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Consumers' preference

WITHDRAWN

DEPARTMENT OF AGRICULTURAL MARKETING
UNIVERSITY OF NEWCASTLE UPON TYNE



cooking
techniques
and consumer
acceptability
of beef

P J Baron
and
A R I Wright

1979

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REPORT 25

COOKING TECHNIQUES AND CONSUMER
ACCEPTABILITY OF BEEF

P. J. Baron

and

A. R. I. Wright

COOKING TECHNIQUES AND CONSUMER ACCEPTABILITY OF BEEF

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CONVENTIONS

Statistical significance is indicated as follows in tables

- * 10% probability level
- ** 5% probability level
- *** 1% probability level

Temperatures are presented in °C in Sections 1 and 3 because this is the predominant usage of scientific literature. The survey results, however, retain °F since housewives reported exclusively in these units.

INTRODUCTION

There are substantial volumes of work studying consumer requirements and preferences for meat. Many involve panel assessment of different types of meat cooked in a standard manner. There are, however, surprisingly few studies of how the meat is actually treated in the home.

The standard cooking techniques used for panel tests aim for a meat of a particular internal temperature, usually 70 - 75°C. Although this produces a meat which is brown, it may well be different to that obtained by housewives. Indeed, there is evidence from consumer studies at Newcastle that many households use techniques which considerably exceed the standard test procedures.

This study set out firstly to discover household cooking procedures in more detail, and secondly to assess their impact on the results obtained in standard laboratory panel tests. It is restricted to the methods of cooking beef.

The research was carried out by Miss A. Wright under the late Professor Carpenter and the senior Author's supervision and was financed by the Meat & Livestock Commission.

SECTION 1 A REVIEW OF BEEF COOKING PROCEDURES

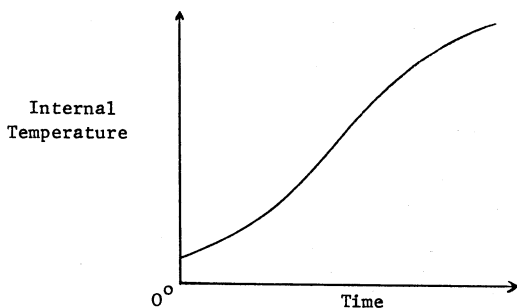
A. Established Test Procedures

Beef palatability tests are represented in an extensive literature. Trials have been employed to examine the effect of numerous production, processing and marketing practices on palatability.

The main elements in meat palatability are usually considered to be divided into tenderness, juiciness and flavour. Other factors may influence a consumer of overall appreciation of the eating quality, such as texture, aroma and colour and other visual characteristics. Of all the attributes of eating quality however, tenderness is rated the most important by the consumer and appears to influence the overall acceptability of the meat far more than either juiciness or flavour. Tenderness is also the factor that can be tested fairly successfully both subjectively, by a panel, and objectively, by mechanical devices such as a Warner Bratzler Shear test. The trial procedures have become substantially standardised although there may be minor variations between institutions. Typical procedure is to compare identical cuts of meat cooked in the same manner to a standard internal temperature. Internal cooking temperatures used in meat trials at Newcastle University are 70°C, Meat Research Institute 72°C and Sainsburys 75°C. The vast majority of tests are conducted using similar internal temperatures.

As will be noted in the section on meat physiology, temperature has a crucial effect on palatability. Originally the standard measurement of heat and time for joint cooking was in minutes per pound at a particular oven setting. Early experiments revealed that heat penetration varied considerably with shape, style and amount of fat; both peripheral and intramuscular. For example, baking whole hams to an internal temperature of 70°C took 25 - 30 minutes/lb. To reach the same internal temperature when cooking half hams the time taken was between 40 - 45 minutes (Alexander 1931). Similarly heat penetration in beef joints varied between 17 and 32 minutes/lb. to achieve an internal temperature of 62°C. The general nature of the relationship between internal temperature and over temperature and cooking time is illustrated below.

Figure 1 Relationship of Internal Temperature to Cooking Time



Unfortunately the function depends on a large number of variables such as oven temperature, place in oven, type of oven, presence of any covering to the meat in addition to variation caused by shape and make up of the meat itself. As yet no one has produced a reliable quantification of the relationship.

To overcome imprecision generated by the variability in heat penetration, experimental cookery resorts to an internal temperature measurement. This is usually measured by a thermo couple inserted into the geometric centre of the meat. Measurement of internal temperature was found to be the most successful method of controlling and comparing cooking procedure (Cline et al, 1944).

B. The Relationship between Internal Temperature and Palatability

Tenderness as the most important characteristic of eating quality has been subjected to considerable experimentation. Alexander (1931) reviewed the results of meat trials carried out by the Co-operative Meat Investigations Studies. Here she reported that constant low oven temperature gave better results and extended the range of roasting meats to those which had only been previously considered satisfactory as pot roasts and stews.

Tenderness is influenced by two structures in meat connective tissue and muscle fibres. Panels can be trained to distinguish between the softness and friability of muscle fibres and the residual stringiness of connective tissue. Further refinement of this description involves three aspects:

- the initial ease with which the heat penetrates the meat, softness;
- the ease with which the meat disintegrates, friability;
- the amount of residue remaining after chewing; connective tissue (Weir, 1960).

Using two internal temperatures, 61°C and 80°C on two different cuts of meat, sirloin steaks (*longissimus dorsi*) and silverside (*biceps femoris*), it was found that scores for tenderness varied between the two steaks. Where the internal temperatures used were 61°C, the softness scores were equally good for both muscles, and at 80°C toughness was increased in both. Similarly friability scores were equal at 61°C but at 80°C the silverside was more friable than the sirloin steak. Connective tissue was more tender in the sirloin steak at both temperatures. Tenderisation of the connective tissue only occurred in the silverside when an internal temperature of 100°C was reached (Cover, 1959).

In an experiment to evaluate whether the rate of cooking affected palatability, meat was cooked to four internal temperatures, 60°C, 70°C, 80°C, 90°C, at three oven temperatures 121°C, 177°C, 232°C. It was found that ratings for overall tenderness decreased as internal temperatures increased and this was more pronounced in older animals (Cross et al. 1976). Tenderness reached a maximum between 60°C and 70°C and from 70°C to 80°C there was a decrease in tenderisation which peaked at 80°C. At 90°C, however, the friability scores increased which boosted overall

tenderness scores (Cross et al., 1976). These findings are substantiated by Parish et al. (1973) but do not correspond with work done by Ritchey et al. (1965) or Tuomy et al. (1963). Ritchey found that there was no change in tenderness between 61°C and 80°C. Tuomy found that it was difficult to compare meat trials due to the variation in time taken to reach the desired internal temperature and similarly to cool down after cooking. To eliminate this, meat was cut into 'logs' and placed in open-ended steel tubes. The meat was then heated in water at 7°C above the desired internal temperature. Meat was heated to 60°C, 71°, 82°, 93°, and 99°C and the come up temperature was reduced to between 3 - 8 minutes while the come down was less than 3 minutes. Similarly to Ritchey, Tuomy found no change in tenderness between 60° - 51°C. He found tenderisation began at 82°C and beyond. At lower than 82°C internal temperatures it was found that time did not effect tenderness.

In contrast Bayne et al. (1969) believed that the tenderisation process started at 60°C and was virtually completed at 64°C. Similarly many trials recommend low oven temperatures (Hood et al.; 1955, Lawrie, 1974) especially for tougher cuts such as silverside; seemingly recognisable tenderer cuts such as sirloin can tolerate greater extremes of heat without deterioration in tenderness. The temperature at which maximum tenderisation occurs is still not absolutely defined, though it is fairly certain that intramuscular fat, rate of heating and dry or moist methods of cooking all have little or no effect compared to the final internal temperature.

Juiciness is often rated as the next more important factor after tenderness. Of the two factors contributing to juiciness in meat, moisture and fat, intramuscular fat is probably the most important. The amount of marbling was found to be associated with juiciness by Cover et al. (1956), and Wellington and Stouffer (1956). Some other workers, however, found no relationship, (Tuma et al., 1962). Bulmer (1963) reported that the relationship although low was consistent and that approximately 16% of the variation in juiciness was due to intramuscular fat, pH and age had no consistent effect on juiciness.

Juiciness has been found to coincide with small weight loss (Cross et al., 1976) and to benefit from low temperature cooking (Cline and Pollock, 1944). Cover (1959) found that when cooking to two internal temperatures, 61°C and 80°C, juiciness was in inverse proportion to doneness. Comparing grilled steaks to braised steaks it was found that low temperature grilling produced the juiciest steaks. When roasting joints, low oven temperatures, despite requiring increased length of time, produced juicier meat. Tender meat also resulted in high juiciness scores and this was thought to be due to the ease of chewing and hence the quick release of moisture.

Both fat and muscle contribute to flavour. Which factor, however, is dominant is still under discussion. Beef fat gives a characteristic smell which influences flavour properties, the two are hard to judge separately. Flavour is improved by hanging and is also influenced by garnish (Brayshaw et al., 1967).

The effects of cooking on flavour is not clearly defined. Flavour appears to be reduced by long cooking cycles (Tuomy, 1963) but improved by high internal temperatures reached in pressure cookers (Fenton et al., 1963); where the internal flavour of the meat was better than roasted joints. It has been noted that when cooked to the same internal temperature, 82°C, roasted meat scored less well than did grilled (Bouton et al., 1957). Other workers (Cross et al., 1976) found that steaks cooked at an oven temperature of 232°C had less flavour than when cooked at 121°C. No difference in cooking rate was found but flavour acceptability decreased with increased internal temperature.

C. Domestic Cookery Book Recommendations and Cooking Appliances

Currently there are several hundred cookery books in print. Housewives might also use cookery texts no longer in print. Unfortunately there are no available statistics for the sale of each and available figures on production are likely to prove very inaccurate because of huge overseas sales.* It was not possible, therefore, to identify with certainty the most popular volumes. For the purposes of this study a range of popular texts was selected after discussions with local booksellers and librarians. These are identified with major recommendations for roasting beef in Table 2.

Experimental cooking and some commercial operations can use measures of internal temperature to denote cooking standards. This measure is unavailable to all but a very small minority of domestic cooks. Consequently books aimed at such an audience have to stick to recommendations about cooking temperatures and time. Recommendations about these and other factors are considered in turn below.

