 points
Very strong beef flavour	4 ,,
Moderately strong beef flavour	3 ,,
Slight beef flavour	2 ,,
No beef flavour	1 ,,

Table 3 summarises the average response on this scale for each steak group in each city and shows in a general way the extent to which co-operators detected differences in flavour. Of particular interest is the comparison of mean scores for barley beef (groups A plus B) against those for mature beef (groups C plus D) :in all cities except Glasgow there is some indication that consumers were on average able to distinguish the flavours of the two meat types, and that barley beef was recognised as possessing slightly less flavour than the grass-finished beef. However, it is worth commenting that up to 27 per cent of respondents, varying from city to city, believed that the barley beef possesssed a "very strong" or "extremely strong" beef flavour. And, in Birmingham, for example, although the group averages in Table 3 (*a*) indicate that the mature beef was more strongly flavoured, at the same time a greater percentage of respondents believed the barley beef to be "strongly" flavoured as compared with the mature beef (see Table 3 (*b*)).

TABLE 3. (*a*) **Recognition of Flavour (Average Scores)**
(maximum = 5, minimum = 1)

	Liverpool		Glasgow		Birmingham		Newcastle		London	
Steak Group	No. of Steaks	Av. Score	No. of Steaks	Av. Score	No. of Steaks	Av. Score	No. of Steaks	Av. Score	No. of Steaks	Av. Score
A	80	2.9	141	2.7	102	3.0	96	2.8	83	2.6
B	68	2.7	62	2.7	83	2.7	94	3.0	100	2.6
C	79	2.9	99	2.6	77	2.9	89	3.1	93	2.8
D	84	3.0	89	2.5	74	3.1	95	2.9	91	2.7
A+B	148	2.8	203	2.7	185	2.9	190	2.9	183	2.6
C+D	163	3.0	188	2.6	151	3.0	184	3.0	184	2.8

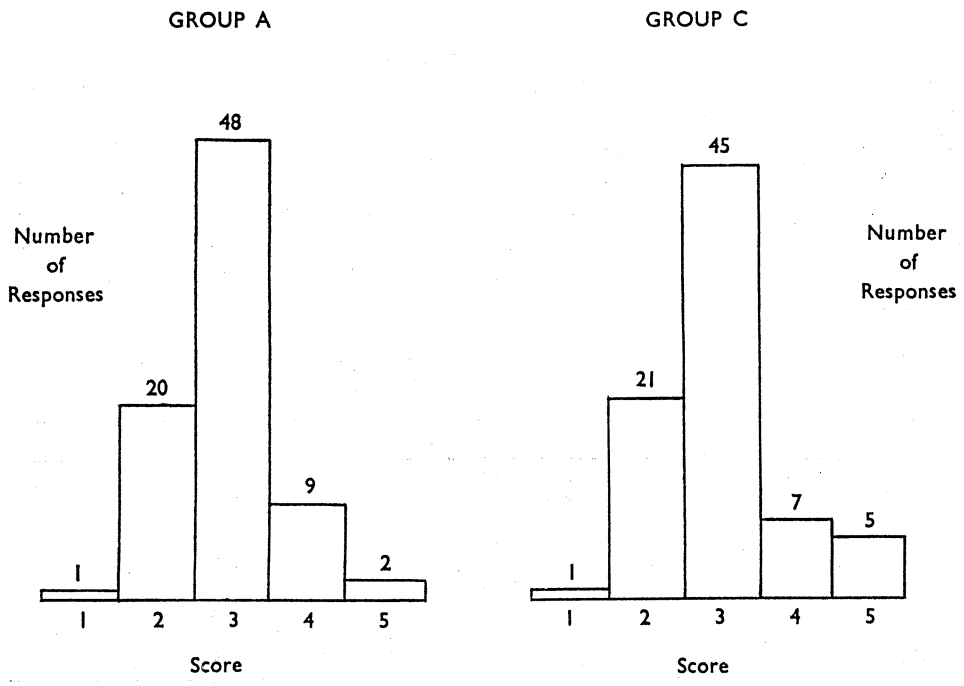
(*b*) **Percentage of Panel Scoring 4 or 5***

Steak Group	Liverpool	Glasgow	Birmingham	Newcastle	London
A	13.8	13.5	25.5	18.7	13.3
B	14.7	19.4	20.5	26.6	9.0
C	15.2	11.1	16.9	29.2	14.0
D	27.4	10.1	20.3	27.4	15.4

* That is, percentage of respondents in each panel believing the steak to possess a "very strong" or "extremely strong" beef flavour.

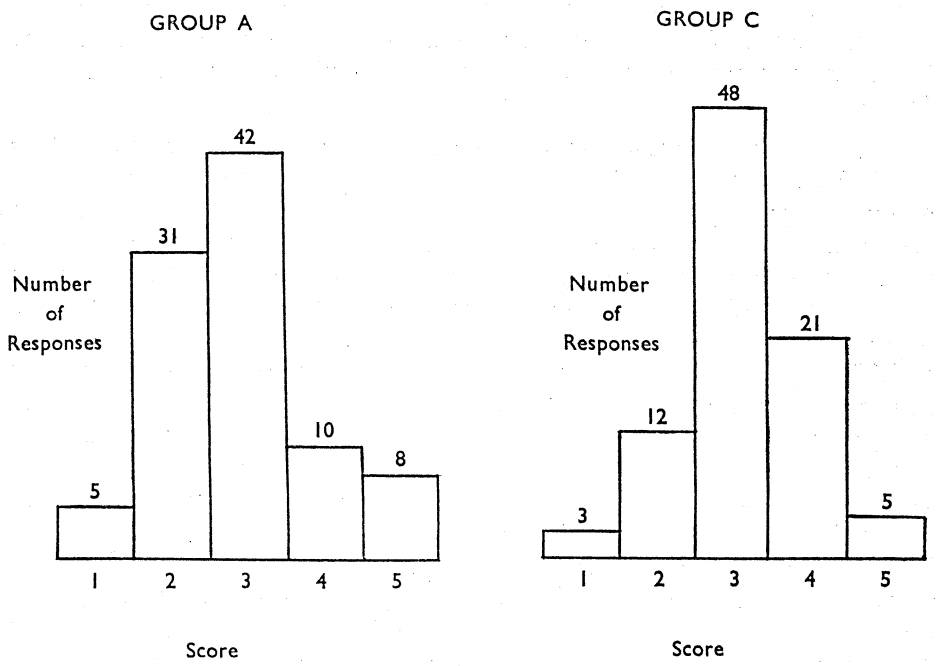
It is unwise, then, to base conclusions solely on a comparison of average scores, for small discrepancies between averages may be accounted for by the smallness of samples and need not be due to inherent characteristics of the meat; and, additionally, averages may conceal important variations in opinions both within and between panels. To examine these underlying problems in an attempt to discover whether those differences in opinions are likely to have arisen by chance or not, use is made of the non-parametric statistical test (White's test) outlined in Appendix I. Basically, the test enables the distribution of scores for any one steak group to be compared with the equivalent distribution for any other steak group distributed within the same city.

In Liverpool, for example, the distributions of respondents' judgements on the intensity of the flavour of steak groups A and C (barley beef and mature beef, respectively) are as follows in diagrammatic or histogram form:



Applying White's test to these data leads to the inference that the two meat types are not significantly different with respect to recognised degree of flavour: that is, the two histograms are so similar that the small differences between them could very easily have arisen by chance. Indeed, the average score is 2.9 for each steak group, but even if the average scores had been slightly different the same inference may have been relevant.

The same test was used to compare all pairs of steak groups (A, B, C and D) in each city in turn: that is A is compared with B, C and D in turn, B with C and D, and C with D, giving six tests for each city or a total of thirty. Of the thirty comparisons made only one suggests* that a pair of histograms represented different scoring patterns on the part of respondents. Thus, in Newcastle the panel tasting steaks in group A (barley beef) gave a significantly lower score for intensity of flavour than the panel tasting group C (mature beef) steaks. The two histograms for these steak groups are shown below, and it is obvious that a much greater percentage of panel members believed the mature beef to be strongly flavoured than was true for the barley beef.



Ten of the foregoing tests for recognised differences in flavour comprised comparisons either between the two groups of barley beef (A and B) or between the two groups of mature beef (C and D): and it is perhaps not surprising that respondents were unable to detect any differences in flavour either between two samples of barley beef or between two of mature beef. However, in spite of the fact that the other

* null hypothesis rejected with $P < 0.05$.

twenty tests involved comparisons between barley beef and mature beef, only in the one case cited above were consumers able to detect a significant difference of flavour.

In view of the apparent similarity in flavour of the two barley beef groups (A plus B) the data on these were pooled for each city in turn and compared with similar pooled data for the two groups of mature beef (C plus D): this procedure is logically valid and enables sample sizes to be approximately doubled. Using White's test again to compare all barley beef with all mature beef in each of the five cities the results indicate that panels could not distinguish any significant flavour difference between the two types of meat on offer. A summary of the statistical tests on both unpooled and pooled data is given later in Tables 6(*a*) and 6(*b*) respectively.

The general inference from the statistical tests is that the consumer panels were unable to detect important differences in flavour. This result possibly implies that the general public is unable to discriminate; or that in the home the flavours of other items, such as garnishes or vegetables, eaten with the steaks make it difficult for untrained palates to separate out any distinctive meat flavour which may have existed. Alternatively, it may be suggested that with consumer surveys of the type carried out, respondents are reluctant to give extreme opinions: in these circumstances it is not surprising that majority opinion often indicated that the steak eaten possessed a "moderately strong beef flavour" perhaps irrespectively of the true intensity of flavour.

Finally, the conclusion may well have been influenced by the framework within which the survey was conducted. For reasons of administrative control over the experiment, as well as for cost considerations, only one steak was eaten by each co-operator. It was envisaged that if, say, one hundred co-operators each eat a similar steak that their consensus of opinion may differ from the consensus of responses of another one hundred consumers who eat a second type of steak. Such differences of opinion have not emerged from this first analysis, possibly due to the variability of steaks which were thought at the outset to be similar and were therefore classified into group A, B, C or D. Consequently, the variations within any steak group may have been as great as variations between steak groups due to the difficulty of ensuring absolute consistency of the raw materials. In order to control as many variables as possible only steaks from topsides were used in the survey. Perhaps greater discernible differences of flavour would have been secured if different cuts had been used or if steaks from extremely different sources, such as barley beef and culled dairy cows, had been considered. But this procedure would not have eliminated the problem of ensuring consistency within a steak group, and at the same time other un-measurable variables would have been introduced into the analysis. It was felt, on balance, that any results from such an investigation, whilst yielding more extreme reactions to flavour, would have been less fruitful in terms of applicability to the mass market for frying and grilling steak.

Preferences for Flavour

The second major question for which answers were sought concerns the extent to which consumers were satisfied with the degree of flavour they believed the steaks

to possess. In particular, the returns were analysed with the object of determining whether the flavour of mature beef was more or less preferred than the detected flavour of the barley beef steaks.

Co-operators were confronted with a nine-point score, ranging from "liked flavour extremely" (9 points) to "disliked flavour extremely" (1 point), and were asked to indicate the description which best described the satisfaction derived from the flavour of the steak on eating it. The average opinion on each of the twenty steak groups is tabulated below:

TABLE 4. (*a*) **Satisfaction with Flavour (Average Scores)**
(maximum = 9, minimum = 1)

	Liverpool		Glasgow		Birmingham		Newcastle		London	
Steak Group	No. of Steaks	Av. Score	No. of Steaks	Av. Score	No. of Steaks	Av. Score	No. of Steaks	Av. Score	No. of Steaks	Av. Score
A	80	7.5	140	6.4	101	7.1	95	7.2	82	6.7
B	66	6.8	62	6.8	83	6.8	94	7.3	98	6.9
C	82	7.6	99	6.4	77	7.3	89	7.3	94	6.8
D	84	7.2	89	6.2	76	7.5	95	7.0	90	6.8
A+B	146	7.2	202	6.5	184	7.0	189	7.2	182	6.8
C+D	166	7.4	188	6.3	153	7.4	184	7.1	184	6.8

(*b*) **Percentage of Panel Scoring 8 or 9***

Steak Group	Liverpool	Glasgow	Birmingham	Newcastle	London
A	53.8	31.4	45.5	51.6	48.8
B	45.5	37.1	53.0	57.4	48.0
C	67.1	29.3	49.4	56.2	31.9
D	53.6	29.2	52.6	50.5	39.6

* That is, percentage of respondents in each panel were satisfied with the flavour either "very much" or "extremely".

A score of 7 on the nine-point scale is indicative of having "liked flavour moderately" and the general impression from the average scores is that consumers were satisfied with the flavour to a "moderate" extent irrespectively of the type of beast from which the steak was derived. Indeed, given that the same panels in general were unable to detect differences between the flavour of barley beef and mature beef, it is not surprising that they should be equally satisfied with the flavours of two basic types of meat.

Once more, small differences between averages in sample surveys cannot be accepted without further analysis, and White's test is again applied to comparisons between pairs of A, B, C and D in each of the five cities. This second set of thirty comparisons is summarised in Table 6; and of the thirty tests, twenty-eight fail to give significant differences between the degrees of satisfaction experienced by the co-operating households.

Only for the Liverpool data do significant differences exist. The comparison between the two groups of barley beef reveals that the flavour of group A was preferred

over that of group B*, which is paradoxical in that the two groups were judged in the previous section to possess a similar degree of flavour. And, in the same city, sample C of mature beef is significantly different** from sample B of barley beef, with the flavour of the mature beef group being preferred. Again, though, the earlier tests have indicated that it is unlikely that consumers had detected a difference in flavour between these two steak groups.

To reduce the likelihood of obtaining such spurious results because of the smallness of sample sizes, the data for the two groups of barley beef were aggregated, and similarly the two groups of mature beef were treated as a single sample in each city. Applying White's test to the simple comparison of all barley beef with mature beef the five tests—one for each city—revealed no significant differences in degree of satisfaction with flavour (Table 6(*b*)). Statistically, it therefore appears reasonable to infer that consumers in general are equally satisfied with the flavours of topsides from barley beef and mature beef. This inference follows logically from the earlier finding that consumers for the most part are unable to detect differences in flavour.

The Importance of Flavour in Merchandising

All of the foregoing conclusions are consistent with the relatively low priority which consumers apparently attach to flavour as a criterion of meat quality. In an earlier report† an analysis of butchers' opinions of consumers' criteria for assessing quality strongly suggested that leanness and tenderness were of greater importance to the housewife.

However, there is some corroborative evidence from the present survey to support the comment made in that report, that the presence of flavour is nevertheless an important feature influencing the success of fresh meat merchandising. Firstly, there undoubtedly exists a body of consumers who are able to detect flavour differences, even though the design of the survey does not facilitate this examination on an individual basis. And, secondly, there are good reasons for stating that consumers in general do in fact prefer steaks with a relatively strong beef flavour even though their palates are not able to discriminate with ease.

For example, if a respondent believes that a steak possesses a strong flavour, even irrespective of its "true" flavour, it is likely to prove more satisfying than a steak which is believed to have only a slight beef flavour. In this context a comparison of the average scores in Table 3 with those in Table 4 shows that if a steak group is reckoned to have only a slight beef flavour then the equivalent score in Table 4 is also likely to be low. Likewise, if a steak group is thought to have a strong flavour (or high score) in Table 3 then the same group in Table 4 is generally shown to be more satisfying.††

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* $P<0.05$.

** $P<0.01$.

† G. H. Brayshaw, E. M. Carpenter and R. A. Phillips, op.cit., pp.: 11-14.

†† For unpooled data, with twenty steak groups, $r=0.827$
Using pooled data ($n=10$), $r=0.845$.

The validity of such correlations is only undermined if it can be demonstrated that consumer panels have different conceptions about the words used in the five-point and nine-point scales, and that these conceptions vary according to the area in which the co-operators live. The only city of the five to which this stricture seems to apply systematically—and the same is true for the other consumer surveys undertaken by the present team—is Glasgow; but even if the Glasgow data are excluded from this part of the analysis the original conclusion is relevant.*

Consequently, it appears that merchandising policies which aim to present customers with flavoursome meat and at the same time inform housewives of the presence of this characteristic are more likely to be successful than policies which ignore this component of meat quality.

Flavour in Relation to Tenderness

Notwithstanding the last comment, the importance of factors other than flavour in determining meat quality makes it desirable to assess the relative significance of those other factors *vis-à-vis* flavour. It will be recalled that for this survey the attempt was made to preserve uniformity of leanness between steaks distributed in any one city. Consequently, it is not possible to examine the extent to which variations in leanness between groups of steaks account for variations in opinions of overall acceptability. However, steak groups which were thought to possess a similar flavour were differentiated according to tenderness, and the laboratory estimates of tenderness have been displayed in Table 2.