The discussion concentrates on roasting joints because of their importance in meat consumption and because cookery books make very few recommendations with regard to steaks. It is worth noting, however, that when ordering a meal, individuals are usually asked how well cooked they like their steak. Probably more than for any other cut of beef consumers consider how well cooked a steak is as important to eating satisfaction (Menu Survey 1961). One set of suggested total times is listed below (Good Housekeeping, 1966).

Doneness Desired	RARE (minutes)	MEDIUM (minutes)	WELL DONE (minutes)
Steak Thickness $\frac{3}{4}$ "	5	9-10	12-15
1"	6-7	10	15
$1\frac{1}{2}$ "	10	12-14	18-20

* Booksellers Association for Great Britain and Ireland.
154 Buckingham Palace Road, London, SW1 W9T2
01-730-8214: personal communication

The normal recommendation is for meat to be put on the middle shelf in a pre-heated oven. Some do suggest the meat should be put into a cold oven (e.g. Hammond, 1963). Starting from cold is supposed to reduce shrivelling and preserve juiciness (Good Housekeeping, 1967).

Most books suggest an initial high temperature (400°F - 450°F) to 'sear' the meat thus keeping in the juices.* This is not a new recommendation. For example Mrs. Beeton (1861) recommends: "To roast a joint to perfection and the juices kept in. The meat should at first be laid close to the fire, and when the outside is set and firm, drawn away a good distance and then left to roast very slowly."

Temperatures suggested for subsequent periods range between 325°F and 450°F. One example (McCulley, 1967) also considers lower temperatures of 200° and 300°F. When different temperatures are suggested they are related to speed of cooking and for degree of doneness required.

English cookery books use minutes per pound weight as the measure of length of cooking time. These vary between 15 and 30 minutes/lb. Usually a further 15 - 25 minutes is advised to allow the joint to head up. Some recommend the use of a meat thermometer as well as the minutes/lb guide (Lyon, 1968; Dando, 1964). Mrs. Beeton recommends 15 minutes/lb.

Expression of recommended time with respect to weight acknowledges the impact of size on speed of heat penetration. This impact is not so severe as might be first imagined, because the surface to centre distance of a joint does not increase directly with its weight. For example in a joint with equal sides it increases with only the cube root of its weight. Nevertheless it is worth noting the joint sizes to which the temperature and time recommendations refer. The size of joint referenced to by these cookery texts ranges from 3 - 8 lbs (Mrs. Beeton recommended that sirloin joints should be no bigger than 16 lbs and that 10 lbs would be sufficient for 8 - 9 persons). On the evidence of surveys carried out at Newcastle and observations of joints available in the shops it would appear that the average size of joint is around 2 lbs. Indeed many housewives appear to buy by price rather than by weight and as the price has increased so their joint sizes have been reduced.

* Gas and electric cookers use different scales to describe the oven temperature setting. A guide to cooking temperatures indicated by manufacturers is given below:

<u>SOLID FUEL</u>	<u>GAS</u>	<u>ELECTRIC</u>	<u>°C</u>
Cool	½ - ½	250	121
Very Slow	1	275	135
Slow	2	300	149
Moderate	(3	325	163
	(4	350	177
	(5	375	190
Moderately Hot	6	400	205
Hot	7	425	218
Very Hot	(8	450	232
	(9	475	246

Housewives have a choice of cooking joints in open or closed tins and whether to wrap the joint in aluminium or transparent foil. Most cookery texts recommend an open roasting tin for roasting a joint. Meat roasted in a covered pan is said to be steamed rather than roasted (McCully, 1968). The Good Housekeeping Encyclopedia (1955) however recommends the use of foil, but that the joint should be uncovered 30 minutes before the finish to brown the joint.

The use of additional fat, either wrapped round the joint or as dripping is widely recommended and frequent basting is considered essential in many books. One effect of basting may be to reduce the oven temperature and so to prevent drying out and shrinkage. The addition of water is frowned upon.

The recommendation by the cookery texts of initial searing of the meat and high temperature cooking remain unchanged, despite changes in fuel, size and finish of the joint. There is little evidence that the recommendations have been derived on an experimental basis. Indeed, most appear to derive from recommendations in earlier cookery books and from personal experience.

Finally it must be noted that there are numerous types of cooking appliance available to the household cook. The majority of households have conventional gas or electric ovens. Electric ovens are usually considered to be better than gas because they heat the air more evenly throughout the oven space. Further, they are unrestricted in the position of the heating element. It can be placed in the middle back or bottom and in many cases a combination of two positions. This allows even heating and less variation in temperature between the top and bottom of the oven (Which Report, 1961). Gas ovens are restricted to having the burners at the back. As heat comes from only one area more space is needed for circulation. Large oven trays tend to restrict air movement causing uneven heating from front to back. Gas ovens also vary in temperature from top to bottom by between 50° to 70°F. Electric ovens are reported as having a smaller range of temperature differences between top and bottom usually 10° to 20°F. Some electric ovens also have fans to circulate the heat so that the temperature is the same throughout the oven (Which GAS, 1966).

The most accurate area of temperature measurement is the middle shelf since the thermostat is usually placed in the centre of the back wall of the oven.* Tests of new electric cookers have shown they take 12 - 19 minutes to reach the set temperature and that many thermostat lights go out at 50°F below it. Gas ovens heat more quickly; the majority in 10 minutes.

* Diamond Controls Ltd: private communication March 1976

Table 2: COOKERY BOOK RECOMMENDATIONS FOR BEEF JOINTS

Author	Title	Publication Date	Cut	Searing	Temperature (°F) (Mk)	Time (min/lb)	Other Treatment/ Comments	
Dando J	Catering with Meat	1964	Sirloin	No	375	5	25 (on bone)	Foil Wrap
			Pot Roasts	No			30 (boned)	
			Topside	No	325	3	40 - 45	
			Rump Brisket Thick Flank					
Manson M	Carefree Cooking		Topside	Yes	425-450	7-8	15 - 20	Old Method
			Sirloin					
			Roasting joints		375-400	5-6	20 (on bone) + 20 mins. 25 (boned) + 25 mins.	New Method
Lyon N	Meat	1968		Yes (at 445°)	380	5	15 (+ 15)	High Heat Roast
				No	375	5	25 (on bone) 30 (boned)	Moderate Heat
				No	355	4	40 - 45	Slow Roast
Morgan R	Cooking for Compliments	1968	Sirloin	No	425	7	15 + 15 20 + 20	Medium Done Well Done
Various	The Art of French Cooking	1963	Sirloin	Yes	450	15		
Carrier R	Great Dishes of theWorld	1963		Yes (at 425)	325	2	15 - 18	Rare
							20 - 24	Medium
							25 - 30	Well Done

	Good Housekeeping	1964	Roasting Joints	Yes	375-400	20 + 20	
			Moderate Smaller Joints	No	350	30 - 35	Cold Oven
Beeton	Cooker & Household Management	1861	Fillet of beef	Yes (at 425 ^o)	350	4 15 + 15	
Hammond B	Cooking Explained	1963		No	400	7 20 + 20	Cold Oven)
				Yes (450-500 ^o)	375	20 + 20	Hot Oven) Quick Roast
				No	325-350	30 - 40	Cold Oven Slow Roast
McCully H	Nobody Ever Tells One These Things	1967		No	200	30 - 35	
					300	15 - 18	Rare Meat
					325	13 - 15	
				Yes	450	20 - 25	
				No	300	15 - 18	
				No	325	13 - 15	Pre-heat Oven
Naldo, M	The International Encyclopedia of Cooking	1967	Pot Roast	No	450	20	
			Sirloin	No	350	15 - 18	
				No	400	12 - 18	Pre-heat oven
Wadley R	Meat Cooking	1977	Aitch Bone	No	425	7 20 + 20	Pre-heat oven

D. Summary

1. There is considerable variability in heat penetration of joints and steaks. Because of this research studies assess degree of cooking by means of internal temperature.
2. Most tests of palatability use an internal end temperature of 70°C to 75°C (162°F to 167°F).
3. There is still controversy over the nature of heat effects on meat. Both time and temperature affect tenderness. Connective tissue is softened by prolonged moist, gentle heat. Hence quality joints with little connective tissue can be cooked at high temperature but non-quality joints are better cooked at a lower temperature for a longer period.
4. Juiciness is reduced by prolonged and high cooking temperature. The picture is affected, however, by numerous other features such as leanness and pH. Initial 'searing' does not 'seal' the surface and is likely to lead to increased weight loss.
5. Flavour is probably reduced by long cooking cycles but increased by high internal temperatures. There is, however, conflicting evidence on flavour effects and this is perhaps the least extensively researched area.
6. Cookery books make recommendations in terms of oven temperature and direction in terms of minutes per lb. There is little evidence that their recommendations are based on scientific studies, they show considerable variation and often refer to larger joints than are believed to be typical.
7. Cookery books make few recommendations for steak cookery. For joints the temperature ranges are 163°C - 232°C (325°F - 450°F) and times from 15 to 30 minutes per lb. plus 15 - 25 minutes extra.

SECTION 2 HOUSEHOLD SURVEY

A. Survey Methodology

There are a number of methods which might be used to collect information about housewives' cooking techniques. These are described below. For the purposes of this study, it was necessary to balance requirements of detail and accuracy against the constraints of expense, time and manpower. In the event a simple interview questionnaire was employed.

One of the methods considered was to visit homes and watch housewives as they cooked. Time, oven temperature and internal meat temperatures, and other details could be recorded. This would possibly have been an accurate method of collecting information. It would assume, however, that housewives did not alter their cooking techniques to what they thought they should do rather than their normal practice. It would also have been very time consuming and therefore difficult to record information from enough people to get a valid cross section of the population.

Another method considered was to leave thermometers and record sheets with housewives. They could then fill in details themselves while they were cooking a joint. With this method there would have been a major problem of equipment cost and possibly some difficulty in recruiting respondents. As in the previous method, it was felt that respondents would be induced to record a cookery text method rather than their own.

One other method of investigation which would have provided accuracy would have been to invite housewives to cook a joint in the University experimental kitchen. This method would also avoid difficulties of equipment expense. There would, nevertheless, be recruiting costs, meat and heating costs, and in all probability the need to reward subjects for their time and hard work. Moreover, they might well have prepared for their visit by reading recipes different to their customary practice. The survey would also have to be restricted to Newcastle.