In order to estimate the overall acceptability of each steak group, respondents recorded their overall opinions, taking factors other than flavour into account, on a second nine-point scale. The descriptive scale ranged from "liked extremely" (9 points) to "disliked extremely" (1 point), and the average score for each steak group is recorded below.

Table 5. (*a*) **Overall Opinions of Steaks (Average Score)**
(maximum = 9, minimum = 1)

	Liverpool		Glasgow		Birmingham		Newcastle		London	
Steak Group	No. of Steaks	Av. Score	No. of Steaks	Av. Score	No. of Steaks	Av. Score	No. of Steaks	Av. Score	No. of Steaks	Av. Score
A	79	7.6	141	6.4	101	7.2	96	7.3	84	6.8
B	67	6.8	62	7.0	83	7.0	94	7.6	100	6.9
C	83	7.7	99	6.1	75	7.3	88	6.9	94	6.6
D	84	7.0	88	5.8	76	7.4	95	6.6	91	6.6

(*b*) **Percentage of Panel Scoring 8 or 9†**

Steak Group	Liverpool	Glasgow	Birmingham	Newcastle	London
A	58.2	31.2	51.5	56.2	41.7
B	41.8	40.3	53.0	66.0	43.9
C	68.7	24.2	44.0	50.0	31.9
D	45.2	26.1	52.6	47.4	45.6

* For unpooled data (n=16) the correlation of average score in Table 3 with average score in Table 4 gives r=0.755.

† That is, percentage of respondents in each panel who enjoyed the overall characteristics of the steaks either "very much" or "extremely".

Comparing Table 4 with Table 5 it is noticeable that when consumers, on average, are highly satisfied with flavour they also tend to record a high general opinion of the steak, and conversely when the flavour is considered to be less satisfactory so is the steak's overall palatability†. At a superficial level, then, one might suppose that the degree of overall acceptability of a steak is very much influenced by its flavour.

However, it has been determined that for any one city there existed no significant differences between steak groups with respect to the degree of satisfaction derived from flavour alone. The analysis must go on to estimate whether or not there are significant differences between the degrees of overall acceptability for the same steak groups in each city. If significant differences are found then these are not likely to be due to variations in flavour, and an attempt must be made to conclude whether or not variations in tenderness constitute the main causes.

White's statistical test has been used, once more, to compare scores on overall acceptability for pairs of steak groups in each city. The results of significance tests for the thirty comparisons are summarised in Table 6 and for convenience of exposition the equivalent results of the earlier tests concerning respondents' recognition of and satisfaction with flavour alone are displayed alongside.

TABLE 6. **(*a*) Four Steak Types**

Significance Tests on Flavour and Acceptability††

(1) City	(2) Steaks Compared	(3) Recognition of Flavour	(4) Satisfaction with Flavour	(5) Overall Acceptability
Liverpool	A—B	—	*	*
	A—C	—	—	—
	A—D	—	—	—
	B—C	—	**	**
	B—D	—	—	—
	C—D	—	—	**
Glasgow	A—B	—	—	*
	A—C	—	—	—
	A—D	—	—	—
	B—C	—	—	**
	B—D	—	—	**
	C—D	—	—	—
Birmingham	A—B	—	—	—
	A—C	—	—	—
	A—D	—	—	—
	B—C	—	—	—
	B—D	—	—	—
	C—D	—	—	—
Newcastle	A—B	—	—	—
	A—C	*	—	—
	A—D	—	—	—
	B—C	—	—	*
	B—D	—	—	**
	C—D	—	—	—
London	A—B	—	—	—
	A—C	—	—	—
	A—D	—	—	—
	B—C	—	—	—
	B—D	—	—	—
	C—D	—	—	—

† For the correlation of Table 4 data with Table 5 averages (n=20), r=0.910. If the Glasgow data are excluded (n=16), r=0.840.

††A single asterisk (*) indicates rejection of the null hypothesis with $P<0.05$; two asterisks (**) indicate rejection of the null hypothesis with $P<0.01$; and a dash (—) signifies $P>0.05$.

(*b*) **Pooled Data**

(1)	(2)	(3)	(4)	(5)
Liverpool	A+B—C+D	—	—	See Table 7
Glasgow	A+B—C+D	—	—	
Birmingham	A+B—C+D	—	—	
Newcastle	A+B—C+D	—	—	
London	A+B—C+D	—	—	

Whereas the earlier tests on recognition and satisfaction of flavour yielded very few significant differences (represented by asterisks) in opinions between steak groups, the tests on overall acceptability do lead to the discovery of a number of differences between steak groups. For example, using Newcastle data, it is unlikely that respondents could recognise a difference of flavour between barley beef (B) and mature beef (D), nor apparently do the flavours of these two steak types give different degrees of satisfaction (Table 6, col. (3) and (4) respectively). The rating of group B on overall acceptability, however, is significantly greater than that of group D (two asterisks in Table 6 col. (5)).

Putting the same result in a rather different way, the average scores for B and D for the question on recognition of intensity of flavour are 3.0 and 2.9 respectively (Table 3); and for the question on satisfaction with flavour the scores are 7.3 and 7.0 respectively (Table 4). These differences are not sufficiently large for us to say with any certainty that the two steak groups are recognisably different, bearing in mind the sample sizes involved. On overall palatability, though, the average scores for the two steak types are 7.6 and 6.6 respectively—a sufficiently large difference not likely to have occurred by chance.

The inference, that the barley beef group is preferred when all characteristics of the two types of meat are taken into account, cannot be due to any marked extent to its better flavour for the reasons mentioned. Nor is it likely that the two meat groups differed consistently in leanness for reasons already given. The only measurable characteristic which, it is likely, could have distinguished the two groups is the degree of tenderness recorded in Table 2. The barley beef group was relatively tender, with a mean shear value of 24.2 compared with a value of 29.0 for the relatively tough mature beef group. On this basis one may conclude that the barley beef was preferred on grounds of tenderness rather than flavour, and that tenderness is the more important criterion for assessing eating quality.

It would be wrong, however, to give the impression that similarly straightforward inferences apply to more than a minority of the thirty statistical comparisons, for in reality there are some inconsistent results and others still which are inconclusive. For the twenty steak groups comprising the survey the average level of palatability is slightly higher for the more tender steaks, but the correlation of the score on acceptability (Table 5) with the average shear value is very weak.* Partly this is due to the generally lower scores given by Glasgow panels for reasons not

* $r = -0.181$ for $n=20$. The sign is correct but the correlation is not significant at the 5% level.

apparently connected with the qualities of the steaks, but even if the Glasgow data are excluded there remains only a poor relationship between overall acceptability and tenderness.†

In addition, the correlation is undoubtedly weakened by our inability to secure sufficiently large variations in tenderness between the steak groups distributed for sampling. For example, both in Glasgow and Newcastle the two groups of barley beef (A and B) did not produce significantly different mean shear readings for the samples retained for evaluation of tenderness. The same is true of the two groups of mature beefsteaks (C and D) in each of those cities; and to a lesser extent this same phenomenon applies in other cities as well.

Where the two barley beef, or mature beef, groups are not significantly different†† in terms of tenderness the data have been pooled together and White's test reapplied to the larger sample sizes. This procedure is not applicable to the Liverpool data, but for the other four cities complete or partial pooling is tenable and the significance tests on the reorganised steak groups are tabulated below.

TABLE 7. **Significance Tests on Pooled Data**

(1) City	(2) Steaks compared	(3) Overall Acceptability
Glasgow	A+B—C+D	**
Birmingham	A—B	—
	A—C+D	—
	B—C+D	—
Newcastle	A+B—C+D	**
London	A—B	—
	A—C+D	—
	B—C+D	—

The results remain inconclusive. In both Birmingham and London the three logically different steak groups (A, B and C plus D) are considered by respondents to be virtually identical in terms of degree of flavour and satisfaction of flavour, and in an overall sense in spite of variations in tenderness from one group to another. In those cities even larger differences in tenderness would have been needed in order to achieve significant differences in overall opinions. In both Glasgow and Newcastle, on the other hand, the results suggest that the achieved variations in tenderness were sufficiently in favour of the barley beef to produce an overall preference for that category of meat.

The important factor to be stressed, though, is not that the mass market prefers barley beef to mature grass-finished meat but rather that tender meat is more acceptable than tough meat. In this particular survey it is perhaps unfortunate that the steaks from barley-fed animals were in most cases the more tender. If the grass-finished animals had yielded meat with similar tenderness characteristics there is no reason to suppose that it would have been less acceptable, and it may have proven

† $r = -0.328$ for $n = 16$. Not significant at the 5% level.
††At the 5% level.

more acceptable than the barley beef. In fact, the mature beef designated group C in Liverpool was the most highly rated of the twenty steak groups in terms of overall palatability (Table 5). It is true that respondents found its flavour to be very satisfactory, but it is also worth noting that it was at least as tender as most of the steaks derived from the barley beef.

The Influence of Other Variables

(*a*) *The Influence of Socio-Economic Class*

A fundamental difficulty in consumer research is that the investigator does not know for certain whether co-operators have interpreted the meanings of words on questionnaires in a similar way. Also, when co-operating panels are given free samples and are asked for their opinions, there exists a danger that responses will be more favourable than actually occur in more realistic market conditions in which consumers are required to pay.

In fact, all steaks distributed in this and the other surveys reported here were not offered free of charge. Steaks were sold to co-operating households with the objective of minimising the bias inherent in free distribution, though it must be admitted that a uniform charge was made irrespective of the quality characteristics of the meat and that the price was less than butchers would have charged in normal circumstances.

The problem of word interpretation can only be realistically overcome by enlarging the sizes of consumer panels. As this could not be done within the budget set for the survey, it was hoped that stratification of consumer panels on socio-economic criteria would provide a greater degree of control over this particular factor. To ease the problem of distribution, all steaks were channelled through co-operating retail butchers drawn from known socio-economic areas of each of the cities surveyed. This method increases the likelihood of achieving representative memberships of panels compared with some other methods, though it is not necessarily true that all members of the panel selected within the same socio-economic area have similar incomes, occupations or other characteristics which may influence their opinions. Consequently, when questionnaires are disaggregated according to whether respondent households are of socio-economic class (i) A. B or C or (ii) D or E some variations between steak groups are revealed, as below:

TABLE 8. **Percentage of Respondents in Socio-Economic Class A, B or C***

Steak Group	Liverpool	Glasgow	Birmingham	Newcastle	London
A	24	40	35	33	39
B	30	40	31	42	27
C	30	48	36	28	34
D	31	41	29	32	39

* The breakdown is made for respondents answering the question on overall palatability of the meat, and differs slightly for other questions because some questionnaires were not fully completed.

Given that each of the twenty panels consisted of only fifty households, or one hundred members, variations of these magnitudes between steak groups could have caused biased results in the foregoing analyses. To obviate this it is necessary to ask,

firstly, whether the two social groups (i) and (ii) do in fact tend to give different responses to the three major questions; and, secondly, if this is true then the whole body of data must be divided according to socio-economic group and the earlier analyses repeated separately for each social group.

The average score given by each social group on the question asking opinion of overall palatability is given in Table 9 and it is clear that the first category (social classes A, B and C) tends to give lower scores than social classes D and E for any single steak group, and in some cases the scores are substantially lower.

TABLE 9. **Average Score on Overall Acceptability*** (by social class)

Steak Group	Liverpool		Glasgow		Birmingham		Newcastle		London	
	(i)	(ii)	(i)	(ii)	(i)	(ii)	(i)	(ii)	(i)	(ii)
A	7.5	7.6	5.9	6.8	6.7	7.5	6.6	7.7	6.8	6.9
B	6.8	6.8	7.0	6.9	6.8	6.9	7.2	7.9	6.9	6.9
C	7.6	7.8	5.6	6.5	6.5	7.6	6.6	7.1	6.0	6.8
D	6.7	7.2	5.1	6.1	7.0	7.5	6.0	6.9	6.4	6.8

* Col. (i) is for social classes A, B and C, and Col. (ii) gives average score for social classes D plus E.

The major conclusions in the earlier parts of the report were dependent upon inferences from the significance tests summarised in Tables 6(*b*) and 7. When the same comparisons are made (using White's test) for each social group in turn, using pooled data where possible, significance tests can be made which are summarised in Table 10.

TABLE 10. (*a*) **Recognition and Satisfaction of Flavour by Social Class**

City	Steaks Compared	Recognition of Flavour		Satisfaction with Flavour	
		Social Class A, B, C	Social Class D, E	Social Class A, B, C	Social Class D, E
Liverpool	A+B—C+D	—	—	—	—
Glasgow	A+B—C+D	—	—	—	—
Birmingham	A+B—C+D	—	—	—	—
Newcastle	A+B—C+D	—	—	—	—
London	A+B—C+D	—	—	—	—

(*b*) **Overall Acceptability by Social Class**

City	Steaks Compared	Social Classes A, B, C	Social Classes D, E
Liverpool	A—B	—	—
	A—C	—	—
	A—D	—	—
	B—C	*	*
	B—D	—	—
	C—D	—	*
Glasgow	A+B—C+D	—	*
Birmingham	A—B	—	—
	A—C+D	—	—
	B—C+D	—	—
Newcastle	A+B—C+D	—	**
London	A—B	—	—
	A—C+D	—	—
	B—C+D	—	—

In Table 10(*a*) the columns of dashes (—) indicate that it is very unlikely that either social group could distinguish differences in flavour between barley beef (A+B) and mature beef (C+D); and that for each social group the indistinguishable flavours of the two types of meat were equally satisfying. It is therefore unlikely that the earlier results are distorted by inequalities in social class representation on the twenty panels.

In Table 10(*b*), however, whereas social classes A, B and C within any city appear to be equally satisfied with the overall characteristics of the meat types offered, the other social class category showed more significant preferences for the barley beef in comparison with mature beef (more asterisks in Table 10(*b*), last column).

Consequently Table 10(*a*) substantiates the conclusions drawn from Table 6(*b*). Table 10(*b*) in comparison with Table 7 yields similar inferences only for Birmingham and London. In the other cities surveyed, it is noticeable that the differences which are found in Table 7 are predominantly due to discrimination between steak groups by social classes D and E, whilst social classes A, B and C are more or less equally satisfied with the various meat types tested for palatability.

The reasons for this are not consistently clear, for although the latter social category responds to the question on overall acceptability with generally lower scores (see Table 9), there is in fact a high correlation in each city between the average scores given by the two social groups for the four steak groups*. This suggests that inferences based on Table 10(*b*) are not definitive, but that they are partly explicable in terms of the small sample sizes involved. Indeed, the correlation of average degree of tenderness with average score on overall palatability for each social group† separately is better than the same correlation for the aggregated data, confirming that tender steaks are more acceptable in an overall sense than tough meat.

(*b*) *The Influence of Cooking Methods*

The objective of the survey was to examine consumers' reactions to meat characteristics under normal domestic conditions rather than in the somewhat artificial environment typical of laboratory tasting panel conditions. In this respect it was obviously not possible to control the methods of preparation and cooking used by respondents. To ensure a degree of homogeneity co-operators were requested to fry or grill the steaks and were asked supplementary questions about the cooking techniques used. Thus, it was possible to discard questionnaires from the body of data where it was obvious that the meat had not been fried or grilled. All of the earlier analyses were made after discarding data which was unsatisfactory on that criterion.

Nevertheless, it is clear that even for the questionnaires included in the analysis variations in exact cooking methods still existed, and in particular it was felt that variations in the length of cooking time between steak groups could have biased the results obtained. Indeed, the percentage of steaks cooked for more than thirty

* Spearman's rank correlation coefficient, Rho, is 0.800, 1.000, 0.775, 0.991 and 0.993 for Liverpool, Glasgow, Birmingham, Newcastle and London respectively (n=4 for each city).

† Excluding Glasgow data for reasons mentioned earlier, for social classes A, B and C r= —0.656, and for social classes D plus E r = —0.276. (n=16 in each case).

minutes varies from one extreme of 6% to 29% between steak groups. Consequently, a two-fold classification of each steak group was made, separating questionnaires according to whether or not the cooking time exceeded thirty minutes, and the same procedure of significance testing was applied as was used earlier for the disaggregation by social class. The detailed results are not given here but it was clear that on this basis respondents who had cooked the steaks for more than thirty minutes tended to give similar answers to all three major questions on recognition and satisfaction of flavour, and on overall acceptability, as those respondents who had used less cooking time. Since co-operators were asked to fry or grill the sample steaks using their normal methods this result is not surprising. It simply implies that if consumers habitually cook their steaks for more or less than thirty minutes then their conception of flavour and eating quality will be influenced by that experience when they cook sample steaks in the same way.