It was decided therefore that a questionnaire survey would be the best solution. In that, housewives could be asked to describe in as much detail as possible their own cooking methods. The technique would not give as much accuracy as the other methods and would not provide information in internal temperatures. This is compensated for by giving a broad picture of many respondents' cooking techniques compared to the other methods. Other advantages of a questionnaire survey were lower costs, rapid results and the absence of special equipment. It could also be designed to incorporate additional information about purchasing practices and steak cooking methods. Virtually any town could be surveyed and a wide cross section of the population could be reached. The temptation for respondents to quote cookery book recommendations for roasting meat, rather than their own method, was hopefully reduced by stressing that it was respondents own particular methods that were required. Further, the immediacy of questioning prevented the housewife from referring to a cookery book.

Before compiling a questionnaire it was necessary to consider all possible aspects of joint and steak cooking. Firstly, the subject was discussed widely with staff in the University. Subsequently, a group

interview of six housewives was held. Four of the women had gas cookers and two had electric cookers. The discussion was tape recorded and lasted approximately two hours.

On the basis of this discussion a pilot questionnaire was drawn up and tested in November 1976 on 40 respondents in Fenham district of Newcastle. A suitably modified questionnaire was produced for the main survey and appears as Appendix I.

The questionnaire sought information on cooking of beef joints and steaks. In the case of joints respondents were questioned about the two they cooked most differently.

One of the difficulties with domestic cookers concerns the accuracy with which it reaches and maintains the set temperature. In a practical test of cookers accuracy, a standard cake mixture is often used as a testing device (Houghton J 1975). There are several dishes which require very specific temperatures for successful cooking such as souffles and meringues. Although these would be very specific tests of temperature, they are not frequently cooked. As a partial check on respondents' ovens, it was, therefore, decided to ask respondents how they cooked a sponge sandwich or a Victoria sponge cake. Although this cake is more tolerant of temperature variations it is perhaps the most commonly cooked cake.

A sponge sandwich cake demands a reasonably accurate and even temperature to be successful. Too high a temperature will burn the outer edges before the centre is cooked. Low temperatures will not allow the cake to rise, and though it may cook through, it will tend to be flat and leathery. The range of temperature recommended for a 7" cake tin lies between 350 - 400°F. Cake packet-mixes recommend a slightly higher temperature 400 - 425°F. The length of time required is between 15 - 25 minutes, with the vast majority of cookery books recommending 20 minutes. This also includes the packet cake-mix instructions.

In addition a set of standard questions covering demographic features was included.

Sample Selection

There is some evidence that cooking methods vary regionally. There is supposed to be particular variation between the North and South of England. To accommodate such variations, the survey used two towns, Reading and Newcastle. Both with populations over 100,000 were large enough to contain representative cross sections of households, and had well defined boundaries. Three areas were chosen within each town to be representatives of the spread of social economic groups. Areas were selected in Newcastle using previous survey data. In Reading the University Department of Geography kindly supplied the information.

The areas chosen and a guide to housing and socio-economic groups in each are displayed in Table 3. A sample of 200 was obtained in each town. Houses for interviewing were selected using the Random Walk method. An equal number of interviews were carried out in the three different socio-economic areas, to ensure that all socio-economic groups were adequately represented.

B. Sample Characteristics

In general housewives were interested in the survey and most were willing to co-operate. Some difficulty was experienced in Whitley and Byker. Here respondents were rather cautious and the proportion of refusals increased to 25% compared to 10% in all other areas.

TABLE 3

Description of Sample Area

Town	Area	Housing Type	Anticipated Socio-Economic Group
Newcastle Pop 205,700	Brunton Park	Post war private housing estate	A B
	Gosforth-Kenton	Mixed housing 1900's - 60's; detached and semi-detached	B C ₁ C ₂
	Byker	Turn century, terraced housing and modern council	C ₂ D E
Reading Pop 132,900	Caversham	Large detached Victorian housing plus modern private housing estates	A B
	Early	New and inter-war private housing estates	B C ₁ C ₂
	Whitley	New and inter-war council housing	C ₂ D E

Respondents were asked for how many people they would normally cook a joint. The average family size was 3.5 persons with the largest group of respondents having four people in the household. The distribution of family size in this survey was substantially similar to the national pattern. Single person families were, however, under represented since they more frequently did not roast a joint of beef.

TABLE 4

Family Size

Number of persons in household	National 1975 %	Survey	
		%	Number
1	7	2.8	11
2	23	25.6	100
3	19	22.3	87
4	25	27.4	107
5	14	13.8	54
6 or more	11	8.1	31
mean family size			3.5

The average numbers of adults per household was 2.6; slightly higher than the national average of 2.1. There was a slight variation between Reading and Newcastle with the latter having a higher proportion of five or more adults. Possibly more Newcastle families are together to eat the main joint of the week.

The larger than average groups of adults eating a joint together may reflect the static nature of the population in Newcastle. 80% of Newcastle respondents originated in the area and consequently most people have families close by. In Reading only 44% came from the area, 27% from London, and the remainder from further afield.

TABLE 5

Number of adults in household

Nos of Adults	1	2	3	4	5 or more
Newcastle	5.2	61.0	16.8	10.6	6.5
Reading	3.8	65.1	15.2	11.7	3.3

Table 6 compares the numbers of children per family in the survey to the National figures. The survey is again reasonably representative of the National average. The slightly smaller average number of children and higher average number of adults may be accounted for by two factors. The interpretation in this survey of the category child was considered to be those young persons who ate less than an adult's portion. Hence adolescent children were probably often considered as adults. It may also be that families with several children ate less roast beef.

TABLE 6

Number of Children

Number of Children	National	Survey
1	37	37.0
2	38	46.2
3	16	13.8
4 or more	9	4.6
mean	2.3	1.3

National figures for the numbers of working women show that there is a higher percentage in the South. This tendency also appeared in the survey, Table 7. Of the women with jobs in Newcastle, 36.3% worked full-time, compared with only 13.3% in Reading.

TABLE 7

Females in employment as a percentage of the total in
that age group

Age	North	South East	UK	Survey	Newcastle	Reading
15 - 24	60.1	63.5	60.4	41.2	50.0	52.4
25 - 44	43.8	49.6	45.7	43.1	43.5	42.6
45 and over	25.4	34.0	30.5	28.5	25.7	33.3
Mean	43.0	49.0	45.5	32.0	32.8	40.27

Source: Abstract of Regional Stats 1972

North and South East defined as for Table 1

The socio-economic characteristics of the sample are displayed in Table 8.

TABLE 8

Socio-economic characteristics (percentage)

Socio-economic Group	Regional Figures (AGB Data)		Survey Figures	
	Tyne Tees	London & South	Newcastle	Reading
AB	10	15	35.0	32.9
C ₁	15	24	21.8	23.3
C ₂	39	33	17.3	25.6
DE	36	28	25.9	18.2

The survey appears to over represent the group AB at the expense of C₂ and DE groups. To some extent this is inevitable because of the selection procedure. It also represents the emphasis on beef joints since it might be anticipated that they are more likely to be cooked by better-off households.

It was decided in the light of the figures in this section, that the remaining results would be presented in unweighted form. On most characteristics, the sample appears reasonably representative and on socio-economic characteristics there do not appear to be any appropriate weighting factors which would incorporate differential beef joint consumption.

C. Cooking Appliances

Among the survey of households, slightly more respondents used gas cookers than electric ones. As both towns were well supplied with mains gas and electricity, there were very few respondents using any other sorts of fuel. In country areas where there is no mains gas supply other fuels may be more popular.

TABLE 9

Distribution of Oven Types

Fuel Type	No of Respondents	%
Gas	234	59.2
Electric	155	39.2
Solid Fuel	5	1.3
Calor Gas	1	0.3

Overall, a higher percentage of respondents in socio-economic group A and B used electric cookers than did other groups. Byker, which is mainly a lower class area, also had a high percentage of electric users. This is probably accounted for by council housing without a gas service.

Because of uncertainty over the accuracy of oven temperature control, respondents were asked about their technique for cooking a Victoria sponge sandwich cake. The sponge cake test of temperature proved only partially successful because, in contrast to the pilot survey, many housewives never cooked such a cake. Consequently only 196 or 49% of housewives were able to give details.

The table below illustrates possible time and temperature combinations. To facilitate discussion each region is labelled with a letter. The central area indicates combination broadly meeting the recommended limits of 15 to 25 minutes at 350° to 425°F. Area A indicates a long period of low temperature cooking and probably refer, because of some misunderstanding, to fruit cakes. Area B, a short time high temperature area, probably refers to

TABLE 10
Possible Cake Cooking Procedure

Time (mins)	25	A	C	C
	15	B		C
		D	D	B
		350	425	Temperature (°F)

biscuit making. Areas C indicate combinations of cooker settings which might represent compensation for a dial setting which shows a higher temperature than that actually achieved. A longer time, a higher than recommended setting, or both would be used to account for the thermostat inaccuracy. Areas D represent the opposite extreme where the cooker dial indicated a lower setting than that actually achieved.

The results obtained are shown below in Table 11. Excluding the one suggested biscuit maker, and ten fruit cake makers, 131 or 69% fell in the recommended areas; 37 or 19.5% had cookers which failed to reach the set temperature and 22 or 11.5% had cookers which exceeded the set temperature.

TABLE 11

Results of the Sponge Cake Temperature Test

Time (mins)			
25	10	36	0
15	6	131	1
	3	13	0
		350	425

The results suggest a fair degree of inaccuracy among cookers. It had been hoped that the results from this check could be used to modify the information given about meat cooking. Because of the poor coverage of ovens, this was not possible and subsequent results for joint cooking must therefore be treated with due caution.

D. Joint Cooking

This section looks at the range of beef joints used by housewives and the methods they commonly use for cooking them. To allow for variation in a given housewife's cooking methods, respondents were asked to describe two most differing cookery methods. There is, nevertheless, a very wide range of techniques available to the housewife. This report attempts to present separately the most commonly used for 'quality joints' and 'other joints'. Appendix 3 contains a list of joints in each category.

The general range of joints used for roasting

Respondents were asked to name the cuts of beef that they "usually used for roasting". 94% were able to name at least one joint of the 16 respondents who did not, 6 were gentlemen who, though they cooked the joint, did not usually buy it. Respondents were less able to name other cuts used for roasting. Of those who could remember, only 33% named two cuts, 8% named 3 cuts and only 1% named four. No respondents could remember 5 cuts although they had the opportunity to do so.

Freezer owners predominated among those who mentioned two or more joints.

TABLE 12

The difference in numbers of joints named by freezer
and non freezer owners

	Respondents who			Total
	named 1 joint	2 joints	3 joints	
Freezer owners	16	24	9	49
Without freezers	174	94	8	276

Pre-packed labelled meat may make freezer owners more conscious of cut names. Although conversely some freezer owners bought only fore-quarters or hind-quarters and had no knowledge of the precise cuts they were using. From general comments made by such respondents, it seems to be that if the consumer has no knowledge of the cuts that she is buying, the butcher joints the meat and divides it into different bags, labelled 'roasting', 'stewing' and 'frying'.

Joints named by the respondent are displayed in Table 13. It can be seen that topside is mentioned much more frequently than any other joint. Other popular named joints are sirloin, brisket and silverside. Comparing the composition of the three lists of named joints topside dominates the first two while in the third, brisket becomes the most frequent, followed by rib joints and sirloin.

The frequency with which topside occurs raises the suspicion that not all the joints claimed are in fact so. This might also be true of brisket. Indeed, Table 13 contains 585 mentions in total. Of them 36.9% are topside, 19.7% sirloin, 17.4% brisket and 6.3% silverside. The ratio of mentions are thus roughly 6:3:3:1, compared to their carcass ratios of about 2:2:2:1.

When comparing the two towns, (Table 14) Newcastle respondents appeared to know a wide range of cuts, though fewer named more than one joint. The distribution of first named joints is also notably different. In Newcastle, sirloin, topside and brisket were almost equally named, unlike Reading where topside has over 50% of the first choice.

Price and weight of joint

Housewives were asked both price and weight of the joint they bought. They said that they cooked joints which were on average 2.34 lbs weight. The range was between 1 and 5.75 lbs. The joint weights seem very low, but using 4 - 6 oz of meat per person as a guide, a 1 - 1½ lb joint would be sufficient for a family of four. Many housewives do not buy their joints by weight but by price. Consequently as the price increases, the joint purchases become smaller. Where they answered both questions, it became clear that they underestimated the price or perhaps overestimated the weight of meat they purchased.

TABLE 13

Joints used for cooking

	First joint mentioned		Second joint mentioned		Third joint mentioned	
	Absolute	Relative freq (%)	Absolute freq	Relative freq (%)	Absolute freq	Relative freq (%)
Topside	164	41.0	50	12.5	2	0.5
Silverside	18	4.5	17	4.2	2	0.5
Sirloin	79	18.7	32	8.0	4	1.0
Brisket	59	14.7	32	8.0	11	2.7
Rib	23	5.7	21	5.2	5	1.2
Standing Rib	12	3.0	6	1.5	3	0.7
Back or Top Rib	10	2.5	3	0.7	1	0.2
Fore Quarter	6	1.5	3	0.7	1	0.2
Hind Quarter	2	0.5	1	0.2	0	0.0
Rump	3	0.7	2	0.5	0	0.0
Fillet	2	0.5	0.0	0.0	0	0.0
Shoulder	2	0.5	1	0.2	0	0.0
Shin	1	0.2	0.0	0.0	0	0.0
Pot Roast	1	0.2	0.0	0.0	0	0.0
Isel-bone in	2	0.5	1	0.2	0	0.0
Flank	0	0.0	2	0.5	1	0.2
No name given	<u>16</u>	<u>4.0</u>	<u>229</u>	<u>57.2</u>	<u>370</u>	<u>92.5</u>
Total	<u>400</u>	<u>100.0</u>	<u>400.0</u>	<u>100.0</u>	<u>400</u>	<u>100.0</u>

At the time of the survey, retail prices were as follows:

Top and Silver side	£1.20
Sirloin	£1.25
Selected rib	£0.74
Brisket	£0.88

The average price quoted for joints was £2.35. This would only have bought 1.856 lbs of topside, sirloin or silverside, but 2.5 lbs of the other cuts. Since most respondents claimed the more expensive cuts, the conclusion must be that they overestimated the weight.

Cooking aims and preparation

Respondents were asked a number of questions concerning their objectives when cooking joints. It was recognised that individuals might be looking for different degrees of doneness. 63% of all respondents liked their meat well done and brown in the centre. Nearly a third (32%) liked medium meat which was pink in the middle and the remaining 5% preferred their joints rare. The most common comment when asked how they liked their joints cooked was "no blood".

Respondents were also asked if they found their joint shrank with cooking and 81% stated that it did. The majority however, thought the shrinkage to be slight. Only 67 respondents, or 17%, thought shrinkage to be "quite a lot" or "a great deal". Nevertheless, almost half the sample (42%) listed methods to prevent the joint shrinking. These methods of prevention are tabulated below and included the addition of water to the meat and searing the joint in a frying pan or a very hot oven initially to "seal it". Indeed, many expressed a wish to know how to reduce shrinkage. Although roast bags were mentioned as a possible method to reduce meat loss, they were frequently rejected as giving the meat a steamed or boiled flavour.

TABLE 15

Methods used to reduce shrinkage

Method	Number	Percentage of sample
Foil	60	15.0
Roast Bag	16	4.0
Water	12	3.0
Cook slowly	46	11.5
Closed Pan	5	1.2
Thaw	1	0.2
Basting	2	0.5
Others	<u>27</u>	<u>6.7</u>
	<u>169</u>	<u>42.3</u>

TABLE 14

Regional Variation in Joints named

<u>Newcastle</u>		<u>Reading</u>	
<u>First named joints</u>			
Sirloin	29.2%	Topside	56.8%
Topside	28.6%	Sirloin	12.0%
Brisket	24.0%	Rolled Rib	8.3%
Silverside	5.2%	Brisket	6.8%
Rolled Rib	3.6%	Silverside	4.2%
Standing and Back Rib,)		Standing Rib,)	
Fore and Hind Quarters,) under		Fore Quarter,)	under
Fillet, Shoulder, Rump,) 2.0%		Flank)	3.0%
Pot Roast, Isel Bone)			
Number naming a joint	192	Number naming a joint	192
<u>Second named joints</u>			
Topside	31.5%	Topside	27.6%
Brisket	10.6%	Sirloin	20.4%
Sirloin	8.2%	Silverside	11.2%
Silverside	66.0%	Brisket	11.2%
Rump, Ribs, Shoulder) under		Ribs, Fore and Hind)	under
Isel) 3.0%		Quarter, Rump, Flank)	3.0%
Number naming a joint	73	Number naming a joint	98
<u>Third mentioned joints</u>			
Topside, Silverside,		Silverside, Sirloin	
Sirloin, Brisket, Rib		Brisket	
		Ribs x 3, Fore	
		Quarter	
		Flank	
Number naming a joint	11	Number naming a joint	19
<u>Fourth named joints</u>			
Number naming a joint	2	Number naming a joint	2

With the fairly widespread use of deep freezers, it was necessary to check on users' treatment of joints prior to cooking. Of the 367 who answered this question 31% of respondents in Newcastle and 42% in Reading purchased frozen beef joints or took from their own deep freezer. Only two individuals, in Reading, claimed to cook without thawing. The remainder thawed their joints for times ranging between 1 and 48 hours. The distribution of thawing times was bimodal at 12 (57%) and 24 (26%) hours.

Finally, the questionnaire asked the methods by which respondents learnt to cook beef. The results are tabulated in Table 16. There are distinct differences between the two sub samples. A much greater proportion of Newcastle respondents learnt from their mother, while in Reading the 'trial and error' method achieves an equal importance. A check showed that learning was not associated with social class. It is perhaps surprising that overall, 37% claim to have learnt by trial and error.

TABLE 16

How respondents learnt to cook meat

	Mother	School	Trial & Error	Others	Total
Newcastle	100	17	57	20	194
Reading	85	16	88	6	195

$$\chi^2 = 18.038***$$

When cooking meat now, 97 respondents or 25% claimed to refer to a book. Of these, 81 could name the book or books with 'Good Housekeeping' being the most popular (31%) and Mrs Beeton next in popularity (10%).

Differences in cooking methods

After naming the joints usually used for roasting, respondents were asked to select the two joints they cooked most differently from each other. Of the 171 who named at least two joints, only 43 could name joints cooked differently. Moreover, when asked later to give details of cooking method only 38 complied. The overwhelming impression is therefore that housewives have a very standard procedure for producing roast beef, applied very often to the same joint.

Table 17 shows the distribution of joints according to different cooking methods. As might be expected, most of these housewives were describing one 'quality' and one 'cheaper' joint. Indeed most contrasted Topside or Sirloin with Brisket.

Because of their inability to describe different cooking methods, this report does not try to examine them in detail but concentrates on the one method described. The results will be presented for 'all quality joints' and 'all cheaper joints'. Where a housewife describes one of each, both her descriptions are included with the appropriate meat type.

TABLE 17

Cross tabulation of two most differently cooked joints

<u>First named joint</u>	<u>Second named joint</u>							
	Topside	Silverside	Sirloin	Brisket	Rolled Rib	Standing Rib	Back or Top Rib	
Topside	0	0	2	13	1	1	17	34
Sirloin	1	0	0	10	1	0	12	24
Brisket	5	0	1	0	0	1	7	14
Rolled Rib	1	1	0	1	0	0	3	6
Standing Rib	0	0	0	3	0	0	3	6
Back or Top Rib	0	0	0	1	0	0	1	2
	7	1	3	28	2	2	43	86

The part of the questionnaire relating to joint cookery is reproduced here for convenience.

Tabulation of Cooking Methods	Name of Joint/Name of Joint
A When you roast beef do you turn on the oven before or after you put the meat in?	
B If BEFORE, how long do you have the oven on before putting in the roast? Minutes	
C What utensils do you cook the beef in? (1) Closed Pan (2) Open Pan (3) Others	
D Do you wrap the meat in foil or other wrap?	
E Do you add fat? (What type?)	
F Do you add water?	
G At the start what temperature is the oven at?	
H Do you leave the meat to cook the whole time at this temperature? (If yes, miss I)	
I What and how many changes do you make to temperature?	
J What position in the oven do you put in the meat?	
K Do you leave the meat to cook the whole time at this position? (If yes, miss L)	
L What and how many changes do you make to position?	
M How many mins/lb do you roast beef for?	
N How long is the total cooking on average?	
O Do you stay in the house all the time the beef is cooking? YES NO	
If NO, what is the longest time you feel you can leave the joint without attention? Hours Minutes	

This part of the questionnaire produced varying numbers of missing cases for particular questions. All percentages are expressed with respect to the total number answering.