General Summary

1. Consumer panels were unable to distinguish to a significant extent between the intensities of flavour which may have been present in the twenty steak groups offered for testing. On average, though, steaks from two- to three-year old beasts were recognised as having a slightly stronger flavour than barley beef steaks.

2. Co-operators in the survey showed no significant difference in the satisfaction derived from the flavours of the various types of meat used in the survey.

3. On average, consumers who believe that the flavour of meat is relatively strong prefer the flavour more than if they believe the flavour to be slight.

CHAPTER III

CONSUMER ATTITUDES TO LEANNESS

Of the three characteristics of meat quality—flavour, leanness and tenderness—analysed in this report the attribute of leanness was considered by butchers* to be the major criterion by which consumers judged quality over the shop counter.

To examine in greater detail consumer attitudes to leanness a two-fold approach has been employed. Firstly, an examination is made of group opinions of the eating qualities and acceptability of steaks possessing different degrees of leanness and fattiness; as with the survey of attitudes to beef flavour, each of some two thousand panel members was asked to record the degree of leanness of a sample steak† and to comment on the extent to which the observed characteristics of the meat were satisfactory. Using nine-point scales, panelists were required to assess (i) the degree of leanness of the steak and (ii) the degree of acceptability of that amount of leanness before cooking. Also, on eating the meat, they were asked to indicate their opinions of (iii) the acceptability of the amount of fat to lean and (iv) the overall palatability. Thus the first two questions relate principally to preferences for leanness or fatness of raw meat at the time of purchase, whilst the latter two questions are related specifically to eating quality.

Secondly, the co-operating housewives in each of the five cities were shown photographs of uncooked sample steaks possessing various proportions of fat and lean and were asked to record their preferences. This second approach, whilst it does not facilitate analysis of eating qualities, does serve as a check on the first part of the main survey and at the same time enables greater control to be exercised than can be achieved with samples of actual meat.

Measurement of Steak Characteristics

For the main survey of consumer reactions four hundred sample steaks, separated into four groups (A, B, C and D), were distributed in each city. By selection and trimming of steaks in comparison with prepared photographs the attempt was made to achieve uniformity of the ratio of fat to lean within each group and differences in the fat/lean ratio between groups in each city. At the same time it was hoped that carcase selection would produce significant differences in tenderness between steak groups in order to analyse the relative importance of leanness and tenderness to overall acceptability.

Randomly selected samples of steaks from each of the twenty groups of meat were retained for laboratory evaluation of leanness and tenderness. Various techniques for measuring the degree of fattiness or leanness exist, and the indicator used in this analysis is the ratio of the area of fat to the total face area. From a prepared photograph of each retained steak this measure was computed, using a planimeter,

* G. H. Brayshaw, E. M. Carpenter and R. A. Phillips, op.cit. pp. 12—13.
† For this survey only sirloin steaks were used.

and for each steak group the average fat percentage is shown in Table 11 together with the average shear estimate of tenderness as determined by the Warner Bratzler instrument.

TABLE 11. **Mean Characteristics of Steak Groups**

City	Steak Group	Percent Fat	Av. degree of Tenderness
Liverpool	A	21.7	23.4
	B	29.0	22.8
	C	35.5 } 37.4	22.7
	D	39.2 }	27.2
Glasgow	A	30.0	14.3
	B	34.3	15.4
	C	43.0 } 44.2	14.8
	D	45.4 }	15.3
Birmingham	A	28.2	26.1
	B	35.3 } 36.0	21.4
	C	36.6 }	18.9
	D	43.6	19.4
Newcastle	A	29.2 } 30.4	16.7
	B	31.5 }	18.5
	C	40.7	17.7
	D	47.6	18.0
London	A	23.3	21.0
	B	27.9 } 29.7	20.1
	C	31.5 }	25.2
	D	42.8	14.7

Initially, the four groups of steaks distinguished by their fat percentages, retain their identities for analysis, and groups are not pooled. On the basis of planimeter measurements of sample steaks, however, it should be noted that in each city there are two groups of steaks which cannot be considered to have different fat percentages. In Table 11, for example, the average fat percentage of group C in Liverpool is less than for group D based on the analysis of samples from each group, but the difference could easily have arisen by chance; and it may be more logical to assume that the two groups were similar in terms of their fat/lean ratio, with a mean fat percentage of 37.4. Similarly, for other cities where the average fat percentage of steak groups are not significantly different the groups are bracketed together in Table 11. In reality, then, it is more likely that there were three and not four groups per city, each with a significantly different* proportion of fat. Nevertheless, a considerable range of leanness has been achieved between groups of steaks in any one city, and also overall, from comparatively lean (21.7% fat for group A in Liverpool) to very fatty steaks (47.6% fat for group D in Newcastle).

RECOGNITION OF VARIATIONS IN LEANNESS

Since it can only be established whether consumers prefer fatty or lean meat if they can in fact recognise variations in the degree of leanness, the first question asked co-operators to describe their opinions of the fattiness of the sample steak. For this,

* $P < 0.05$.

a scale was used which offered nine alternative descriptions ranging from "extremely fat" (1 point) to "extremely lean" (9 points), and the average response for each steak group is given in Table 12.

TABLE 12. (*a*) **Recognition of Leanness (Average Scores)**
(maximum = 9, minimum = 1)

Steak Group	Liverpool No. of Steaks	Liverpool Av. Score	Glasgow No. of Steaks	Glasgow Av. Score	Birmingham No. of Steaks	Birmingham Av. Score	Newcastle No. of Steaks	Newcastle Av. Score	London No. of Steaks	London Av. Score
A	100	5.2	82	5.4	92	5.9	74	5.9	111	5.9
B	112	4.9	110	4.5	85	5.4	88	5.3	106	4.5
C	104	4.0	107	4.1	72	4.3	110	4.2	92	4.2
D	80	3.4	96	3.9	73	3.6	88	3.4	78	3.2

(*b*) **Percentage of Panel Scoring 8 or 9***

Steak Group	Liverpool	Glasgow	Birmingham	Newcastle	London
A	20.0	26.8	33.3	27.0	39.6
B	17.0	8.2	25.9	22.7	9.4
C	11.5	9.3	9.7	10.0	9.8
D	1.3	11.5	1.4	6.8	1.3

* That is, percentage of respondents in each panel believing the steak to be "very lean" or "extremely lean".

The average assessment of leanness in each city is correctly ordered, with the leanest group (A) accorded the highest score and the fattiest steak group (D) given the lowest score. Overall, as well, for the twenty steak groups distributed in the survey, those with the lowest measured proportions of fat (Table 11) are recognised as being significantly leaner than those with high laboratory measurements of fat area†.

As with the flavour survey, the distribution of scores for each steak group is compared with the equivalent distribution for each other steak group in the same city to determine whether or not it is likely that small differences in assessments between steak groups could have arisen by chance. Applying White's non-parametric test, the thirty significance tests are summarised in Table 13. There a pair of asterisks (**) indicates that the different assessments of leanness of the two steak groups compared are almost certainly not due to chance factors. Also, a single asterisk (*) strongly indicates that the general public is able to distinguish by sight between the different degrees of leanness of two steaks; whilst a dash (—) suggests that consumers were unable to differentiate between two groups, either because the two steak groups possessed similar degrees of leanness or because actual differences in leanness were not detectable by the human eye.

† The correlation of average score in Table 12 with average fat percentage in Table 11 yields r = —0.814 (n=20).

TABLE 13. **Significance Tests on Recognition of Leanness††**

Steak Groups Compared	Liverpool	Glasgow	Birmingham	Newcastle	London
A—B	—	**	—	—	**
A—C	**	**	**	**	**
A—D	**	**	**	**	**
B—C	**	*	**	**	—
B—D	**	**	**	**	**
C—D	*	—	—	**	**

†† ** indicates null hypothesis rejected with $P<0.01$.
* indicates null hypothesis rejected with $P<0.05$.

The comparison between groups A and B in Newcastle fails to reveal significantly different assessments of leanness, and the same is true for groups C and D in Glasgow, and B and C in London. In all of those cases, however, laboratory assessments of leanness were also similar. Only in three cases were respondents unable to distinguish between the fat proportions of steak groups which did in fact possess significantly different degrees of fattiness. For the great majority of the thirty comparisons panels were able to detect significant variations in leanness, and in each city the ordering of steak groups according to leanness was also correct (Table 12). Indeed, it is noteworthy that respondents were able to distinguish correctly between steaks whose fat cover differed by only four or five per cent: for example, in Glasgow, the average fat percentages of steak groups A and B were 30.0 and 34.3 respectively but the panels accorded a significantly higher rating to group A on the leanness scale, and similar situations apply in the other cities as well. As a general conclusion it can be stated that when consumers are offered steaks with various fat/lean proportions they are able to recognise those differences and are therefore in a position to make a rational choice in the butcher's shop according to their preferences for leanness or fatness.

PREFERENCES FOR LEANNESS: UNCOOKED STEAKS

It has been established that consumers are able to differentiate accurately between steaks with different proportions of fat and lean even when the differences are small. To determine whether or not there is an equally clear pattern of preferences for the leaner or fattier steak groups panelists recorded on a second nine-point scale the extent to which they were satisfied with the amount of fat to lean before cooking the meat. The scale offered nine alternative descriptions varying from "liked extremely" (9 points) to "disliked extremely" (1 point) and was to be completed before cooking the steak.

TABLE 14. (*a*) **Satisfaction with Fattiness of Uncooked Steaks (Av. Scores)** (maximum = 9, minimum = 1)

Steak Group	Liverpool No. of Steaks	Liverpool Av. Score	Glasgow No. of Steaks	Glasgow Av. Score	Birmingham No. of Steaks	Birmingham Av. Score	Newcastle No. of Steaks	Newcastle Av. Score	London No. of Steaks	London Av. Score
A	100	7.3	82	7.4	91	6.9	74	7.6	111	6.7
B	112	6.8	110	7.2	85	7.3	88	6.7	108	6.3
C	104	7.1	107	6.8	72	7.1	110	6.6	92	6.6
D	80	6.0	96	6.6	73	6.5	88	6.1	77	6.3

(*b*) **Percentage of Panel Scoring 8 or 9***

Steak Group	Liverpool	Glasgow	Birmingham	Newcastle	London
A	59.0	61.0	49.5	73.0	48.7
B	50.9	60.9	58.8	50.0	32.4
C	51.0	45.8	51.4	38.2	37.0
D	28.8	60.6	38.4	35.2	22.1

* That is, percentage of each panel liking the proportion of fat to lean "very much" or "extremely".

Thus, if consumers prefer lean meat in comparison with fatty meat the scores given to groups A, B, C and D respectively should be in descending order of magnitude; with the pattern of responses reversed if fattier steaks are preferred. In general, the average responses given in Table 14 confirm the first of these hypotheses with the fat/lean ratios of the leaner steaks being preferred (i.e. given higher scores) over the fattier steaks. Even though the pattern of responses in Birmingham and London is not entirely consistent with that general impression, there does exist high correlation between satisfaction with fatness on the one hand, and the measured degree of fatness on the other†.

Using White's test to assess the validity of differences between responses to the four steak groups in each city (Table 15), the only general inference which can be drawn from the data is that consumers are significantly more satisfied with the leanest categories (A and B) than with the fattiest class (group D). Thus, in Table 15 there are fewer asterisks than in Table 13, indicating that although panelists were able to detect quite small differences in fat proportions, these differences are not invariably important from the viewpoint of consumer acceptability. In Liverpool, for example, respondents were able to recognise a difference in the fat proportions of group B

TABLE 15. **Significance Tests on Preferences for Fattiness of Uncooked Steaks**

Steak Groups Compared	Liverpool	Glasgow	Birmingham	Newcastle	London
A—B	—	—	*	**	*
A—C	—	—	—	**	—
A—D	**	**	—	**	**
B—C	—	—	—	—	—
B—D	**	**	**	*	—
C—D	—	—	—	—	—

and group C—29.0% and 35.5% respectively—as indicated by two asterisks (**) in Table 13. In Table 15, however, the dash (—) indicates that there is no significant preference for one of these groups in comparison with the other.

A similar pattern of responses is evident for comparisons between other steak groups, both in Liverpool and in the other cities. Part of the explanation may be due to the fact that all consumers do not necessarily prefer very lean steaks but that some prefer meat with rather more fat, so long as the fat percentage does not reach the high levels typical of group D.

† For the 20 steak groups, the correlation of satisfaction with fatness (Table 14) with measured fat percentage (Table 11) gives $r = -0.717$, the negative sign indicating that satisfaction with the amount of fatness increases as the fat percentage decreases.

Secondly, a clear pattern of responses from city to city may have been obscured in Table 15 assuming that there were four distinct types in each city. It has already been noted that from the laboratory analysis it is only reasonable to suppose that there were three groups, differentiated by their fat proportions, in each of the five cities. Consequently, and where this is justifiable, data have been pooled for further significance tests relating to recognition and acceptability of fatness, and these are shown in Table 16.

In column (3) of that table panelists are shown to have been able to distinguish between the fatness of "lean", "intermediate" and "fat" steak groups in all but one of the fifteen comparisons made, confirming the inferences drawn from Table 13. In column (4), however, whilst it is generally true that the second comparison in each city—between the "lean" and the "fat" groups—shows a significant preference for the lean steaks, the other comparisons, between "lean" and "intermediate" or "intermediate" and "fat", do not reveal a clear set of inferences. This appears to be mainly accounted for by the fact that the terms "lean", "intermediate" and "fat"

TABLE 16. **Significance Tests on Pooled Data**
Uncooked Steaks

(1) City	(2) Steak Groups Compared	(3) Recognition of Fattiness	(4) Satisfaction with Fattiness
Liverpool	A—B	—	—
	A—C+D	**	**
	B—C+D	**	—
Glasgow	A—B	**	—
	A—C+D	**	**
	B—C+D	**	**
Birmingham	A—B+C	**	—
	A—D	**	—
	B+C—D	**	**
Newcastle	A+B—C	**	**
	A+B—D	**	**
	C—D	**	—
London	A—B+C	**	—
	A—D	**	**
	B+C—D	**	—

are not identical in each city. In this context, where there is a difference of about eight per cent or less between the fat proportions of "lean" or "fat" and "intermediate" steaks this is not of crucial importance in determining consumer choice; and if the proportions of fat differ by more than about 8 points the variation is sufficiently large for consumers in general to prefer the leaner steak group.

PREFERENCES FOR LEANNESS: COOKED STEAKS

As in the flavour survey, panelists were requested to fry or grill the sample steaks using their normal methods and to record their satisfaction with the observed degree of fattiness during eating on a nine-point scale identical with that used in the preceding section. Supplementary questions related to cooking methods and other

factors to facilitate classification of data and eliminate spurious results. And, additionally, since it was recognised that individual consumers would normally trim and discard excess fat during eating, and so alter the fat to lean ratio, respondents recorded whether no fat, a little fat, or a lot of fat remained on the plate after the meal.

The average score of acceptability of the fat to lean ratio after cooking is shown for each steak group in Table 17. Overall, these results are similar to those displayed in Table 14, and there is in fact a high correlation between satisfaction with fattiness before and after cooking†. However, the degree of acceptability of fattiness after

TABLE 17. (*a*) **Satisfaction with Fattiness of Cooked Steaks (Average Scores)** (maximum = 9, minimum = 1)

Steak Group	Liverpool No. of Steaks	Liverpool Av. Score	Glasgow No. of Steaks	Glasgow Av. Score	Birmingham No. of Steaks	Birmingham Av. Score	Newcastle No. of Steaks	Newcastle Av. Score	London No. of Steaks	London Av. Score
A	98	7.5	82	7.5	92	6.9	74	7.7	110	6.6
B	111	7.0	109	7.1	85	7.2	88	7.0	107	6.4
C	103	7.3	106	7.2	72	7.3	107	7.3	91	6.8
D	80	6.6	95	7.0	72	6.6	88	6.5	77	6.6

(*b*) **Percentage of Panel Scoring 8 or 9**

Steak Group	Liverpool	Glasgow	Birmingham	Newcastle	London
A	64.3	70.7	50.0	74.3	45.5
B	53.2	61.5	55.3	57.9	37.4
C	62.1	58.5	61.1	58.9	45.1
D	45.0	47.4	48.6	40.9	35.1

cooking is not so well related to the fat proportion of the raw steak as measured from photographs,†† because differences in acceptability between steak groups after cooking are less pronounced. Indeed, the application of White's test to comparisons between steak groups in each city reveals that, with few exceptions, the scores on acceptability of cooked steaks are only significantly different if the fat proportions of the groups compared were widely different before cooking (Tables 18(*a*) and 18(*b*)). Thus, in Table 18(*a*) the comparisons between group A (leanest group) and group D

TABLE 18. **Significance Tests on Preferences for Fattiness of Cooked Steaks**

(*a*) **Unpooled Data**

Steak Groups Compared	Liverpool	Glasgow	Birmingham	Newcastle	London
A—B	—	—	—	*	—
A—C	—	—	—	*	—
A—D	**	**	—	**	—
B—C	—	—	—	—	—
B—D	—	**	—	—	—
C—D	*	—	—	*	—

† The correlation between scores in Table 14(*a*) and Table 15(*a*) gives r = 0.871 (n=20).

†† The correlation of average score in Table 15(*a*) with average fat percentage in Table 11 gives r = —0.528 (n=20).

(*b*) **Pooled Data**

City	Steak Groups Compared	Significance of Difference
Liverpool	A—B	—
	A—C+D	*
	B—C+D	—
Glasgow	A—B	—
	A—C+D	**
	B—C+D	**
Birmingham	A—B+C	—
	A—D	—
	B+C—D	*
Newcastle	A+B—C	—
	A+B—D	**
	C—D	*
London	A—B+C	—
	A—D	—
	B+C—D	—

(fattiest group) yield significant differences† in acceptability in favour of the lean group in three of the five cities. And, with pooled data in Table 18(*b*), again there is a general tendency for significant preferences to be expressed for a lean group only if that steak group was markedly leaner than another at the time of distribution.

Apart from the revealed preference for the leaner of two steak groups with extremely different initial proportions of fat, no consistent pattern of conclusions emerges. In Newcastle, for example, steaks C and D with fat percentages of 40.7 and 47.6 were rated significantly different†† in terms of satisfaction, whilst in Birmingham, at the other extreme, steaks with fat percentages of 28.2 and 43.6 were not rated differently.

It must be stressed, though, that whilst control could be exercised over the fat to lean ratio of raw steaks at the distribution stage, no control existed over the quantities of fat discarded during eating. Consequently, given that more fat was removed from the fattier steaks during eating it is plausible that the above results may be due to panelists rating the steaks after the excess fat had been removed rather than taking quantity of excess fat into consideration. Indeed, it is noteworthy that consumers of the leaner steaks in each city tended to leave little or no fat on their plates whilst relatively large percentages of respondents consuming fattier steaks discarded a lot (Table 19).

For the five sets of steaks designated "group A", with fat accounting for between 22% and 29% of the total face-area, very few respondents discarded a lot of fat; but even for steaks classified as "group D" with an average fat proportion of between 39% and 48%, only between 22% and 33% of the respondents stated that they had

† Represented, as elsewhere in this report, by two asterisks (**) signifying $P<0.01$, or one asterisk (*) signifying $P<0.05$.
††$P<0.05$.

TABLE 19. **Fat Not Eaten**

Percentages of Respondents Leaving Different Quantities of Fat

Steak Group	Quantity of Fat left on plate	Percentages of Respondents				
		Liverpool	Glasgow	Birmingham	Newcastle	London
A	None	47.6	36.1	53.4	58.9	33.0
	A little	46.3	60.3	43.3	39.7	53.4
	A lot	6.1	3.6	3.3	1.4	13.6
B	None	34.0	29.0	51.2	43.2	37.2
	A little	53.2	44.7	36.9	43.2	43.6
	A lot	12.8	26.3	11.9	13.6	19.2
C	None	43.1	28.0	52.1	28.8	21.1
	A little	45.1	54.2	38.0	55.9	56.3
	A lot	11.8	17.8	9.9	15.3	22.6
D	None	28.2	23.3	34.7	35.2	34.6
	A little	42.3	43.4	43.1	40.9	39.8
	A lot	29.5	33.3	22.2	23.9	25.6

left a large amount of fat. This may be because panelists realised that they were part of an experiment and were thus reluctant to "spoil the results" by not consuming the whole steak; but, more likely, the result suggests that a proportion of consumers do in fact prefer steaks with a relatively high percentage of fat. In Birmingham and Newcastle this appears to be especially valid (even though small differences between values given in Table 18 are not particularly meaningful) supporting in some measure the findings presented in "Butchers and Their Customers"*. In those two cities 29% of butchers stated that they left at least a half of an inch of back fat on rump steaks, more than in the other three cities investigated. Overall, however, the conclusion that consumers do exhibit a preference for lean steaks stands, and in the context of mass-market requirements it is likely that consumers who prefer fattier meat represent a minority, both from the viewpoint of exercising choice within the butcher's shop and in terms of enjoyment derived during eating.

Acceptable Degrees of Fattiness and Market Requirements

It was considered inadvisable to attempt to determine acceptable levels of fattiness simply on the basis of each panelist consuming and commenting on a single sample steak. The foregoing analyses have enabled us to say that in general lean steaks are preferred in comparison with fat steaks, especially in the raw but also in the cooked state. Such procedures, though, do not enable us to say with any precision how lean steaks should be to gain widespread acceptance, nor do they facilitate a specific evaluation of the breakdown of market requirements for steaks with different proportions of fat.

To answer these and related questions, a separate experiment was devised. Each housewife, when collecting the two sample steaks for herself and her husband, was shown a prepared set of four photographs† of steaks with differing proportions

* op cit. p.12.

† See Appendix III.

of fat and lean and was asked which had most nearly what she considered the right amount of fat. The four photographs, labelled here A, B, C and D, showed steaks with 21.2, 26.2, 26.3 and 34.5 per cent of fat respectively, as measured by planimeter; and the question was answered by about two hundred panelists in each city, with the following results:

TABLE 20. **Market Requirements for Leanness**

Percentage of respondents preferring steak:

Steak	A	B	C	D	
Proportion of Fat (%)	21.2	26.2	26.3	34.5	No. of Respondents
City					
Liverpool	35.3	25.0	26.5	13.2	204
Glasgow	41.4	23.3	24.4	10.9	193
Birmingham	35.3	23.5	23.0	18.2	170
Newcastle	38.3	23.9	26.4	11.4	201
London	31.7	22.6	28.4	17.3	208
All five cities	36.4	23.7	25.8	14.1	976

Small differences in percentages within and between cities are not important in the context of applicability of sample results to the market at large. Consequently, it is reasonable to state that no more than about 15% of consumers in aggregate require steaks with more than approximately 30% of fat. Of the housewives interviewed half felt that steak B or C best fulfilled their preferences, suggesting a major demand for steaks with between 24% and 30% of fat; and just over one-third of consumers exhibited a preference for steak with less than about 24% fat cover.

To gauge better the extent of preferences for very lean and very fatty meat those housewives who chose steak A were asked whether they would prefer even less fat, and, if less, then whether they preferred steaks with no fat at all. Similarly, those who indicated a preference for steak D were asked whether they would prefer even more fat. The extent of these three extreme sets of preferences in the total market are indicated in Table 21.

TABLE 21. **Preferences for Very Lean and Very Fat Steaks**

Percentage of total respondents preferring:

City	(1) Less than 21.2% Fat	(2) No Fat at all (included in Col. (1))	(3) More than 34.5% Fat
Liverpool	11.8	4.9	2.0
Glasgow	13.0	6.7	2.1
Birmingham	12.9	4.7	1.2
Newcastle	16.4	9.0	2.0
London	12.5	3.8	1.9
All five cities	13.3	5.8	1.9

In aggregate then, about 85% of market requirements are likely to be expressed for steaks with between 20% and 35% fat coverage, and about 70% of consumers prefer to have between 20% and 30% of fat on the steaks they purchase.

Consumers' Criteria for Assessing Fattiness

During all of the analyses here the indicator of fattiness used has been the total area of fat as a percentage of the total face area of the steak. Although it has been shown (pages 26-28) that a good relationship exists between this measure and consumers' opinions of fattiness it was realised at the outset that some consumers may judge fattiness solely by the thickness of back fat, thus failing to take inter- and intra-muscular fat into account. The photographic survey therefore gave an opportunity to determine the extent of anomalies which may have arisen because of these dual standards for judging fattiness.

Co-operating housewives were consequently shown two more photographs of steaks, here labelled E and F (see Appendix III). Steak E possessed a total fat percentage of 26.2 compared with a value of 26.8% for steak F. Literally, then, steak F is fattier but it seems reasonable to suppose that the difference is not apparent to the human eye. When asked to determine which of the two has the larger proportion of fat to lean one would therefore expect that approximately equal percentages of respondents would choose each steak. It is noticeable, though, that steak E possesses more back fat than steak F: consequently if a large proportion of consumers judge fattiness on the basis of back fat alone one would expect that considerably more than 50% of respondents would judge steak E as being the fattier of the two.

The tabulation of replies from asking which of the two steaks possessed the greater proportion of fat to lean are shown in Table 22. Very few housewives in aggregate believed that the proportions of fat were identical and if these are excluded 52.8% believed E to be the fattier, whilst the remaining 47.2% selected steak F. With a sample size of 953 housewives this difference is not consistent with the hypothesis that back fat alone is the criterion of judgment used by consumers in general*.

Table 22. **Recognition of Fattiness**

City	Percentage of Respondents believing: Steak E to be the fattier	Steak F to be the fattier	No difference to exist
Liverpool	53.9	44.1	2.0
Glasgow	51.8	44.6	3.6
Birmingham	47.0	46.5	6.5
Newcastle	55.7	44.3	0
London	48.6	51.0	0.4
All five cities	51.5	46.1	2.4

For the individual city samples the same conclusion emerges. Even the Newcastle data, showing that 55.7% of respondents believed steak E to be the fattier of the two, does not substantiate the hypothesis that back fat alone is the sole criterion of judgment used by some consumers. For that to be true at least 57.1% of the sample of 201 housewives would have been required to choose steak E†.

* To accept the hypothesis at the 95% confidence level at least 53.3% of respondents would have been required to select steak E, ignoring the finite population correction.

† At the 95% confidence level, ignoring the finite population correction.

LEANNESS AND TENDERNESS

In order to assess the relative importance of leanness and tenderness in determining the enjoyability derived from frying and grilling steaks, respondents recorded their overall impressions of the sample steaks, again using a nine-point scale ranging from "liked extremely" (9 points) to "disliked extremely" (1 point). The average score for each steak group, using this criterion, is shown in Table 23.

TABLE 23. (*a*) **Overall Opinions on Steaks (Average Score)**

Steak Group	Liverpool No. of Steaks	Liverpool Av. Score	Glasgow No. of Steaks	Glasgow Av. Score	Birmingham No. of Steaks	Birmingham Av. Score	Newcastle No. of Steaks	Newcastle Av. Score	London No. of Steaks	London Av. Score
A	98	7.9	82	8.0	92	7.2	74	8.2	112	7.0
B	110	7.7	110	7.9	85	7.2	88	8.1	108	6.6
C	104	8.0	107	8.1	72	7.6	110	8.1	91	7.1
D	79	7.6	95	7.8	73	7.6	88	7.7	78	7.0

(*b*) **Percentage of Panel Scoring 8 or 9**

Steak Group	Liverpool	Glasgow	Birmingham	Newcastle	London
A	73.5	84.1	55.4	86.5	49.1
B	72.7	74.5	61.2	87.5	43.5
C	76.9	81.3	66.7	82.7	49.5
D	68.5	70.5	67.1	72.7	57.7

It is immediately noticeable that there is no longer a clear relationship between the degree of leanness of a steak group and assessed eating quality: for example, in only one city is the leannest steak group (A) given the highest score in Table 23(*a*). The correlation of laboratory estimates of fattiness with overall opinions for the twenty steak groups is very weak†, and this cannot be attributed to the possibility that average scores given for eating quality in London are consistently lower than for other cities††.

Indeed, application of White's test to comparisons of scores given on overall acceptability reveals that in all but two cases there are no significant differences between opinions of the palatability of the four steak groups in each city in turn. This is indicated by the predominance of dashes (—) in Table 24.

TABLE 24. **Significance Tests on Differences between Overall Eating Qualities of Steaks**

Steak Groups Compared	Liverpool	Glasgow	Birmingham	Newcastle	London
A—B	—	—	—	—	—
A—C	—	—	*	—	—
A—D	—	*	—	—	—
B—C	—	—	—	—	—
B—D	—	—	—	—	—
C—D	—	—	—	—	—

† The correlation coefficient, r = 0.180 (n=20).
††If London data are excluded r = —0.035 (n=16).

The only two comparisons which do suggest significant differences of opinions are those which compare steak groups A and D in Glasgow and A with C in Birmingham. In the first of these cases the preferred group, A, was very much leaner and slightly more tender than group D; and for the Birmingham comparison group C was preferred, in spite of its greater coverage of fat, presumably because the group was considerably more tender than group A. However, similar differences between steak groups in other cities with respect both to proportions of fat and degrees of tenderness, have not led to significantly different responses by panelists assessing the overall merits of the sample steaks.

Undoubtedly, part of the reason for the poor relationship between overall palatability and fattiness is due to the tendency observed earlier for individual respondents to remove excess fat from those steaks with a high initial proportion of fat. In fact, there is a rather better correlation of average score for overall palatability with the mean shear estimate of tenderness* than with the mean percentage of fat. Also, if an analysis is made of the effects of both fattiness and tenderness together in determining eating quality, it is found that fattiness is not a statistically significant determinant† whilst tenderness is a significant influence.

Various methods of expressing potential relationships between indicators of tenderness, fattiness and eating quality have been explored, incorporating the present data in regression models‡ but nearly all of these lead to the rejection of the hypothesis that fattiness influences acceptability. Again, though, this may be because panelists had not allowed for fat left on the plate in making an overall appraisal of the steak eaten.

The only method of analysis which has been used in which fattiness becomes a contributory determinant of overall acceptability is represented by a mathematical relationship which assumes that it is the interaction between tenderness and fattiness which determines palatability.** However, this "interaction effect" is not significant when data on all twenty steak groups are included in the analysis. When data for London are excluded the interaction effect does become significant,† suggesting that there may be grounds for supposing that consumers are indifferent as to whether they

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* The correlation of score in Table 23(*a*) with shear value in Table 11 gives r = —0.346. That is, acceptability increases as shear value—or toughness—falls, though the coefficient is not significant at the 5% level (n=20).

† For the linear regression model $Y = \alpha + \beta_1 X_1 + \beta_2 X_2$, where Y=average score for overall acceptability, X_1=average shear value and X_2=average percentage of fat, $Y = 5.644 - \underset{(0.026)}{0.058} X_1 + \underset{(0.014)}{0.024} X_2$, with standard errors in parenthesis.
With n=20, F=2.81 is not significant.

‡ For example, linear, semi-log and log-linear relationships, including and excluding London data. and using zero-one dummy variables to allow for variations in tastes from one city to another, The independent variables in all cases included the data given in Table 11 and the dependent variable has been data in either Table 23(*a*) or Table 23(*b*).

** Using the model $Y = \alpha + \beta_3(X_1X_2)$ where Y=average score on overall acceptability, and X_1X_2= (average shear value *times* average percentage of fat) ÷ 100, yields

$$Y = 7.884 - \underset{(0.069)}{0.039}(X_1X_2) \qquad (r = -0.133,\ n = 20).$$

eat a lean but relatively tough steak or a fattier but relatively tender steak. However, no valid reasons appear to exist for excluding part of the data on *a priori* grounds.

Overall, it is not possible to separate out in a meaningful way the influences of tenderness and leanness on eating quality because of the difficulty of knowing for certain the extent to which consumers have been assessing steaks after discarding excess fat during the meal. Assuming that steaks have in all cases been trimmed when more than the desired proportion of fat existed, it is not surprising that variations in acceptability are better related to other variables, such as tenderness, rather than to the initial proportions of fat which were believed to exist. More surprising, perhaps is the finding that relatively high percentages of co-operators were either "very" or "extremely satisfied" even with some of the very fatty, relatively tough steak groups.

The Effects of Extraneous Variables

(*a*) *The Influence of Socio-Economic Class*

The validity of the foregoing analyses and results, using correlations and White's test, depends upon the assumption that extraneous variables have had similar influences on any two or more sets of data which have been compared. For example, if a fatty group of steaks is sampled by a panel containing a high proportion of A, B and C-class panelists and a lean group of steaks is eaten by a panel comprising mainly D and E-class panelists, it is not immediately obvious whether any differences between the two sets of scores can be attributed to the "leanness" factor or to the "social class" factor. If, however, it can be shown that the social classes are approximately uniformly represented, or if it can be shown that social class has not been an important determinant of the score given, then such differences as occur are likely to be due to variations in leanness.

In fact, in this survey the two socio-economic groups are not equally represented on all twenty steak group panels, as shown in Table 25. In addition, there is a general tendency for social classes A, B and C to record lower scores on the nine-point scales than socio-economic group D plus E (Table 26).