QUALITY JOINTS

Type of joint:

Quality joints were described most frequently. 307 individuals or 80% of those who cooked joints described a quality joint. As with purchases, topside was by far the most common, being described by 129 of these cooks. The average weight of these reporting quality joints was 2.34 lb. When topside joints only are examined the weight was 2.19 lb. These are very close to the reported mean weights for joints purchased, presented earlier.

Preparation:

Almost one third (101) placed their meat in a closed dish. Of the other two thirds (203) using an open dish, many wrapped the meat in some way or other. Foil was by far the most popular wrapping reported. Often this was specified as a foil lid to the open dish.

TABLE 18

Wrappings used for quality joints

	Number	Proportion of all cooking quality joints
Foil	125	41.7
Roasting Bag	14	4.7
Greased Paper	4	1.3
See through film	2	0.7
Base of percentage		

Slightly more than half (58.1%) of the respondents added additional fat to the joint. Of these 49 (27.8%) used lard, 87 (49.4%) used dripping, 17 (9.7%) used vegetable oil, and the remainder used various products such as butter, margarine and suet or were not able to say. Only one quarter of the respondents added a little water (24.1%).

Time and Temperature:

Factors important to heating the meat concern pre-heating the oven, position of the joint in the oven, the pattern of oven temperature and the duration of cooking. Housewives were given the opportunity to describe these in some detail but it must be noted here that it proved impossible to precisely measure the temperatures reached. This was particularly so because the planned cake test was defeated by the infrequency with which respondents prepared a sponge cake.

TABLE 19

Time used to pre-heat oven for quality joints

	0	1-5	6-10	11-15	16-20
Number	32	27	71	77	37
Percentage	10.8	23.9	25.9	12.5	1.0
	21-25	over 25	till pilot goes out	Aga	
Number	3	18	29	3	
Percentage	1.0	6.1	9.8	1.0	

Most respondents pre-heated their ovens, for ten minutes or more, or in the case of electric cookers until the pilot went out. 'Which' (1973) reports that the majority of cookers take longer than ten minutes to warm so that as many as one quarter of respondents may be putting their meat in before the set temperature has been reached.

The middle shelf was the most typical placing for the meat (227). A few used the top (39) and a few the bottom (30). Most did not change the position although a few (24 or 7.8%) made an adjustment, usually to the bottom shelf.

The starting temperature reported by housewives are tabulated below.* There is a wide range of starting temperatures used with no clear favourite. About 45% fall in the range 375° - 400°F which is commonly recommended in the cookery tests. 163 (65%) reported changing the temperature while the joint was cooking. The most common timings for this were 20 minutes (25%), 30 minutes (42%) or 60 minutes (20%) after the joint was started. On average for quality joints the temperature change represented a reduction of 31°F. No one reported a further change in temperature.

Most respondents could not give a figure of how many minutes per lb they cooked the meat, and when a figure was given it did not correspond accurately with the weights and total time given. It was decided therefore to disregard this figure. Total times were obviously much better known and freely given by all but 14 respondents. It would appear that they tend to think in terms of total time in a similar manner to their thinking of total price of a joint rather than price per lb.

* Gas marks were converted to F as follows:

½ = 250°, 1 = 275°, 2 = 300°, 3 = 325°, 4 = 350°, 5 = 375°, 6 = 400°,
7 = 425°, 8 = 450°, 9 = 475°.

TABLE 20

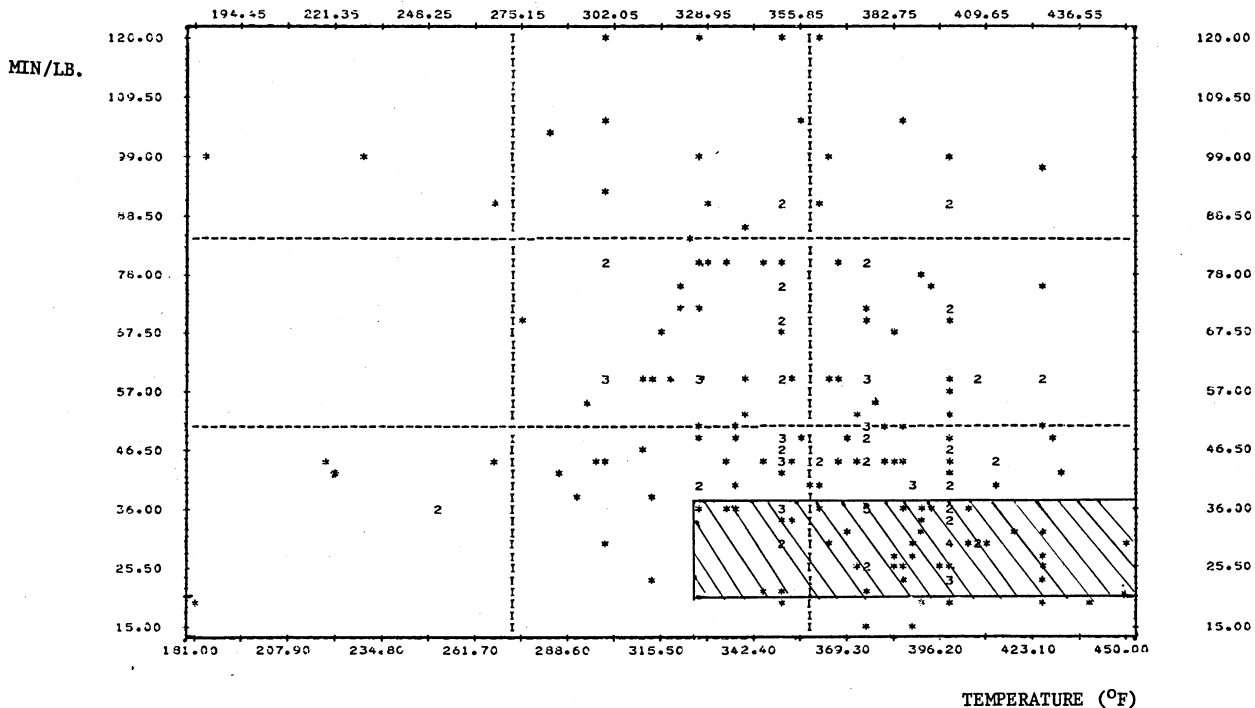
Starting Temperatures Reported for Quality Joints

	<u>Number</u>	<u>Percentage</u>
200	3	1.0
225	1	0.3
250	1	0.3
275	4	1.3
300	23	7.5
325	21	6.8
350	51	16.6
375	52	16.9
380	1	0.3
400	85	27.7
425	36	11.7
450	16	5.2
475	6	1.9
Unknown	7	2.5
Total	307	100.0

Although it is recognised that temperature and minutes per lb are not an accurate scientific measure of heat transfer to the joint, they are presented below as the best available. They also allow comparison with recommended values. Table 21 presents a scattergram of minutes per lb and average reported temperature for the joints. Average temperature is used because just over half changed the temperature and although, as already reported, the change was on average slight, there were some significant changes. It is used here as a better measure of the temperatures used over the whole cooking period.

The shaded area on Table 21 indicates the limits of commonly recommended times and temperatures. It is clear that a substantial proportion fall outside this area. Indeed, only 59 or 27.1% are within these limits. The major factor of deviation is in minutes per lb used by cooks, so that 80 (36.7%) exceed the recommendations and 7 (3.7%) lie below. Unfortunately it is not possible to say clearly whether this is due to the need to compensate for inaccurate thermostats, or because housewives prefer their meat cooked to a higher internal temperature than that obtained at the recommended settings. The cake check on cooker temperatures was available for few households. Of those who had apparently accurate cookers similar meat cooking practices were reported to those in Table 21. 25 or 39.8% were in the recommended ranges; 65.6% exceeded the time recommendations, even though in the correct temperature range.

TABLE 21: SCATTERGRAM OF TEMPERATURE BY MIN/LB FOR QUALITY JOINTS.



32



Recommended Region

NOTE: Limits of Min/lb have been adjusted to include the 'additional time'. 5 min/lb added to lower limit, 8 min/lb. to upper limit.

NON-QUALITY JOINTS

Type of joint:

Only 112 housewives or 29% of those who cooked joints described a non-quality joint. Again the joints reported mirrored purchase patterns with most describing Brisket. The average weight of joints was 2.23 lbs.

Preparation:

A higher proportion (55%) used a closed dish when cooking non-quality joints. Moreover, even if not using a closed dish, most (96%) wrapped the meat in some way or other. Table 22 shows foil to be by far the most common method.

Sixty-two per cent added fat to the joint, with lard and dripping being most common. Fifty-seven (51%) added a little water to the joint.

Time and Temperature:

Most respondents preheated their ovens as indicated in Table 23. The distribution of times however suggests that typically this is for a shorter

TABLE 22

Wrappings used for non quality joints

	Number	Percentage of all cooking non-quality joints
Foil	79	70.5
Roasting Bag	26	23.2
Greased Paper	3	2.7
See through film	0	0.0
Base of percentage		112

period. Indeed 23% do not pre-heat the oven at all.

TABLE 23

Time used to pre-heat oven for non quality joints

	0	1 - 5	6-10	11-15	16-20
Number	23	6	26	16	10
Percentage	23.4	6.1	26.5	18.4	10.2
	21-25	over 25	till pilot goes out	ago	ago
Number	0	7	7	1	
Percentage	0.0	7.1	7.1	1.0	

As with quality joints the middle shelf was the most typical starting place for non quality joints (74 households). Only 18 used the top shelf and 10 the bottom. All but 14 left the meat in the starting position.

The starting temperatures reported for non quality joints appear in Table 24. As with quality joints there is a wide range of reported temperatures with the range 300° to 400°F being most popular. In general the reported starting temperatures appear to be about 25°F below those used for quality joints.

Temperature changes during cooking were reported by 51%, typically a reduction of 25°F after 30 minutes.