TABLE 25. **Percentage of Respondents in Socio-Economic Class A, B or C***

Steak Group	Liverpool	Glasgow	Birmingham	Newcastle	London
A	29	63	32	35	35
B	31	43	33	41	35
C	35	39	42	27	31
D	27	47	23	25	32

* The breakdown is made here for respondents answering the question on overall acceptability of steaks and is similar but not identical for the other questions examined earlier.

† If London data are excluded the independent variable (X_1X_2) becomes significant and its coefficient retains the "correct" sign:

$$Y = 8.435 - \underset{(0.043)}{0.933}(X_1X_2) \qquad (r = -0.499,\ n = 16)$$

In both cases, though, it is variable X_1 rather than X_2 which "explains" most of the variation in Y.

TABLE 26. **Average Scores by Socio-Economic Class***

(*a*) Recognition of Leanness

Steak Group	Liverpool (i)	Liverpool (ii)	Glasgow (i)	Glasgow (ii)	Birmingham (i)	Birmingham (ii)	Newcastle (i)	Newcastle (ii)	London (i)	London (ii)
A	4.6	5.4	5.5	5.2	6.0	5.9	5.5	6.1	5.6	6.0
B	5.1	4.7	4.2	4.6	5.2	5.5	5.1	5.4	4.7	4.4
C	4.2	3.9	3.6	4.2	4.7	4.0	4.1	4.3	4.0	4.3
D	3.0	3.6	3.0	3.0	3.7	3.6	3.3	3.4	3.2	3.2

(*b*) Preferences for Leanness (Uncooked Steaks)

Steak Group	Liverpool (i)	Liverpool (ii)	Glasgow (i)	Glasgow (ii)	Birmingham (i)	Birmingham (ii)	Newcastle (i)	Newcastle (ii)	London (i)	London (ii)
A	7.4	7.3	7.4	7.4	6.7	7.0	7.0	7.9	6.9	6.6
B	6.4	7.0	7.1	7.4	6.8	7.6	6.8	6.6	6.2	6.4
C	6.9	7.2	6.0	7.2	7.1	7.1	5.8	6.8	6.5	6.7
D	5.6	6.1	6.6	6.6	6.2	6.5	5.7	6.2	6.6	6.1

(*c*) Preferences for Leanness (Cooked Steaks)

Steak Group	Liverpool (i)	Liverpool (ii)	Glasgow (i)	Glasgow (ii)	Birmingham (i)	Birmingham (ii)	Newcastle (i)	Newcastle (ii)	London (i)	London (ii)
A	7.5	7.4	7.5	7.8	7.6	6.9	7.3	8.0	6.9	6.5
B	6.8	7.1	7.0	7.4	7.0	7.3	7.2	6.9	6.7	6.3
C	7.1	7.5	7.2	7.7	7.3	7.3	6.6	7.6	6.6	7.0
D	6.4	6.8	7.0	6.9	6.9	6.5	5.7	6.8	6.8	6.5

(*d*) Overall Acceptability of Cooked Steaks

Steak Group	Liverpool (i)	Liverpool (ii)	Glasgow (i)	Glasgow (ii)	Birmingham (i)	Birmingham (ii)	Newcastle (i)	Newcastle (ii)	London (i)	London (ii)
A	7.5	8.1	7.9	8.3	7.3	7.3	8.1	8.2	7.1	6.9
B	7.8	7.6	7.5	8.2	7.1	7.2	8.0	8.2	7.0	6.4
C	7.7	8.1	7.9	7.7	7.2	7.9	7.8	8.2	7.5	6.9
D	8.2	7.3	7.8	8.1	7.8	7.5	7.0	8.0	7.1	6.9

* In all four tables the maximum score is 9 and the minimum is 1. Col. (i) is for socio-economic classes A, B and C, and Col. (ii) gives average score for social groups D plus E.

Using White's test and pooled data whenever possible, an estimate has been made of the significance of the differences between responses given by the two social groupings to each steak group in each city in turn. The detailed tabulations are not shown here, but for the question asking opinions of the degree of leanness it is evident that in all of the cases examined the differences between the responses given by the two social groups were likely to have arisen by chance: that is the average opinions given by the two social groupings for each steak group in Table 26(*a*) are not significantly different. Similar inferences are drawn with respect to the data given in Table 26(*b*) and 26(*c*) with the exception that in Glasgow steak group C plus D (pooled) has been given a significantly higher score by social grouping D plus E†. For the final question, asking overall opinions of the sample steaks, steak group A in Liverpool, B in Glasgow, and groups C and D in Newcastle were all found to be rated significantly more palatable†† by social grouping D plus E than by socio-economic grouping A, B and C. However, in no cases is it likely that these few

† $P<0.05$.

††In all four cases $P<0.05$.

discrepancies between ratings given by the two socio-economic groups could have led to different or more positive conclusions than have already been inferred in the earlier parts of this chapter.

(*b*) *The Influence of Cooking Methods*

For reasons given in the preceding chapter, a second supplementary analysis has been made, disaggregating all data according to length of time which the sample steaks were stated to have been fried or grilled. Again there were substantial variations between steak groups in the proportions of steaks which were cooked for more or less than thirty minutes and it was thought advisable to compare the ratings given by respondents, for each steak type in each city, disaggregating the data into two groups by length of cooking time. For this analysis it is only necessary to make the comparisons for the two questions relating to opinions of the leanness of cooked steaks and to overall opinions of the eating quality of cooked steaks.

For the first of these questions only steak group B plus C (pooled) in London is rated significantly differently by the two groups of respondents; and for the question concerned with overall palatability only steak group D in Newcastle is given a different assessment according to whether the steaks were cooked for more or less than thirty minutes. In an overall sense, then, it is not realistic to suppose that differences in the length of cooking time have been an important influence on the results already obtained.

GENERAL SUMMARY

1. Consumers in general are able to differentiate to fine limits between the degrees of leanness of sirloin steaks possessing different proportions of fat and lean.

2. In aggregate, seventy per cent of housewives prefer to purchase steaks with a twenty to thirty per cent fat cover and there appears to be but little demand for steaks with more than thirty-five per cent of fat.

3. In assessing fattiness housewives appear to take account of the total amount of fat present and not just the amount of back fat.

4. Consumers prefer to eat lean steaks but do not discriminate against steaks from which it is necessary to remove excess fat during eating.

5. Because of the latter factor consumers tend to judge the overall acceptability by the presence of other characteristics such as tenderness.

CHAPTER IV

CONSUMER ATTITUDES TO TENDERNESS

In the two preceding chapters it has been established that the ultimate determinant of assessments of eating quality of grilling and frying steaks is not flavour or leanness but that these characteristics are outweighed in importance by the tenderness of the meat. Insofar as consumers are able to modify, disguise or improve the apparent flavour of meat by varying the type or amount of garnish eaten with a meal, or reduce the degree of fattiness by discarding excess fat, this finding is perhaps not surprising. It is far less easy for the housewife to alter the tenderness characteristic, especially after the meat has been cooked and prepared.

Similarly, when buying the raw meat certain characteristics, such as colour, marbling and fattiness are amenable to visual appraisal. Other features of eating quality, including tenderness, cannot be assessed in the same way, and deductive reasoning from the presence or absence of other, visual, factors does not always provide a good indication of these. Certainly relatively few housewives profess to be good judges of the tenderness of meat in the retail shop*.

Selection and Evaluation of Steaks for Measuring Attitudes to Tenderness

The same general difficulties were experienced by the present team in attempting to procure topside steaks possessing varying degrees of tenderness for attitude measurement amongst a group of two thousand panelists. Although no synthetic or mechanical induction of tenderness either before or after slaughter was attempted, it was hoped that by using skilled buyers, by purchasing young intensively-fed and older grass-finished beasts and by hanging carcases for varying periods of time, sufficient variations in the tenderness of the topsides would be achieved to distribute four groups of steaks (A, B, C and D) each possessing a significantly different degree of tenderness, in each of the five cities in which the survey was undertaken. At the same time the attempt was made to achieve uniformity of fattiness amongst all steaks distributed.

The tenderness of random samples of cold cores from each steak group was measured, as before, by the Warner Bratzler instrument after preparing and cooking the steaks under laboratory conditions, and similar cores were appraised by tasting panels at the same time. Although reasonable agreement exists between the two methods of measurement**, the average Warner Bratzler estimate for each group is used throughout the following analysis as the quantitative measure of tenderness.

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* Evidence to support this is to be published in a separate report on consumers' meat shopping habits.

** Other evidence also suggests fairly good agreement between subjective estimates and machine estimates of tenderness. See F. M. O'Carroll and F. Hill, *Relationship between Warner Bratzler shear values and subjective tenderness*, paper read at Symposium on Instrumentation as a Guide to Meat Quality, Cambridge, June, 1966.

The basic characteristics of each steak group are summarised in Table 27 and show a range from 14.4 lb. to 31.8 lb. in the shear resistance of cores. In any one city, however, statistical analysis of the core data suggests that two or three of the four steak groups did not possess significantly different mean shear readings. For part of the analysis data relating to these groups (bracketed in Table 27) are therefore pooled.

TABLE 27. **Mean Characteristics of Steak Groups Analysed**

City	Steak Group	Type	Days Hung	Average Shear (lb.)	
Liverpool	A	Barley Beef	9	21.7	21.9 "Tender"
	B	2½ years	9	22.1	
	C	2½ years	3	24.2	24.9 "Tough"
	D	Barley Beef	3	25.8	
Glasgow	A	Barley Beef	9	21.7	21.9 "Tender"
	B	2½ years	9	22.1	
	C	2½ years	3	24.2	24.9 "Tough"
	D	Barley Beef	3	25.8	
Birmingham	A	Barley Beef	9	24.0	
	B	2½ years	3	25.9	25.5 "Tender"
	C	Barley Beef	3	26.5	
	D	2 years	3	29.0	"Tough"
Newcastle	A	Barley Beef	9	14.4	"Tender"
	B	2 years	2	16.6	
	C	2½ years	2	18.1	17.8 "Tough"
	D	2 years	9	18.7	
London	A	2 years	11	22.2	
	B	2 years	4	22.3	22.5 "Tender"
	C	2 years	11	22.9	
	D	2½ years	4	31.8	"Tough"

The design of the questionnaire followed the same procedure as that described in the two preceding chapters. Firstly, each panelist was (i) to record his or her estimate of the tenderness of the sample steak at the time of eating on a nine-point scale; and using similar scales of merit co-operators were asked (ii) to record the extent to which they were satisfied with the observed degree of tenderness and (iii) to indicate their appreciation of the overall palatability of the steak when eaten.

SUBJECTIVE RECOGNITION OF TENDERNESS

The nine-point scale by which co-operators judged the tenderness of the steaks comprised descriptions ranging from "extremely tender" (nine points) to "extremely tough" (one point), and for the usable returns the mean score for each steak group is given in Table 28(*a*). In all cases the most tender steak group in each city is accorded the highest score and in four of the five cities the second most tender has the next highest score. Similarly, in Table 28(*b*) those steak groups which were rated as the more tender in the laboratory were thought to be either very tender or extremely tender by greater proportions of respondents. Finally, using pooled data, the average results in Table 28(*c*) indicate that the tender group in each city is rated more tender by panelists on the basis of the subjective scale.

TABLE 28. (*a*) **Recognition of Tenderness (Average Scores)**
(maximum = 9, minimum = 1)

Steak Group	Liverpool		Glasgow		Birmingham		Newcastle		London	
	No. of Steaks	Av. Score	No. of Steaks	Av. Score	No. of Steaks	Av. Score	No. of Steaks	Av. Score	No. of Steaks	Av. Score
A	85	7.0	85	6.0	68	6.5	96	6.7	98	5.2
B	79	6.1	84	5.0	78	5.6	101	6.5	84	5.0
C	92	5.3	103	3.7	71	6.4	90	6.4	97	4.5
D	70	5.4	118	5.4	81	5.6	96	6.3	93	4.4

(*b*) **Percentage of Respondents Scoring 8 or 9***

Steak Group	Liverpool	Glasgow	Birmingham	Newcastle	London
A	45.9	28.2	23.5	44.8	16.3
B	24.1	21.4	15.4	37.6	11.9
C	20.6	6.8	25.4	36.7	6.2
D	17.1	12.7	17.3	36.5	10.7

(*c*) **Pooled Data****

Steak Type	Liverpool		Glasgow		Birmingham		Newcastle		London	
	Av. Shear	Av. Score	Av. Shear	Av. Score	Av. Shear	Av. Score	Av. Shear	Av. Score	Av. Shear	Av. Score
"Tender"	21.9	6.6	21.9	5.5	25.5	6.1	14.4	6.7	22.5	4.9
"Tough"	24.9	5.3	25.1	4.6	29.0	5.6	17.8	6.4	31.8	4.4

* That is percentage of respondents in each panel believing the steak to be "very tender" "or extremely tender".
** The mean shears are weighted by the proportional importance of each component steak group as measured by number of usable responses.

However, Table 28 does reveal a number of anomalies. In the first place the meat for Liverpool and Glasgow was procured from a joint consignment of carcases and the survey in those two cities was undertaken on the same day. One might therefore expect a similar pattern of scores for the two cities, but for three of the four steak groups, as well as with the pooled data, this result does not emerge. Instead, there is a tendency for Liverpool respondents to award higher scores than those in Glasgow‡, possibly because in Glasgow topside is not so frequently associated with frying or grilling as a culinary use but is more usually stewed or minced‡‡. Secondly and using average scores as a basis for judgments, Table 28 reveals that for London scores are lower than for Birmingham even though three of the four steak groups in London were apparently more tender. Similar anomalies can be shown to exist elsewhere in the table both within and between cities. Even so, there is a reasonably good correlation (inverse) of average score in Table 28(*a*) with the objective measure of tenderness in Table 27† indicating that subjective estimates of tenderness tend to rise as the shear resistance (toughness) of the meat falls. For the pooled data, though, whilst a similar correlation exists this is not statistically significant††.

‡ Using pooled data, White's test shows that the "tender" group is rated more tender in Liverpool with $P<0.01$, and the "tough" group is likewise rated significantly less tough by the Liverpool panelists, again with $P<0.01$.
‡‡G. H. Brayshaw, E. M. Carpenter and R. A. Phillips, op. cit. Table 9, p. 15.
† The correlation coefficient $r = -0.509$ ($n=20$, $P<0.05$).
††$r = -0.574$ ($n=10$ N.S.).

Finally, White's non-parametric test is used to determine the statistical significance of differences between responses for the four steak groups in each city in turn, and the results are shown in Table 29. Excepting London, there was not a great

TABLE 29. **Significance Tests for Recognition of Tenderness**

(*a*) **Unpooled Data**

Steak Groups Compared	Liverpool	Glasgow	Birmingham	Newcastle	London
A—B	**	**	*	—	—
A—C	**	**	—	—	—
A—D	**	*	*	—	*
B—C	*	**	*	—	*
B—D	—	—	—	—	—
C—D	—	**	*	—	—

(*b*) **Pooled Data**

"Tender"—"Tough"	**	**	—	—	—

difference in the measured degree of tenderness between the most tender and least tender group of steaks in any single city; consequently it is not surprising that the statistical test should reveal that all four steak groups in Newcastle were judged to have a similar degree of tenderness. In the other four cities, however, the most tender group as determined by the Warner Bratzler instrument is rated significantly more tender on the subjective scale than the least tender group (Table 29(*a*), comparison of group A with group D), although many of the intra-city anomalies which are exhibited in Table 28 are not removed by application of the test†.

The intra-city analyses show in general that consumers are able to identify differences in tenderness when the shear resistance differs by about five pounds, though it must be stressed that this pattern is not consistently observable. However, for the inter-city analysis, with the opportunity to examine reactions to steaks within a larger range of shear resistance, it has been shown that subjective assessments of tenderness increase as the measured degree of toughness decreases. Even so it is noticeable that those steak groups with a recorded mean shear value of twenty pounds or less have not been rated as "very tender" or "extremely tender" by more than a substantial minority of respondents; though this reluctance to record extreme scores, which is typical of many consumer surveys, may give a falsely pessimistic picture of consumers' everyday attitudes.

THE CONTRIBUTION OF TENDERNESS TO PALATABILITY

Average reactions by panelists to the second question, asking the extent to which consumers were satisfied with the observed tenderness of the steak, are recorded in Table 30. Again, a nine-point scale was used for responses with a range of descriptions from "liked extremely" (9 points) to "disliked extremely" (1 point).

† For example, both in Liverpool and Glasgow steak group A is rated significantly more tender than group B even though the difference in shear resistance is only 0.4 lb., whilst in London a difference of 8.9 lb. in the shear resistance of steak groups C and D has not led to significantly different ratings on the nine-point scale.

TABLE 30. (*a*) **Consumer Satisfaction with Tenderness (Average Scores)**
(maximum = 9, minimum = 1)

Steak Group	Liverpool No. of Steaks	Liverpool Av. Score	Glasgow No. of Steaks	Glasgow Av. Score	Birmingham No. of Steaks	Birmingham Av. Score	Newcastle No. of Steaks	Newcastle Av. Score	London No. of Steaks	London Av. Score
A	84	7.2	81	6.0	64	6.8	95	7.0	90	5.6
B	74	6.6	75	5.0	72	5.8	100	6.9	80	5.6
C	81	6.0	84	3.7	68	6.7	90	6.7	84	4.9
D	65	6.3	112	5.4	73	6.0	95	6.7	79	4.9

(*b*) **Percentage of Respondents scoring 8 or 9***

Steak Group	Liverpool	Glasgow	Birmingham	Newcastle	London
A	63.1	37.0	40.6	46.3	22.2
B	35.1	33.3	22.2	48.0	21.3
C	28.4	16.7	32.3	45.6	11.9
D	43.1	26.8	24.7	43.2	20.3

(*c*) **Pooled Data (Average Scores)****

Steak Type	Liverpool Av. Shear	Liverpool Av. Score	Glasgow Av. Shear	Glasgow Av. Score	Birmingham Av. Shear	Birmingham Av. Score	Newcastle Av. Shear	Newcastle Av. Score	London Av. Shear	London Av. Score
"Tender"	21.9	6.9	21.9	5.5	25.5	6.4	14.4	7.0	22.5	5.4
"Tough"	24.9	6.1	25.1	4.7	29.0	6.0	17.8	6.8	31.8	4.9

* Percentage of respondents liking the degree of tenderness "very much" or "extremely".
** The method of weighting is the same as for Table 28(*c*).

The pattern of scores in Table 30(*a*) and (*c*) is very similar to that shown in the corresponding parts of Table 28 indicating that the more tender steaks gave greater eating satisfaction than those steak groups which were thought to be relatively tough†. In each of the five cities the steak group identified as the most tender by the Warner Bratzler instrument has been accorded a higher score than that group of steaks measured as the toughest; and, similarly, after pooling of data, the "tender" group is in each case rated more satisfactory than the "tough" group. Consequently, it is not surprising that an inverse correlation exists between the objective estimate of toughness in Table 27 and the mean value of eating satisfaction in Table 30, though for the pooled data the correlation is again not significant††.

Again, anomalies exist in Table 30(*a*) both between cities and within three of the five cities' data, though with panel sizes of less than one hundred in most cases, small differences in mean scores may not be meaningful from the viewpoint of general applicability of the conclusions drawn. To examine the statistical significance of differences which exist between the four sets of responses for each city, White's test is applied to all paired comparisons of steak groups in the same way as before, and the results are summarised in Table 31.

† Correlating average score in Table 30(*a*) with the corresponding table of scores in Table 28(*a*) gives r=0.964 (n=20). An identical result is obtained from the correlation for pooled data in Tables 30(*c*) and 28(*c*) with n=10.
††For the unpooled data r = —0.459. $P<0.05$ with n=20;
and for pooled data r = —0.426 with n=10.

TABLE 31. (*a*) **Significance Tests on Satisfaction with Tenderness Unpooled Data**

Steak Groups Compared	Liverpool	Glasgow	Birmingham	Newcastle	London
A—B	**	—	*	—	—
A—C	**	**	—	—	—
A—D	**	—	*	—	—
B—C	—	**	*	—	—
B—D	—	—	—	—	—
C—D	—	**	*	—	—
		(*b*) **Pooled Data**			
"Tender"—"Tough"	**	**	—	—	—

It is found that no consistent inferences can be drawn from the analyses. Whereas it was determined that consumers can recognise difference in the degree of tenderness of steaks with shear differences of approximately five pounds or more (see Table 29), variations of this size are not generally found to be important from the viewpoint of the satisfaction derived in eating the steak in Table 31. On the other hand, some of the comparisons in Table 31 suggest that consumers are significantly more satisfied with the tenderness of a steak even though it may be only marginally more tender than another sample. Once more, though, it must be stated that in each city, with the exception of London, the four steak groups distributed were not widely different in terms of shear resistance. When this range is increased by considering responses to all twenty steak groups, significant differences in the satisfaction derived are found between the more and less tender groups, and consumer satisfaction is found to be significantly correlated with the laboratory estimate of tenderness, as already mentioned.

Tenderness and Overall Palatability

The third question, asking co-operators to assess the eating quality of the steak after taking all attributes into account was again answered on a nine-point scale, with alternative responses ranging from "liked extremely" to "disliked extremely". Since efforts were made to prevent large variations in the degree of fattiness from one steak group to another, variations in responses between steak groups should logically reflect inter-group variations in observed tenderness and flavour. Already, though, it has been determined that differences in flavour between only two steak groups are not important determinants of subjective assessments of overall eating quality. Consequently, answers to the question can be expected to be very similar to those forming the basis of the preceding section. This in fact does occur, and the scores for this question (Table 32) are closely correlated with those in Table 30†, suggesting that when the degree of tenderness is relatively satisfactory then the overall eating quality of the steak is also regarded as relatively high.

† The correlation of average score on overall acceptability with average score on the satisfaction of tenderness alone gives r=0.938 for the twenty steak groups and r=0.948 for the pooled data (n=10).

TABLE 32. (*a*) **Overall Acceptability of Steaks (Average Scores)**
(maximum = 9, minimum = 1)

Steak Group	Liverpool No. of Steaks	Liverpool Av. Score	Glasgow No. of Steaks	Glasgow Av. Score	Birmingham No. of Steaks	Birmingham Av. Score	Newcastle No. of Steaks	Newcastle Av. Score	London No. of Steaks	London Av. Score
A	85	7.5	86	6.7	67	7.4	96	7.3	97	6.2
B	79	6.8	83	5.8	76	5.9	100	7.2	84	5.9
C	90	6.4	103	5.1	71	7.0	89	7.2	96	5.3
D	70	6.5	118	6.5	81	6.3	96	7.3	93	5.2

(*b*) **Percentage of Respondents scoring 8 or 9**

Steak Group	Liverpool	Glasgow	Birmingham	Newcastle	London
A	67.1	45.4	55.2	50.0	27.8
B	40.5	38.6	27.6	56.0	21.4
C	36.7	16.5	42.2	48.3	16.7
D	40.0	31.4	27.2	52.1	20.4

(*c*) **Pooled Data (Average Scores)**

Steak Type	Liverpool Av. Shear	Liverpool Av. Score	Glasgow Av. Shear	Glasgow Av. Score	Birmingham Av. Shear	Birmingham Av. Score	Newcastle Av. Shear	Newcastle Av. Score	London Av. Shear	London Av. Score
"Tender"	21.9	7.2	21.9	6.3	25.5	6.7	14.4	7.3	22.5	5.8
"Tough"	24.9	6.4	25.1	5.8	29.0	6.3	17.8	7.2	31.8	5.2

Likewise, there is a good association between the subjective measure of tenderness (Table 28) and the values recorded in Table 32†, and a fairly good relationship between the degree of tenderness as measured by the Warner Bratzler instrument and assessments of overall eating quality††.

A final application of White's test, to examine the significance of differences between responses for the steak groups in each city, leads to the tabulations in Table 33. Again, it is not unexpected that respondents in Newcastle were unable to detect

TABLE 33. (*a*) **Significance Tests on Overall Satisfaction**
Unpooled Data

Steak Groups Compared	Liverpool	Glasgow	Birmingham	Newcastle	London
A—B	**	—	**	—	—
A—C	**	**	—	—	**
A—D	**	—	**	—	**
B—C	—	*	**	—	—
B—D	—	—	—	—	—
C—D	—	**	**	—	—

(*b*) **Pooled Data**

"Tender"—"Tough"	**	*	*	—	*

† r=0.962 for the twenty steak groups and r=0.977 for the pooled data (n=10).
††The correlation of average shear in Table 27 with average score on overall acceptability gives r = —0.548 for the twenty steak groups (P<0.05) and r = —0.492 for the pooled data (N.S.).

meaningful differences in the palatability of the four steak types offered in view of the small differences in shear resistance separating them. In three of the other four cities, however, the most tender steak group was significantly preferred over the least tender group, and using pooled data, the tender group of steaks was rated significantly more palatable than the tough group in all four of these cities.

Logically, if flavour is not an important determinant of subjective assessments of overall eating quality the results in Tables 32 and 33 should conform with those in Tables 30 and 31 since both sets then reflect attitudes towards tenderness. In general, the two sets of results are consistent with this hypothesis. For London steak group A is preferred over groups C and D in an overall sense (Table 33) but the three groups were not considered significantly different with respect to the degree of satisfaction derived from tenderness alone (Table 31): this is the only case which diverges from the consistent pattern, but since all three groups of meat were derived from relatively mature beasts it is not valid to assume that the overall preference for group A results from its superior flavour.

In conclusion, then, it appears that steaks with a shear resistance of about twenty-two pounds or less are likely to be rated very satisfactory or extremely satisfactory by more than fifty per cent of consumers (Table 32(*b*)), and there is little reason to suppose that the presence of a mature beef flavour can compensate markedly if the meat lacks tenderness.

The Effects of Socio-Economic Class and Cooking Methods on Recognition and Acceptability

In this as in the surveys analysed in the two previous chapters the breakdown of respondents by socio-economic class reveals differences in proportions from one steak group to another (Table 34). Insofar as socio-economic groups A, B and C tend to give lower scores on each of the three nine-point scales (Tables 35) this feature may be of importance from the viewpoint of the analyses undertaken in the preceding sections.

It is therefore necessary to examine whether the scoring patterns of the two social groups are significantly different and whether the conclusions reached earlier are likely to be erroneous on this account.

Table 34. **Percentage of Respondents in Socio-Economic Class A, B or C***

Steak Group	Liverpool	Glasgow	Birmingham	Newcastle	London
A	29	49	27	38	43
B	29	41	21	28	31
C	29	53	25	37	32
D	28	49	28	39	35

* The breakdown is made for those respondents answering the question relating to overall acceptability of steaks.

TABLE 35. **Average Scores by Socio-Economic Class***

(*a*) Recognition of Tenderness

Steak Group	Liverpool (i)	Liverpool (ii)	Glasgow (i)	Glasgow (ii)	Birmingham (i)	Birmingham (ii)	Newcastle (i)	Newcastle (ii)	London (i)	London (ii)
A	6.3	7.4	5.5	6.5	6.2	6.7	6.4	6.9	5.1	5.2
B	5.7	6.2	4.8	5.1	4.9	5.7	6.1	6.6	4.8	5.1
C	4.5	5.6	3.5	3.9	5.7	6.6	5.5	6.9	4.0	4.6
D	5.2	5.5	5.2	5.7	5.1	6.0	5.9	6.7	4.1	4.6

(*b*) Preferences for Tenderness

Steak Group	Liverpool (i)	Liverpool (ii)	Glasgow (i)	Glasgow (ii)	Birmingham (i)	Birmingham (ii)	Newcastle (i)	Newcastle (ii)	London (i)	London (ii)
A	7.3	7.7	6.0	6.9	6.3	7.0	6.7	7.2	5.3	5.8
B	6.5	6.6	5.0	5.7	4.9	6.0	6.7	6.9	5.2	5.8
C	5.4	6.5	3.7	5.3	5.7	7.0	6.0	7.1	4.2	5.1
D	6.2	6.3	5.7	6.5	5.0	6.5	6.1	7.2	4.2	5.5

(*c*) Overall Acceptability

Steak Group	Liverpool (i)	Liverpool (ii)	Glasgow (i)	Glasgow (ii)	Birmingham (i)	Birmingham (ii)	Newcastle (i)	Newcastle (ii)	London (i)	London (ii)
A	7.6	7.7	6.4	7.0	7.1	7.5	7.2	7.3	5.9	6.4
B	6.6	6.8	5.6	5.9	4.9	6.2	6.8	7.4	6.2	5.9
C	5.8	6.6	4.7	5.5	5.8	7.5	6.5	7.6	4.8	5.4
D	6.4	6.5	6.2	6.7	6.0	6.8	6.8	7.7	5.1	5.4

* Col. (i) records scores for socio-economic classes A, B and C, and Col. (ii) those of social grouping D plus E.

For each steak group in turn, the frequency distributions of responses given by the two social groupings on each question have been compared using White's test. The results for each question are very similar, and here attention is paid only to differences between responses for the question concerned with the overall acceptability of the meat. For Liverpool, Glasgow and London data, there is no significant difference between the ratings given by the two social groups for any of the four steak types. In Birmingham steak type B is rated significantly more acceptable by social grouping D plus E, whilst the same is true for steak groups B, C and D in Newcastle. In each of these cities, however, the percentage of respondents in each social grouping does not vary sufficiently from one steak group to another for those significant differences to affect the conclusions reached earlier. Indeed, the detailed analysis, disaggregating by social class, reveals that the general conclusions already reached apply with the same force to both social groupings.

A similar picture emerges when the average score for each social class on the three questions is correlated with the average shear resistance (Table 27). For example, for the question asking respondents to identify the degree of tenderness the correlation coefficient (r) is —0.538 for social grouping A, B and C and —0.486 for social grouping D plus E. And, for the final question seeking opinions of the overall palatability of the steaks the value of r is —0.550 and —0.484 for the two social groups respectively. There is some indication in these figures, though it does not

warrant emphasis, that social group A, B and C is better able to judge variations in tenderness; and, tentatively, it may be suggested that this is because wealthier consumers habitually eat more steak and are consequently more discriminating*.

Finally, the whole body of data has been disaggregated into two groups according to whether the respondent cooked the sample steak for more than thirty minutes or not. For most of the steak groups fewer than twenty questionnaires are available relating to opinions of steaks cooked for more than thirty minutes, and any detailed analysis based on such small samples could be very misleading in the context of applicability to the market for steaks in general. The use of White's test to explore the significance of differences in responses between the two groups of data shows that for most steak groups the responses are not significantly different**, and that even where differences are significant the pattern of responses is not consistently uniform. In some cases the steaks cooked for less than thirty minutes are rated more tender and more acceptable than those cooked for a longer period of time, and in other cases the opposite pattern occurs.

Degrees of Tenderness and Market Requirements

In this chapter and the two previous ones it has been established that the overall degree of acceptability of a steak group is associated by consumers more with the tenderness of the meat than with any other of the characteristics of quality which have been investigated here. This finding prompts us to utilise jointly all of the data from the three sets of surveys in an attempt to determine underlying relationships between objective measures of tenderness and consumer reactions in order to prescribe levels of tenderness acceptable to the mass market.

For each of the sixty steak groups involved (four in each of five cities on three occasions) the objective measure of tenderness used is the average value of shear resistance (see Tables 2, 11 and 27). A satisfactory and meaningful measure of consumer acceptability is less easy to devise from the viewpoint of generalising about market requirements. Firstly there may exist regional variations in taste—though this is later disputed—which leads to problems of weighting the empirical observations. But, more importantly, there exists a number of alternative methods of actual measurement. One measure could be the average score for the steak group on the question asking for respondents' overall impressions of the meat eaten. As we have seen, however, (Chapter 2, pages 11-14) an average response conceals variations about the mean. Thus, it would be possible to have two batches of steaks, X and Y, both of which are "liked moderately" as an average response, but steak group X may have been scored "liked moderately" by all respondents whilst group Y may have been "liked extremely" by half of its consumers and liked only a little by the remaining half. The average score, then, is of little use in guiding us as to which type of meat best meets the approval of the majority of consumers. For if we are interested in

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* A later report, based on a questionnaire survey, will attempt to define more positively the factors influencing consumers' ability to judge meat quality.

** For the question relating to overall acceptability, for example, only steak type D is rated significantly different by the two groups of respondents in Liverpool, Glasgow, Newcastle and London, and the same is true for steak type A in London alone.

supplying steaks which meet with "moderate" approval as a minimal standard then steak X best satisfies the objective, whilst if the objective is to supply meat which is to be liked at least "very much" then group Y is found to "satisfy" a greater proportion of customers. An alternative, and the one which is used here, is to quantify the degree of palatability of each steak group by the actual percentage of respondents stating that they have liked the sample steak either (i) "extremely" or "very much", or (ii) extremely, "very much" or "moderately". Statistical relationships between one of these measures and average shear resistance then yield directly the approximate degree of tenderness which is necessary in order to satisfy, say, 50%, 60%, 70% etc., of the consumer market either (i) at least "very much" or (ii) at least "moderately".