TABLE 24

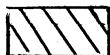
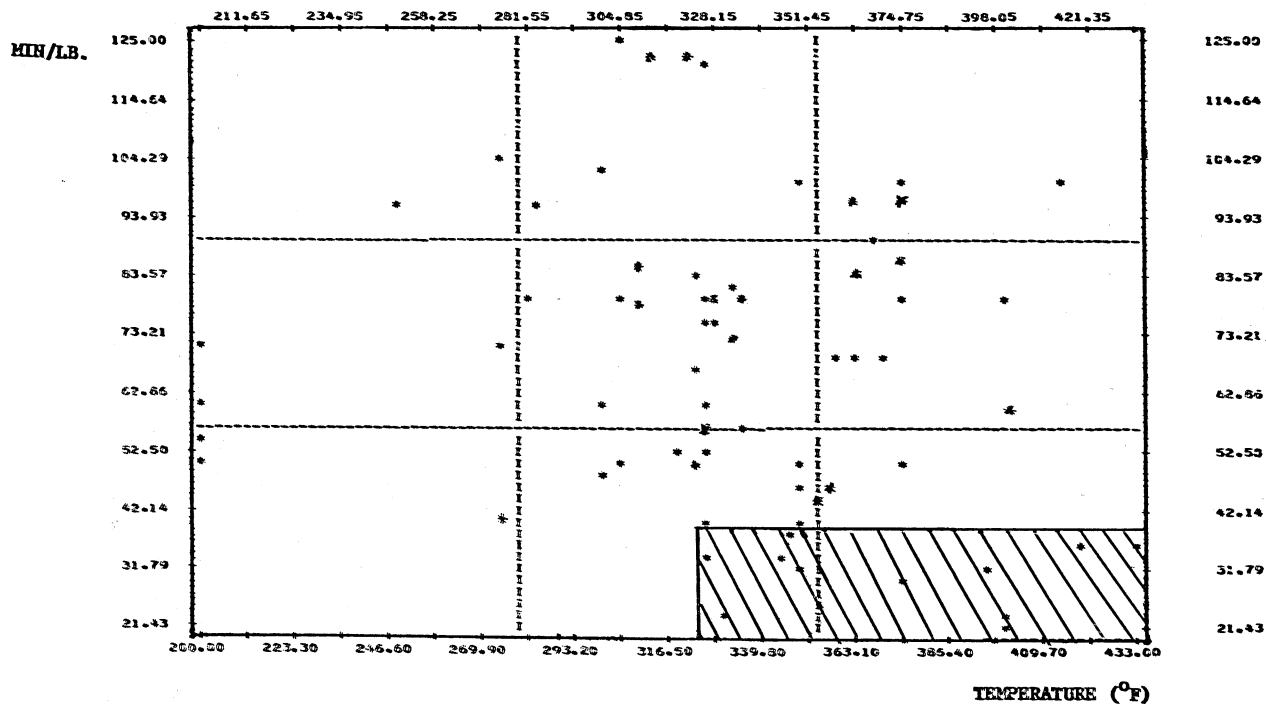
Starting temperature reported for non quality joints

	Number	Percentage
200	8	7.1
250	2	1.8
275	5	4.5
300	12	10.7
325	20	17.9
350	16	14.3
375	13	11.6
400	16	14.3
420	3	2.7
425	4	3.6
450	3	2.7
475	4	3.6
Unknown	11	9.8
Total	112	

Finally Table 25 presents on scattergram of minutes per lb and average temperature for non quality joints. The text book recommended ranges are shaded as before with only 12 or 16.7% in this area.

Only 21 (29%) of the 72 plotted points are outside the recommended temperature range and all of these represent lower than recommended temperatures. 64 (88%), however, reported cooking the joints for longer than the recommended number of minutes per lb. As with quality joints it was not possible to assess to what extent the apparently lengthy cooking time represented compensation for inaccurate oven settings. There were 23 cases who passed the cake check and of these only 3 fell in the recommended region. Nevertheless, the substantial numbers cooking between 300° and 400°F for an hour or more per lb do suggest that the sampled housewives cook these joints much more than is commonly recommended.

TABLE 25. SCATTERGRAM OF TEMPERATURE BY MIN/LB FOR NON-QUALITY JOINTS



Recommended Region

NOTE:

Limits of Min/lb have been adjusted to include the 'additional time'. 5 min/lb added to lower limit, 8 min/lb. to upper limit.

Subsequent Treatment

Cooks were also questioned generally on a number of other aspects. They were asked what else they did to the joint while it was cooking. These are tabulated below. Most reported only one activity, most commonly basting. Nearly half did nothing. In total only 28 uncovered the meat at any stage.

TABLE 26

	<u>First Report</u>		<u>Second Report</u>	
	No.	%	No.	%
Nothing	187	46.7	342	85.0
Look at it	18	4.5	2	0.5
Turn	25	6.3	21	5.2
Uncover	10	2.5	18	4.5
Add veg.	4	1.0	6	1.5
Baste	156	39.0	11	2.7
Total	400	100.0	400	100

Respondents were also asked how they knew when the beef was done. The methods are reported in Table 27.

TABLE 27

	No.	%
Fork	116	30.4
Skewer	18	4.7
Knife	21	5.5
Visual	93	24.4
Turn	8	2.1
Taste	108	28.3
Experience/ Thermostat	13	3.4
Others	4	1.0
Total Reporting	381	

Several reported more than one method and only the first reported is tabulated. Apparently very simple methods were used and no cases of meat thermometers which would test internal temperature were recorded. The assessment based on piercing with an implment most commonly checked that there was no blood or only pale pink juices emerging. Alternatively the implment should slide in and out easily.

To try and assess how concerned housewives were with joint cooking, they were asked what they did while the joint was cooking and how long they felt they could leave it unattended. 62% stayed at home while it was cooking and most got on with other activities; mostly preparing the vegetables or dessert. The question on how long it could be left was badly answered but of the 12% who did the mean time was 98 minutes.

Finally the cooks were asked when the meat was eaten and if not immediately, for how long it was kept warm. 64% ate most of it immediately and only two of those who did not, tried to keep it warm. Of those who ate all or some later, 65 re-heated the meat and 80 ate it cold.

E. Steak Cooking

Sample characteristics

Of the 400 respondents, 59% said they cooked and ate steaks. 41% did not or not frequently enough to be sure of their cooking methods. There was no significant difference in this proportion between the two towns.

Examination of household characteristics of these steak eaters showed some concentration among households with two children and with increasing numbers of adults (Table 28).

TABLE 28

Family size of steak eating households

Number of adults	Number and percentage of total sample in each cell				Total
	0	1	2	over 2	
1	6 (54.5)	0 (0.0)	3 (100)	1 (50.0)	10 (55.5)
2	55 (55.5)	29 (55.8)	44 (66.7)	15 (51.7)	143 (58.1)
over 2	48 (56.4)	10 (55.5)	15 (60.0)	3 (60.0)	76 (60.3)
Total	109 (58.0)	39 (54.2)	62 (66.0)	19 (53.0)	229

There was also a distinct relationship with socio-economic class as might be anticipated (Table 29).

Choice of steaks

Respondents were asked what cuts of beef they usually bought for frying or grilling. They were given the opportunity to name three cuts. The majority were able to name one cut but very few named three cuts. Interestingly, of the 28% who did list three cuts 72% were freezer owners.

Rump steak was the most frequently mentioned cut which was listed 130 times compared to fillet 67, and frying steak 47 times. Frying steak possibly contained several different cuts including "minute frying steaks". The latter is often sold in markets and is frequently mechanically tenderised. Frying steak appeared to be a euphemism for meat that only needed light cooking; in this survey 8% of respondents actually grilled the steak.

TABLE 29
Social economic class table

Social Economic Class	Sample Number	Number eating steak	Steak eaters percentage
A	24	17	70.8
B	111	80	72.1
C ₁	95	50	52.6
C ₂	78	41	52.6
D	39	19	48.7

There were distinct regional differences in choice of cuts, as indicated in Table 30. Reading respondents' choice was dominated by one cut, rump. The choice in Newcastle was more evenly distributed between several cuts, rump, fillet and sirloin. Three north-eastern respondents cooked prime steak all of whom came from one survey district (Kenton). It seems likely to have been a description used by a particular butcher.

TABLE 30
Types of steaks chosen

	Newcastle	Reading	Total
Rump	35	66	101
Fillet	24	18	42
Sirloin	23	11	34
Frying	33	7	40
Grilling	3	1	4
Porter Ho'	1	10	11
Others	3	0	3

$$\chi^2 = 42.97***$$

When buying steak, 20% in both towns bought pre-tenderised steak, either from supermarkets or their local butcher. Those who did not frequently commented that with tenderised steaks you could not be sure of the cut you were getting.

Respondents were not asked about the weight bought but were asked the thickness of the steak. Most people found it difficult to remember and be accurate about the thickness of the steaks. To assist them they were offered a card with different thickness drawn on it (see Appendix IV for card). The range of thickness was between a quarter and two inches. Over 80% of respondents said they cooked steaks between a quarter of an inch and an inch. Looking in local butchers' shops in the areas surveyed this was approximately the thickness available.

TABLE 31

Steak thickness

Thickness Inches	Absolute frequency	Pct frequency
1/16 - 1/8	4	1.7
1/4	32	13.6
1/2	99	41.9
3/4	62	26.2
1	25	10.6
1½ - 2	13	5.9

Cooking methods

There are a number of ways of cooking steaks. Conventional frying and grilling seem obvious methods but infra red grills and roasting are also possible. For example, in the pilot survey approximately 20% of respondents used infra red grills. In the main survey either frying or grilling dominated the cooking methods and only 11% of respondents used infra red grills. Oven roasting was usually done in a flat, open pan, with the addition of a little butter. This method was exclusive to Newcastle and represented only a very small percentage of the total.

TABLE 32

Methods of steak cookery

	Fry	Grill	Other	Total
Newcastle	66	53	3	122
Reading	35	79	2	116

$$X^2 = 14.653^{***}$$

There was some evidence of different regional cooking preferences. In Newcastle frying was slightly more popular than grilling. In contrast, in Reading more than twice as many respondents preferred grilling to frying. Where respondents named more than one steak cut they frequently listed different methods of cooking.

The internal finish of the meat was much more important for steaks. Unlike a joint, a hostess or restaurateur will ask how well cooked a person likes their steak. Probably more than any other cut of beef, consumers consider how well cooked a steak is important in eating satisfaction (Menu Survey 1961).