Various mathematical forms of relationships between the two variables have been investigated but the form which best fits the data and at the same time appears plausible from an *a priori* viewpoint is the simple linear relationship:

$$Y = \alpha + \beta X$$

where Y is the percentage of consumers rating the steak group either

(i) at least "very" acceptable, or

(ii) at least "moderately" acceptable,

and where X is the mean shear resistance.

(*a*) *Shear Standards for a High Degree of Acceptability*

Using the first measure of acceptability—the percentage of respondents rating the steak at least "very" acceptable—the method of analysis has been to compute the values of α and β* for each city in turn, using the data of all twelve of the steak groups distributed in each city. These results are tabulated in Table 36.

Although the estimates of α and β vary from city to city there is no good reason to believe that these differences are generally of statistical significance**; for often the equation $Y=\alpha+\beta X$ does not "fit" the empirical observations very closely and for this reason the best estimates of α and β are not necessarily reliable estimates in the context of general applicability.

TABLE 36. **Relationships between Acceptability and Shear Resistance†**

City	Value of: α	Value of: β	Standard error of β	Correlation coefficient(r)	Number of observations
Liverpool	58.30	—0.04	2.28	—0.01	12
Glasgow	139.25	—4.53	0.73	—0.89	12
Birmingham	105.84	—2.25	0.75	—0.69	12
Newcastle	87.88	—1.25	1.06	—0.35	12
London	60.03	—0.93	0.73	—0.37	12
All Cities	98.76	—2.13	0.45	—0.52	60

† All values are rounded.

* By least squares.

** The difference between the estimate of β for Glasgow and London is significant with $P<0.05$ but the meat distributed in London was generally tougher with $\bar{x}=24.33$ against $\bar{x}=20.36$ in Glasgow.

Because of this it was felt acceptable to pool all of the data and estimate the overall relationship (Table 36, last row). In all cases the value of β is negative, indicating that as the shear resistance (toughness) of the meat falls so a greater percentage of consumers find the meat at least "very" satisfactory. Using the overall relationship, $Y=98.762 - 2.125X$, and substituting numerical values in place of "X it is found that with shear resistances of 22 lb., 18 lb. and 14 lb. for example, it is likely that 52%, 60.5% and 69% of consumers respectively would have rated these steaks either as "very satisfactory" or "extremely satisfactory". It must be emphasised, however, that these percentages are only *estimates* based on the responses of heterogeneous samples of co-operators. For consumers *in general* the true values of α and β are not known with precision; and in addition it must be remembered that respondents to questionnaire surveys are often reluctant to use the whole range of, in this case, the nine-point scale open to them.

(*b*) *Tenderness Requirements for "Moderate" Acceptability*

If the measure of market acceptability (Y) is modified to include for each steak group the percentage of respondents rating the meat "moderately satisfying" as well as "very" or "extremely" acceptable, new values for α and β can be computed consistent with the relationship $Y = \alpha + \beta X$, where X, as before, is the mean shear resistance (lbs.) of the meat.

The new estimates of α and β are recorded in Table 37, and again these suggest that the differences between the estimates for the five cities are not statistically significant. Thus, again, it is reasonable to pool all of the data to compute an overall relationship between acceptability and toughness. Given that the best estimates of α and β (Table 37, last row) are 108.887 and —1.469 respectively, it can be established that mean shear values of 22 lb., 18 lb. and 14 lb. should satisfy approximately 76%, 82% and 88% of consumers to a "moderate" or greater extent. Indeed, the equation suggests that even if the mean shear resistance of the steak is as high as 30 lb. (i.e. relatively tough), approximately 65% of consumers would be at least "moderately" satisfied. Again, though, it is necessary to treat these estimates with caution when applying them to the population as a whole, for the true but unknown values of α and β may be larger or smaller than those computed from the sample data.

TABLE 37. **Relationships between Acceptability and Shear Resistance†**

City	Value of: α	Value of: β	Standard error of β	Correlation coefficient(r)	Number of observations
Liverpool	92.90	—0.42	1.50	—0.09	12
Glasgow	146.48	—3.71	0.67	—0.87	12
Birmingham	99.49	—0.87	0.72	—0.36	12
Newcastle	109.56	—1.33	0.59	—0.58	12
London	79.53	—0.62	0.82	—0.23	12
All Cities	108.89	—1.47	0.38	—0.45	60

† All values are rounded.

Finally, and because it has been noted for each of the three surveys that socio-economic group A, B and C tends to respond with lower scores than social group D and E to the questions asked, the same type of analysis is performed for each socio-economic class in turn. For each group the relationship $Y = \alpha + \beta X$ is computed for each city in turn, and for all cities together, where Y is the percentage of respondents in each group who have rated the sample steaks at least "moderately" acceptable in an overall sense. Variable X, as before, is the mean shear reading for each steak group and the same value is assumed to be common to both analyses.

TABLE 38. **Relationships between Acceptability and Shear Resistance***

(i) Socio-Economic groups A, B and C

City	Value of α	Value of β	Standard error of β	Correlation coefficient(r)	Number of observations
Liverpool	107.72	—1.12	2.12	—0.17	12
Glasgow	149.84	—4.16	0.88	—0.83	12
Birmingham	113.42	—1.84	0.84	—0.57	12
Newcastle	111.39	—1.86	0.88	—0.56	12
London	88.58	—1.05	0.92	—0.34	12
All Cities	111.75	—1.84	0.45	—0.47	60

(ii) Socio-Economic groups D and E

City	Value of α	Value of β	Standard error of β	Correlation coefficient(r)	Number of observations
Liverpool	91.30	—0.32	1.53	—0.07	12
Glasgow	144.27	—3.38	0.58	—0.88	12
Birmingham	94.80	—0.47	0.85	—0.17	12
Newcastle	107.34	—0.99	0.52	—0.52	12
London	71.89	—0.29	0.81	—0.11	12
All Cities	107.88	—1.29	0.39	—0.40	60

* All values are rounded.

The results, shown in Table 38, suggest that disaggregation by socio-economic group does not substantially improve the reliability of estimates of α and β. For each individual city, and for all cities combined, the results suggest that the parameters (α and β) of the relationship are not significantly different as between the two socio-economic groups. Overall, for example, if X (the mean shear resistance) is given the value 22 lbs., then approximately 71% of the higher income group are at least "moderately" satisfied whilst for social grouping D plus E 79% are likely to be at least moderately satisfied. These percentages, however, are not significantly different in a statistical sense, but it does seem that within the range of tenderness likely to be achieved in practice socio-economic groups A, B and C may be less satisfied than groups D and E. Again, this may be due to the apparent evidence that the former groups are better able to judge tenderness, as reflected by the higher (though in some cases, still weak) correlations between acceptability and tenderness in Table 38(i) than in Table 38(ii).

However, even for relatively tough steak, with a shear resistance of 30 lbs. the values of α and β in Table 38 suggest that approximately 57% of the higher income groups (A, B, C) and 69% of the lower income groups (D and E) would find the meat at least "moderately" acceptable. Such percentages may appear unduly high and they must, indeed, be interpreted in the light of the reservations made above about the applicability of sample results to the market in general: but supplementary evidence from another survey* does confirm that the great majority of consumers are "usually satisfied" with the meat they buy.

General Summary

1. The data from a third survey, investigating the attitudes of nearly 2,000 consumers to tenderness, suggests that respondents' subjective estimates of tenderness accord well with objective estimates determined by the Warner Bratzler instrument.

2. Respondents were generally able to detect a significant difference in tenderness between two samples of steak when their shear resistance differed by about five pounds or more.

3. Tenderness was found to be an important factor contributing to respondents' satisfaction, and the more tender groups of meat distributed were significantly more acceptable to co-operators than the tougher groups.

4. Although it is not possible to specify exactly the minimum degree of tenderness necessary to satisfy consumer requirements, the data from all three surveys undertaken suggests that a shear resistance of about 22 lbs. will satisfy approximately 52 per cent of consumers at least "very much" or 76 per cent of consumers at least "moderately".

5. The evidence suggests that although consumers in socio-economic classes A, B and C are less satisfied, on average, with steaks of any given degree of tenderness such differences between the judgments of socio-economic groups are not statistically significant.

* G. H. Brayshaw and R. J. Perkins, The Competitive Advantages of Alternative Methods of Meat Retailing, University of Newcastle upon Tyne, Department of Agricultural Marketing, Report No. 5, 1966, Table 4.

CHAPTER V

CONCLUSIONS

In the absence of any possibility of distinguishing a number of important categories of beef carcase, the research reported in these pages aimed at evaluating the significance of certain criteria of quality. More work of this type using other retail cuts for test purposes could provide the basis for quite accurate carcase specification in terms of consumer preference. The foregoing analysis deals only with consumer reactions to varying degrees of tenderness, fattiness and flavour in steaks from the round or the sirloin. Whether the results can have further application to other frying or grilling steaks or even roasting joints must remain a matter of personal judgment. It is, after all, entirely possible that consumers' attitudes regarding quality in sirloin steaks will be different from those which they apply to other beef for frying or grilling. With these provisos it is, nevertheless, possible to draw certain conclusions which seem at least to apply to the type of steaks tested and which may have wider significance.

Flavour

The importance or otherwise of flavour in consumers' estimates of quality is a matter of some controversy. Since there is no meaningful way of measuring either the type or intensity of beef flavour except by using expert tasting panels, general agreement may be far off. In this investigation it was assumed that intensively produced barley beef would have little characteristic beef flavour, while mature meat from animals killed at two to two-and-a-half years or older would have a strong beef flavour. The significance which readers attach to the results will, therefore, be influenced by the extent to which they agree with this hypothesis.

Consumers scored, on eating, what they considered to be the intensity of the flavour on a five-point scale from "extremely strong beef flavour" (5 points), to "no beef flavour" (1 point). In all cities, except one, consumers gave average scores indicating barley beef to have slightly less flavour than the more mature beef. In only one city, however, was there any suggestion that the lower score for barley beef was significantly different from that for the mature beef. One may conclude, therefore, that these consumer panels were unable, on average, to detect important differences in flavour, provided these existed. This may imply that most people are unable to discriminate or that garnishes and vegetables eaten with the steaks make it difficult for untrained palates to distinguish flavour differences.

Since these consumers were shown not to distinguish differences in flavour, it is not surprising that they were also, on average, equally satisfied with the flavour of the steaks from barley and mature beef in these tests. Nevertheless, there undoubtedly exists a body of consumers who are able to detect flavour differences and consumers in general may prefer steaks with a relatively strong beef flavour, even though they cannot distinguish it with ease. Thus in the survey, where a steak group was thought to have a strong flavour this was generally scored as more acceptable.

Leanness

Consumers were able in the tests to distinguish between steaks with fat contents differing only by four or five per cent. But when acceptance of uncooked steaks with different visible fat contents was examined, only if these differed by about sixteen per cent were significantly different preference scores obtained. Then, as might be expected, the leaner steaks were preferred. A similar conclusion was obtained when the steaks had been eaten. In this connection, however, it should be noted that while little fat from the leaner steaks was left on the plate, a relatively large proportion of those who consumed the fattier steaks discarded a lot of fat.

Further evidence of preference for leaner beef was obtained by asking consumers to choose from four photographs of different steaks that which most nearly approximated to the right amount of fattiness. These had 21.2%, 26.2%, 26.3% and 34.5% visible surface fat. From this it has been estimated that not more than fifteen per cent of consumers are likely to require steaks with more than approximately thirty per cent of fat.

Despite suggestions in some quarters that large numbers of consumers regard any fat as waste, only thirteen per cent of all the panelists would have liked steaks with less than twenty-one per cent of fat. For sirloins at least about eight-five per cent of market requirements are likely to be for steaks with between twenty and thirty-five per cent of fat, and threequarters for steaks with between twenty and thirty per cent.

Tenderness

In a previous report* it was shown that butchers believed that leanness and tenderness were the most important criteria by which consumers judged quality, with leanness most important. The results of this investigation suggest that tenderness is the overriding quality characteristic.

By asking panelists in the flavour and fattiness tests to record their overall satisfaction with the steak as well as that related to the specific characteristic under examination, information was obtained which pointed to the primary importance of tenderness. Tenderness was measured throughout the tests with the Warner Bratzler shear. In those specifically dealing with tenderness, shear values varied from fourteen pounds, which represents extremely tender meat, to very tough meat with a shear value of thirty-two pounds. As might be expected, the more tender the steaks the higher on average the scores they were awarded for acceptability. However, steaks with a shear value up to twenty-two pounds were considered very tender by more than fifty per cent of the sample of consumers and were liked at least moderately by seventy-six per cent.

The results of these tests confirm earlier impressions that quality characteristics can vary within quite broad limits and still result in a reasonable degree of satisfaction for the consumer. In other words, consumers may be rather less discriminating in judging quality than is sometimes thought. Nevertheless, a broad picture of a frying steak generally acceptable to the mass market can perhaps be drawn. It should,

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* G. H. Brayshaw, E. M. Carpenter, R. A. Phillips. op. cit.

above all, be tender, with a Warner Bratzler shear of not more than twenty-two pounds. Next, it should have a visible fat content of between twenty and thirty per cent. Finally, although consumers are unlikely to detect quite marked differences, they should probably believe that it has a strong beef flavour.

Since some steaks fitting this specification were obtained for the tests from carcases derived from beasts of varying ages and which had been hung for differing periods, it is impossible to say much at this stage about related systems of production. Nevertheless, it is clear that one particular type of beast, if subjected to efficient slaughtering and maturing procedures, is almost certain to yield the type of steak most acceptable to the mass market. This would be an animal slaughtered at about eighteen to twenty months.

APPENDIX I

The frequency distributions of replies to many of the questions asked in the surveys reported here reflect difficulties which respondents have encountered in interpreting the descriptive scales.

For Chapter IV, for example, consumers were asked to assess the tenderness of sample steaks by reference to the following nine-point scale:

Description	*Points*
Extremely tender	9
Very tender	8
Moderately tender	7
Slightly tender	6
Neither tender nor tough	5
Slightly tough	4
Moderately tough	3
Very tough	2
Extremely tough	1

and to tick the description which they thought most appropriate.

In most instances consumers have appeared to utilise *either* the top half *or* the bottom half of the scale, and there are relatively few observations at the "neither tender nor tough" point. In consequence most of the frequency distributions exhibit a bi-modal form.

This aspect of non-normality of the distributions for each steak group (A, B, C, D) in each city is in many cases accompanied by skewness and kurtosis, implying further departures from the assumptions of the normal distribution. Absence of normality does of course weaken the efficiency of statistical tests involving classical methods, and use is therefore made of non-parametric, or rank, methods which require no assumptions to be made about the form of the population distributions.

One such test, in effect a form of analysis of variance, is that devised by Wilcoxon*, but this is applicable only if the samples involved in the test are of equal size. This condition is not satisfied by the data generated by our surveys. However, an adaptation of the test, devised by White**, is available for comparing groups of unequal size, though it suffers from the limitation that only two groups of data can be compared at a time. The mechanics of the test are fully explained both by White and Snedecor.

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* F. Wilcoxon, *Biometrics* (Bulletin) Vol. 1, 1945.

** C. White, The use of ranks in a test of significance for comparing two treatments, *Biometrics*, Vol. 8, 1952. See also G. W. Snedecor, *Statistical Methods*, Iowa State Univ. Press, Chapter 5 for method of testing.

APPENDIX II

FLAVOUR QUESTIONNAIRE

UNIVERSITY OF NEWCASTLE UPON TYNE

Department of Agricultural Marketing

Index ..... Steak No. .....

Name ..... Date Steak Eaten .....

Address .....

.....

Date .....

1. FLAVOUR ONLY

Please tick whichever of the following describes best your opinion on the FLAVOUR of the steak:

(a) *Flavour*

Extremely strong beef flavour .....
Very strong beef flavour .....
Moderately strong beef flavour .....
Slight beef flavour .....
No beef flavour .....

Please tick whichever of the following describes best the extent to which you enjoyed the FLAVOUR of the steak:

(b) *Satisfaction with degree of flavour*

Liked flavour extremely .....
Liked flavour very much .....
Liked flavour moderately .....
Liked flavour slightly.....
Neither liked nor disliked flavour .....
Disliked flavour slightly .....
Disliked flavour moderately .....
Disliked flavour very much .....
Disliked flavour extremely .....

2. STAGE OF DONENESS:

Rare (very pink) Medium (slightly pink) Well done (no pink)

3. STEAK WAS COOKED:

(a) In frying pan
(b) On grill

4. HEAT USED:
   (a) High..... (b) Medium..... (c) Low.....
   (d) High and then Low..... (e) Low and then High.....

5. How long was the steak cooked?.....

6. (a) In cooking was any fat or liquid added: Yes..... No.....
   IF YES What kind .....
   (b) Anything else? .....

7. (a) On eating, did you add anything to the steak, e.g. sauce?
   Yes..... No.....
   (b) IF YES What did you add? .....
   (State sort of sauce, etc.) .....
   (c) Do you normally add this?
   (d) Did you add more, less or the same amount as usual:
   More..... Less..... As Usual.....
   (e) IF MORE OR LESS THAN USUAL Why did you add more / less than usual.

8. Did you eat potatoes with the steak? Yes..... No.....
   IF YES How were they cooked .....

9. What vegetables or other foods did you eat with the steak? .....
   .....

10. Please explain why you liked or disliked the flavour of the steak:

11. Please list the following in the order of importance you attach to them in judging the quality of beef steaks.
   (a) Tenderness..... (b) Flavour..... (c) Leanness.....

12. OVERALL OPINION OF THE STEAK WHEN EATEN
   Taking everything into consideration, please tick which of the following best describes how much you enjoyed eating the steak:
   Liked extremely .....
   Liked very much .....
   Liked moderately .....
   Liked slightly .....
   Neither liked nor disliked .....
   Disliked slightly .....
   Disliked moderately .....
   Disliked very much .....
   Disliked extremely .....

13. ANY COMMENTS—both favourable and unfavourable comments are useful to us, and are greatly appreciated:

LEANNESS QUESTIONNAIRE

UNIVERSITY OF NEWCASTLE UPON TYNE
Department of Agricultural Marketing

Index..... Steak No.....

Name .....

Address .....

.....

Date..... Date Steak Eaten.....

TO BE ANSWERED *BEFORE* COOKING THE STEAK

1. PROPORTION OF FAT TO LEAN ONLY
Please tick whichever of the following describes best your opinion of the fatness or leanness of the steak:

(a) *Amount of Fat to Lean*
Extremely fat .....
Very fat .....
Moderately fat .....
Slightly fat .....
Neither fat nor lean .....
Slightly lean .....
Moderately lean .....
Very lean .....
Extremely lean .....

Please tick whichever of the following describes best the extent to which you like this amount of fat to lean:

(b) *Satisfaction with amount of Fat to Lean*
Like extremely .....
Like very much .....
Like moderately .....
Like slightly .....
Neither like nor disliked .....
Dislike slightly .....
Dislike moderately .....
Dislike very much .....
Dislike extremely .....

TO BE ANSWERED *on* EATING THE STEAK

2. Please tick whichever of the following describes best the extent to which you ENJOYED the amount of fat to lean:

Satisfaction with amount of Fat to Lean on eating the steak
Liked extremely .....
Liked very much .....
Liked moderately .....
Liked slightly .....
Neither liked nor disliked .....
Disliked slightly .....
Disliked moderately .....
Disliked very much .....
Disliked extremely .....

3. Please tick whichever best describes the amount of fat left on plate after eating the steak:
   None A little A lot
4. STAGE OF DONENESS:
   Rare (very pink) Medium (slightly pink) Well done (no pink)
5. STEAK WAS COOKED:
   (a) In frying pan
   (b) On grill
6. HEAT USED:
   (a) High..... (b) Medium..... (c) Low.....
   (d) High and then Low..... (e) Low and then High.....
7. How long was the steak cooked?.....
8. (a) In cooking was any fat or liquid added: Yes..... No.....
   IF YES What kind .....
   (b) Anything else? .....
9. On eating, did you add anything to the steak, e.g. sauce?
   Yes..... No.....
   IF YES What did you add? .....
10. OVERALL OPINION OF THE STEAK WHEN EATEN
    Taking everything into consideration, please tick which of the following best describes how much you enjoyed eating the steak:
    Liked extremely .....
    Liked very much .....
    Liked moderately .....
    Liked slightly .....
    Neither liked nor disliked .....
    Disliked slightly .....
    Disliked moderately .....
    Disliked very much .....
    Disliked extremely .....
11. ANY COMMENTS—both favourable and unfavourable comments are useful to us, and are greatly appreciated:

UNIVERSITY OF NEWCASTLE UPON TYNE
Department of Agricultural Marketing

PHOTOGRAPHIC ASSESSMENT OF LEAN FAT RATIO PREFERENCES

Index ..... Date .....
Name .....
Address .....
.....

1. Which of these four Steaks has most nearly what you consider the right amount of fat:
   A B C D

If A—Would you prefer even less fat:
   YES NO

If YES—Would you prefer no fat at all:
   YES NO

If D—Would you prefer even more fat:
   YES NO

2. Which of these steaks do you think has the larger proportion of fat to lean:
   E F

TENDERNESS QUESTIONNAIRE

UNIVERSITY OF NEWCASTLE UPON TYNE
Department of Agricultural Marketing

Index ..... Steak No. .....

Name .....

Address .....

.....

Date ..... Date Steak Eaten .....

1. TENDERNESS ONLY
Please tick whichever of the following describes best your opinion on the TENDERNESS of the steak:

(a) *Tenderness*

Extremely tender .....
Very tender .....
Moderately tender .....
Slightly tender.....
Neither tender nor tough .....
Slightly tough .....
Moderately tough .....
Very tough .....
Extremely tough .....

Please tick whichever of the following describes best the extent to which you ENJOYED the degree of TENDERNESS:

(b) *Satisfaction with degree of tenderness*

Liked tenderness extremely .....
Liked tenderness very much .....
Liked tenderness moderately .....
Liked tenderness slightly .....
Neither liked nor disliked tenderness .....
Disliked tenderness slightly .....
Disliked tenderness moderately .....
Disliked tenderness very much.....
Disliked tenderness extremely .....

2. STAGE OF DONENESS:

Rare (very pink) Medium (slightly pink) Well done (no pink)

3. STEAK WAS COOKED:

(a) In frying pan
(b) On grill

4. HEAT USED:
   (a) High..... (b) Medium..... (c) Low.....
   (d) High and then Low..... (e) Low and then High.....

5. How long was the steak cooked?.....

6. Was any fat or liquid added: Yes..... No.....
   IF YES What kind? .....

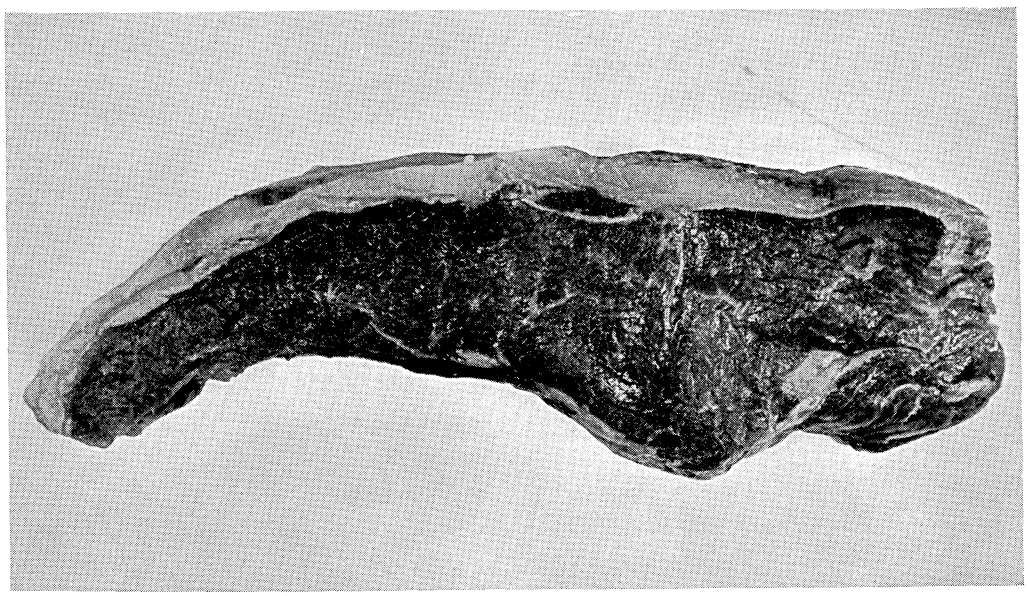
7. Did you add anything to the steak when cooking or eating it, e.g. sauce?
   .....
   IF YES What did you add? .....

8. OVERALL EATABILITY
   Please tick whichever of the following describes best the extent to which you enjoyed eating the steak
   Eatability
   Liked extremely .....
   Liked very much .....
   Liked moderately .....
   Liked slightly .....
   Neither liked nor disliked .....
   Disliked slightly .....
   Disliked moderately .....
   Disliked very much .....
   Disliked extremely .....

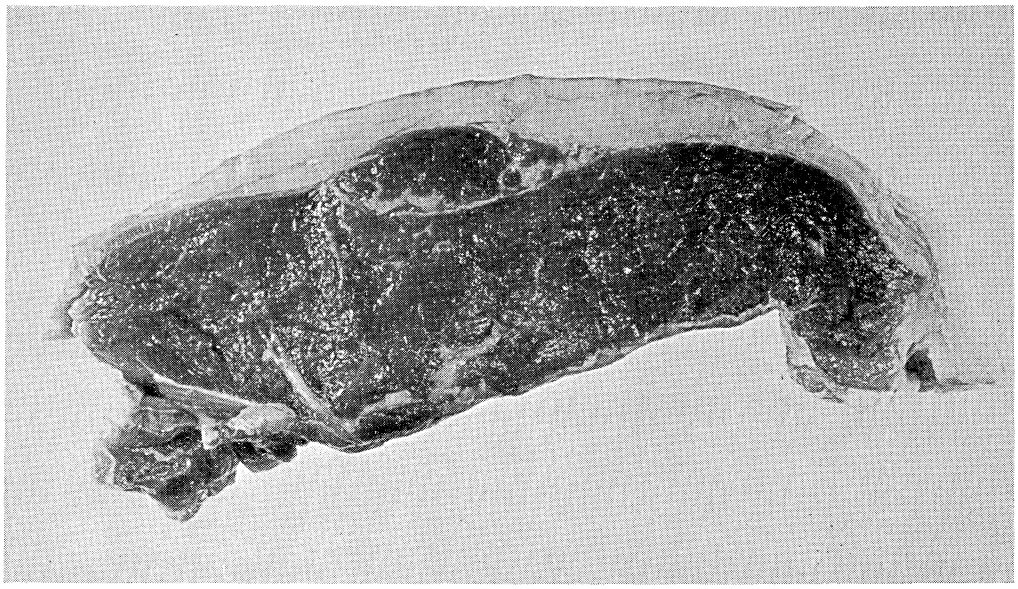
9. ANY COMMENTS—both favourable and unfavourable comments are useful to us, and are greatly appreciated:

APPENDIX III

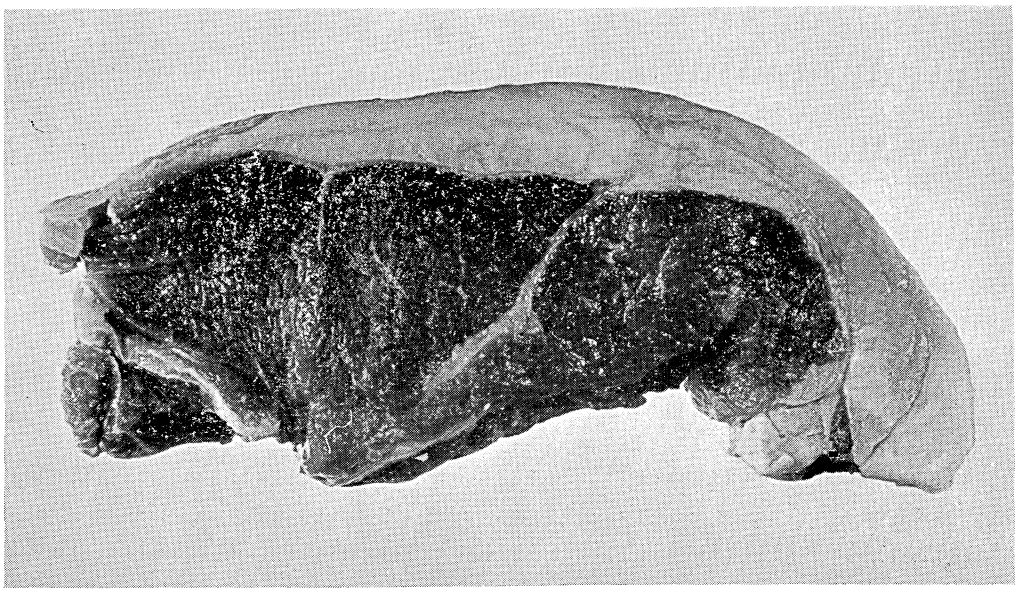
STEAK A — fat content 21.2%



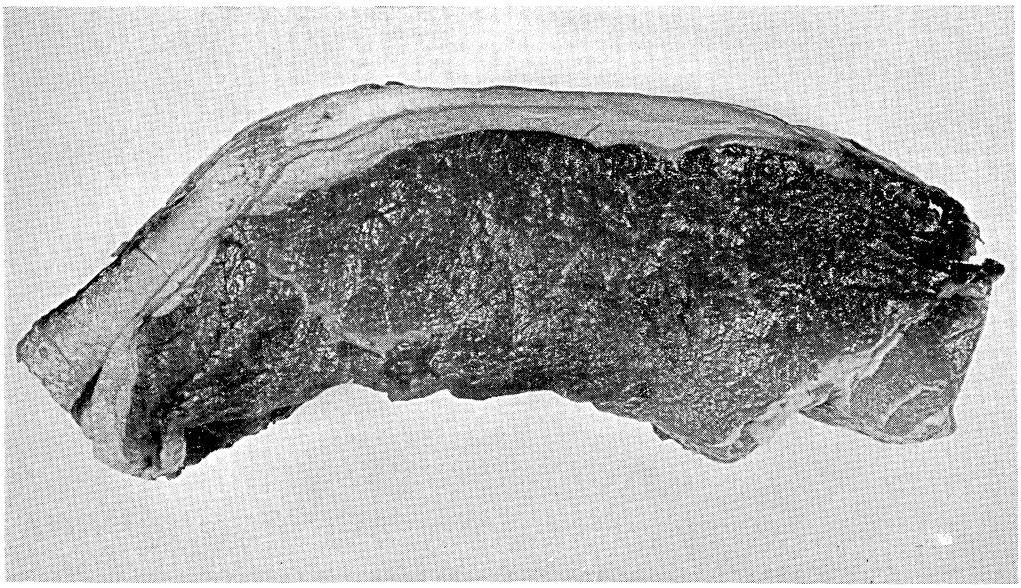
STEAK B — fat content 26.2%



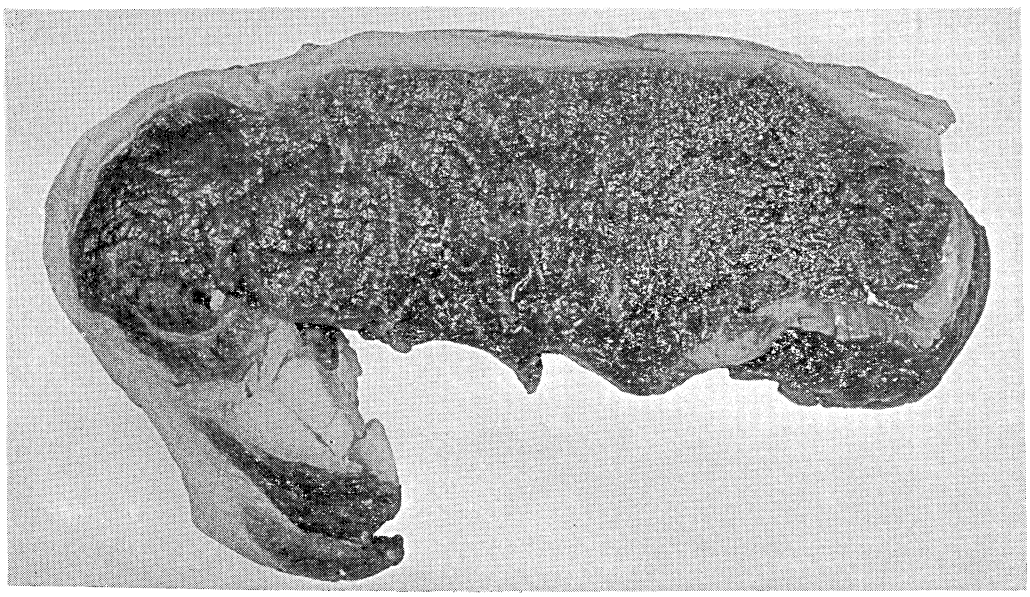
STEAK C — fat content 26.3%



STEAK D — fat content 34.5%



STEAK E — fat content 26.2%



STEAK F — fat content 26.8%

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