Respondents were asked therefore how they liked their steaks cooked. The degree of doneness was divided into three classes, rare, medium and well done. Rare steaks were considered to be red at the centre with red-pink juices. Medium steaks had pink centres and pale pink juices, while well done steaks were brown all the way through.

The majority of respondents in both towns liked their steaks medium or well done. Of respondents who fried their steaks a slightly higher percentage like either steaks well done than did those who grilled.

TABLE 33

	<u>Choice of doneness</u>			Total
	Rare	Medium	Well	
Newcastle	11	53	57	121
Reading	13	55	46	114

All respondents were asked at what heat they cooked their steaks. Gas users used the terms 'high', 'medium' or 'low' heat as did some electric users. Many electric cookers have "heat numbers" usually ranging from 1 to 6 but occasionally from 1 to 10 marks. These were converted into high, medium and low heat equivalents. High heat was defined as having the appliance full on, low was the first mark or, in the case of gas, as low as it was feasible to have the appliance. Medium heat was as near the middle heat as possible. With respondents who grilled there was a further problem that on some cooker types the grill pan can be placed at a varying distance from the heat source. This would affect the heat intensity. These respondents were, therefore, asked the distance between the grill pan and the heat source. Most were unsure of the distance. Fortunately, however, respondents with a choice of positions placed the grill pan as near as possible to the heat source. A frequent comment as "in the same position as for toast". Table 34 shows the distribution of desired degree of doneness; heat intensity; and method of cooking.

TABLE 34

Required finish by heat intensity

(number of respondents)

Cooking method	Heat Intensity	Degree of doneness			Total
		Rare	Medium	Well done	
<u>Frying</u>	High heat	2	8	3	13
	Medium	3	15	21	39
	Low heat	0	7	26	33
<u>Grilling</u>	High heat	11	28	18	57
	Medium	2	12	10	24
	Low heat	0	3	8	13
Total for both methods		18	73	86	177
Percentage		1	46	53	100

The range of time taken for cooking steaks varied from three to thirty minutes on each side. Thus total time varied from six minutes to an hour. There is some doubt whether any respondents actually cooked their steaks for an hour. Even using low heat the meat would be very dry and over-cooked (trial tests in this survey). It is possible that such respondents gave, by mistake, an overall cooking time rather than a time for each side. It was not possible, however, to distinguish and adjust any of these cases.

Table 35 details cooking times for steaks. There is a visible correlation between heat intensity and cooking time. The cooking time increases with the reduction of heat intensity. This is true within each heat intensity group and is especially clear in the medium heat group.

There were no significant differences in cooking times between towns. People who fried their steaks cooked them for less time than did people using grills. Amongst those respondents who grilled their steaks, there was a larger range of times than those who fried. Respondents using high and medium grilling heats pre-heated their grills more frequently than did people using low heat. It is possible that the generally longer grilling times used compared to frying and the sudden increase of time between low heat and high/medium heat may be accounted for by the time taken for the grill unit to heat, whereas the heat transfer to the frying pan is more instantaneous. The times given are mostly longer than those given on Page 8 despite the generally thinner nature of the survey steaks.

TABLE 35

Mean total cooking times (minutes)

Standard errors in parenthesis

Cooking Method	Heat Intensity	Rare	Medium	Well Done
FRYING	High	6.5 (0.5)	20 (6.07)	9.3 (0.67)
	Medium	7.7 (1.20)	15.2 (2.05)	18.5 (1.15)
	Low	- -	15.7 (1.87)	20.6 (2.87)
GRILLING	High	8.63 (1.36)	11.21 (0.75)	14.0 (1.43)
	Medium	13.0 (3.0)	13.25 (2.19)	13.8 (1.84)
	Low	- -	20.0 (0.0)	27.75 (5.48)

Finally it is possible to make additives to steaks while cooking. Most respondents added fat. In both towns butter was the most frequent additive, although vegetable oil was frequently mentioned in Reading. Newcastle responses produced a wider range of fats.

A major problem in assessing the steak data acquired in the Survey arises from the variety of factors which may influence the finished product. Rare, Medium and Well done steaks may follow from variations in heat intensity, length of working time, cooking method (frying or grilling), thickness of steaks, and pre-heating of grill, use of oven or covered frying pan, and fat additives. In an attempt to assess the relative importance of these factors the relationship of "doneness" to them was estimated using a discriminant analysis. The discriminant functions obtained are displayed in Table 36.

This test suffers from the obvious weakness that it relies for a measure of how well the steaks are cooked, on the housewives' personal judgement and preferences. It may well be that a "medium" steak for one individual will be "rare" for another person. Table 36 shows that only moderate successes were achieved. Neither function was significant for frying, whereas better results were obtained for grilling with one significant function. The confusion matrices (Table 37) show that misclassification occurred most for the medium done steaks. Nevertheless if the functions are treated as at least best estimates, then it can be seen that for both types of steaks, steak thickness is of little importance

TABLE 36

Discriminant functions of doneness of steaks

Variable	FRYING		GRILLING	
	Function 1	Function 2	Function 1	Function 2
Time	0.82	-0.15	-0.82	-0.12
Heat level	0.01	-0.02	-0.35	0.26
Steak thickness	-0.06	-1.01	0.05	0.52
If covered pan	-0.54	0.05	-	-
If fat added	-0.18	0.21	-	-
Nearness to heat	-	-	0.05	-0.50
If grill pre-heated	-	-	-0.18	-0.76
Test of significance	9.41*	0.42 ^{NS}	17.52 ^{NS}	3.99 ^{NS}

TABLE 37

Confusion Matrix for discriminant analysis

Actual group	Number of cases	Predicted group membership		
		Rare %	Medium %	Well done %
<u>Grilling Steaks</u>				
Rare	13	76.9 (10)	7.7 (1)	15.4 (2)
Medium	46	47.8 (22)	39.1 (18)	13.0 (6)
Well done	35	25.7 (9)	37.1 (13)	37.1 (13)

Percentage of "grouped" cases correctly classified: 43.65%

Frying Steaks

Rare	9	88.9 (8)	0.0 (0)	11.1 (1)
Medium	33	45.5 (15)	12.1 (4)	42.4 (14)
Well done	55	29.1 (16)	16.4 (9)	54.5 (30)

Percentage of "grouped" cases correctly classified: 43.30%

and that fat additives and nearness of heat can be ignored.* Time of cooking is in both cases very important. For grilling, heat level, and for frying, covering the pan also assume importance. Pre-heating the grill assumes importance in the second function for grilling.

* Because the discriminant functions are standardised the relative importance of each factor is revealed by the size of co-efficient.

F. Survey Summary

1. A cake test of cooker accuracy was only moderately successful. It suggested 69% to be operating properly, 19.5% with cookers which failed to reach the set temperature, and 11.5% exceeding it.
2. Joints commonly cooked were Topside, Silverside, Sirloin and Brisket, although most named only a limited range. They averaged 2.34 lb in weight although the average price quoted of £2.32 suggests a slightly smaller weight.
3. Most respondents wanted their joints well done and only 3% aimed for a rare finish. Shrinkage of the joint was a common concern and nearly one third of the sample covered or wrapped the joint.
4. Only a quarter of the sample referred to a book when cooking now. Methods of learning included 37% recording 'by trial and error' and 48% 'from their mother'. Few therefore remembered or would admit any formal learning.
5. Joints are typically placed on the middle shelf of an oven pre-warmed for 10 minutes. Estimates of heat level and duration showed only about a quarter of declared cooking methods fell in the recommended temperature and duration ranges. Some cooked at a lower temperature and many cooked for longer than recommended, even if in the recommended temperature range. The suggestion is that a fair proportion of these joints are being cooked much more than recommended or modelled in research procedure.
6. Half the sample do nothing else to the joint, 39% baste it. The most common instrument used to check for cooking completion was a fork or skewer inserted into the meat. 64% of the sample ate the joint immediately.
7. Most respondents could only name one steak they cooked, commonly Rump. Over 80% cooked steaks between $\frac{1}{2}$ " and 1" thick.
8. Medium or well done steaks were most popular, with only 10% wanting a rare finish. Though the assessment is less clear cut than for joints there was some evidence that steaks were cooked for longer than recommended times.
9. Few regional differences in cooking methods were discovered. Newcastle respondents knew a wider range of cuts and are more likely than Reading respondents to name Brisket or Sirloin. They also knew a wider range of steaks. There were differences in method by which they learnt to cook meat with Reading respondents more typically reporting 'trial and error'. Grilling of steaks was much more popular than frying in Reading whereas the methods were equally popular in Newcastle.
10. Deep freeze owners report knowing a wider range of joints. Very few, however, cook joints before de-frosting.

SECTION 3 PANEL TESTS

It was not possible in the survey to accurately measure the end result of housewives' cooking methods. In other words it was not possible to record internal end temperatures of joints or steaks. Nor was it possible to make an accurate estimate of internal end temperatures from the various details recorded. It was decided, therefore, to use the actual cooking methods reported by housewives with no attempt being made to achieve set internal end temperatures. The aim was, therefore, to use a standardised test material and product assessment method to investigate the effect of different household cooking procedures under the inherent variation caused by joint and oven variability.

A. Panel Methodology

The test material was cooked in two household electric cookers which form part of the Department's kitchen equipment. Internal temperatures were recorded for each joint and steak.

Joints:

The questionnaire survey revealed that the average size of joint was $1\frac{1}{2}$ lbs and the most frequently named cut was topside. The range of mins/lb that housewives used for topside was from 20 - 90mins/lb with an average of 42 mins/lb. This was a little lower than for all quality joints and was considerably longer than the cookery book recommendations of 20 - 25 mins/lb + 15 minutes. Recommended temperature for topside is 375° - 400° F. Temperatures used by housewives, however, varied considerably from 200° - 450° F, the mean being 363° F.

The majority of respondents also liked their meat well cooked, and brown in the centre. The most frequent comment about joints was that there should be "no blood" visible. Preliminary tests showed that to ensure a brown centre, an internal temperature of at least 68° C had to be reached.

To represent the different cooking procedures revealed in the survey two methods were chosen:

High heat	450° F	for 40 mins/lb
Low heat	225° F	for 80 mins/lb*

The joints cooked at high heat were placed in an open pan with a little fat in the bottom. Low heat joints were cooked in an enclosed pan with two tablespoons of water in the bottom. The two cooking methods, therefore, erred on the side of over cooked but were reasonably representative of the extremes of reported procedures. Each joint was trimmed to weigh 2.3 lb, the average survey value.

* This is slightly longer time than revealed by respondents but preliminary trials showed to be necessary to avoid a "rare" centre to the joint.

Steaks:

From the survey it was found that equal numbers of people liked their steaks medium-cooked (slightly pink in the centre) as well-cooked (brown in the centre). The taste panel, described later, also expressed definite views as to how well cooked they liked their steaks. Consequently two steak trials were run - one on medium steaks and one for well-cooked steaks. Steak cooking methods reported by housewives favoured grilling (67%). The tests reported in the previous section on factors influencing reported "doneness" of steaks were also more clear cut in the case of grilling, suggesting time and heat intensity to be the major factors. Moreover, respondents' descriptions of grilling were more precise. Consequently the trials were carried out for grilled steaks.

The lengths of cooking times chosen for the steak trials were the mean times used by housewives for well-cooked and medium-cooked steaks. In an attempt to reflect reported differences in heat levels when grilling both well and medium cooked steaks were tested at two different levels.

The different cooking treatments are illustrated in the Table below and it should be noted that each steak was turned over exactly half way through the total cooking time.

TABLE 38

Rate of heat Application	Total time of grilling	
	Medium-Cooked Steaks Minutes	Well-Cooked Steaks Minutes
High	10	14
Low	20	27

On the 8 point heat scale of the grills used for the tests, Mark 3 was defined as low and Mark 8 was considered to be high heat. 90% of respondents who grilled steaks, pre-heated their grills for an average of 10 minutes. This procedure was also adopted for these meat trials.

Selection of the test material:

The question raised initially concerned the effect of household cooking methods on differences in beef eating quality reported from laboratory experiments. It was decided to re-examine preferences for barley beef versus mature grass-fed animals. These have, in the past, been reported to have significantly different shear and palatability characteristics (Hinks & Prescott, 1971).

The animals used in the steak trial were as similar as possible to those used in the previous experiments by Hinks & Prescott. Tops of beef were purchased with a known history from local meat wholesalers. The barley beef was box-fed, 12 months old. The grass fed animals were 30 months old. Both animals were slaughtered and hung for seven days at 34°F. On the eighth day they were cut and frozen. The meat was thawed for 18 hours before cooking.

Selection of the panel

Subjects for the panel were volunteers from amongst the university clerical staff in the faculty of Agriculture. Each person was tested on six consecutive occasions using pieces of grilled steak in a triangle test. This test method asks panellists to select the different sample from a group of three where two are the same and one is different. In this case panellists had to select from steak samples of two different animals. One was a mature four year old cow and the other a prime 18 month old steer. The rump was used for each of these animals and was sliced into half to threequarter inch steaks. The steaks were grilled together in the same pan (to an internal temperature of 75°C). They were well cooked, i.e. brown all the way through, and were shear tested. The Warner Bratzler shear score for each steak is displayed below.

The probability that a person would be able to select the different one correctly 5 out of 6 times by chance only was 0.016.

This was considered to be a stringent enough test to identify a set of discriminating panellists. Although this method does not select individuals with the most sensitive palates, it does remove people who are unable to distinguish the most important meat characteristic: tenderness.

In all, 25 people were tested and of these, 12 correctly identified the different one in 6 out of 6 tests, and 4 had 5 out of 6 correct. These 16 were then used in the steak and joint trials. Interestingly of the 4 people who chose correctly, 5 out of 6 times, 3 made their incorrect decision in the first sample, suggesting an element of training. Amongst the original 25 people who were tested, 3 people were heavy smokers (20 plus a day) however, all succeeded in identifying the samples. The group that did least well were those people with false teeth. Out of 5 people who had them only one succeeded to the panel.

TABLE 39

Shear tests of steak usee in triangle tests
(pounds Warner-Bratzler)

	Mature Animal 3/4 Year Cow	Prime Animal 18 month steer
	22.25	14.00
	35.00	18.75
	28.00	24.00
	18.75	17.50
	22.00	17.25
	17.75	12.25
	22.75	14.25
	18.00	11.50
	23.00	14.75
	28.25	17.00
	26.75	20.25
Mean	<u>23.90</u>	Mean <u>16.50</u>

Experimental design for panel testing

In both steak and joint trials, 2 cooking methods were employed to cook meat from 2 different animals, this resulted in four treatment types. The difficulty then arose that no panellist could test and compare more than three treatment types at any one time.

An experimental design was needed that would allow panellists to test all the treatment types but in groups of three at a time. A balanced incomplete block design was used. It is balanced in that all the treatment types are tested on each test occasion, and that in a block which is a group of test occasions all the treatment types are tested by all the panellists an equal number of times. It is illustrated with the four treatment types labelled A, B, C, D and panellists numbered 1 to 4.

For steak trials, panellists were separated into two groups: 8 preferring medium; 8 preferring well done steaks. Eight replications were carried out so that each combination of 3 treatment types was tested in total 16 times. Sixteen panellists were used on 4 test occasions. This resulted in the same number of treatments being tested.

TABLE 40

Experimental design

<u>First test</u>	Panellist	<u>Second test</u>	Panellist
	1) A B C		1) C D A
	2) B A D		2) A B C
	3) D C B		3) B A D
	4) C D A		4) D C B
<u>Third test</u>	1) D C B	<u>Fourth test</u>	1) B A D
	2) C D A		2) D C B
	3) A B C		3) C D A
	4) B A D		4) A B C

Questionnaire design for panel testing

One questionnaire was designed to be used in both the steak and joint trials and was titled "Beef Taste Panel". Panellists were asked to score on a seven point scale for flavour, juiciness, tenderness and overall acceptability. The number of points used in the scale was chosen as being large enough to detect small variations in people's opinions of the meat. It was felt that a five point scale would have been too limiting and would have tended to cause bunching around the mid-point. On the other hand, it was felt that a nine point scale was too wide to be meaningful. Each point on the seven point scale was given a number and a verbal title to help identify the meaning. The questionnaire is reproduced in Appendix V.

After each assessment of quality, panellists were asked to list the samples in order of preference, even if they had given the same score. In this way it was hoped to crystallise the panellists' preferences for the meat more clearly. This was particularly so where a panellist may have given a high score for flavour, but may not have liked the flavour.

For testing all the samples were cut into cubes, without connective tissue or fat, approximately an inch square. They were then wrapped in foil and marked with a coloured mapping pin. The samples were collected into threes and given to the panellist for testing. Different coloured pins were assigned to different treatments from day to day so that there could be no colour/sample association. The samples were kept warm in an earthenware pot for about 5 minutes while being distributed. The panellists tested the steak at their work desks usually alone. They were given a glass of water to accompany the sample.

B. Joint Appraisal

Both joint cooking methods produced well done meat and high internal temperatures (Table 41). Indeed the high heat cooking method produced temperatures well above those used experimentally.

TABLE 41

Mean internal temperature of joints

	High Heat		Low Heat
	80°C		70°C
	86°C		72°C
	84°C		74°C
	90°C		76°C
Mean	<u>85°C</u>	Mean	<u>72.5°C</u>

Warner-Bratzler shear readings are given in Table 42. The low heat joints show less difference in tenderness than do those cooked at a high

TABLE 42

Warner-Bratzler Shear readings (lbs) for joints

[non-significantly different means underlined]

	Grass	Barley	Grass	Barley
	High heat	High heat	Low heat	Low heat
	14.75	10.75	11.25	10.00
	14.00	14.25	7.00	8.75
	21.25	13.25	10.25	9.25
	16.25	12.50	11.00	9.75
Mean	16.56	12.69	<u>9.87</u>	<u>9.44</u>

heat. There is, however, greater variability in the high heat shear rating. There were significant differences between grass and barley beef at high temperatures, and between the same meat at different temperatures.

The mean scores awarded by the trained panellists appear as Table 43. Only tenderness and juiciness show significant differences although it is perhaps worth noting that flavour scores do tend to be higher for the joints cooked at a high temperature. In the case of tenderness the difference between barley and mature grass animals is insignificant when cooked at a high heat. The significantly different juiciness scores do not show marked cooking effects but largely show the difference between the barley (juicier) and more mature (drier) beef. The differences detected were not sufficient to influence overall acceptability. Nevertheless both shear and panel measures suggest that a different cooking method could reveal different tenderness judgement, in addition to those apparent when the two meats are cooked in a similar manner. Moreover the order is reversed. High temperature barley beef is judged more tender than low heat barley while high temperature mature beef is judged less tender than low heat grass beef. Nor does the ordering of toughness agree with the shear tests which were at least intuitively more logical.

TABLE 43

Mean panel scores for joints

[non significant results (5%) underlined]

	Barley Low heat	Grass High heat	Barley High heat	Grass Low heat
	C	B	A	D
Tenderness	3.473	<u>3.790</u>	<u>3.841</u>	4.056
	C	D	B	D
Flavour	<u>3.480</u>	<u>3.632</u>	<u>3.770</u>	<u>3.871</u>
	B	D	A	C
Juiciness	<u>1.886</u>	<u>2.046</u>	<u>2.073</u>	<u>2.292</u>
	C	B	A	D
Overall Acceptability	<u>4.200</u>	<u>4.400</u>	<u>4.900</u>	<u>5.200</u>

C. Steak appraisal

The internal end temperatures reached are presented below. At both rates of heat application the medium done steaks reached a lower internal temperature than used by other experimenters, and well done steaks exceed them.

TABLE 44

Mean internal end temperature

	Level of heat Application	
	Low	High
Medium done	62°C	64°C
Well done	77°C	87°C

Table 45 lists the Warner-Bratzler shear values of the steaks tested by the panel. In each case the barley beef is on average more tender than the mature grass beef. There is also a very slight tendency for the mean shear value of well done steaks there is much more variability in the result so that the differences between barley and grass are not so clearly significant statistically. Only at high heat are they clearly different.

TABLE 45

Warner-Bratzler shear readings (lbs) for steaks

non-significantly different means (5%) underlined

Medium cooked

	Grass Low heat	Grass High heat	Barley Low heat	Barley High heat
	16.25	10.75	9.75	10.75
	14.00	15.25	9.75	9.50
	27.00	20.75	14.00	13.00
	18.00	19.75	10.25	11.75
	14.25	15.00	12.75	9.75
	15.00	17.00	12.25	11.00
	19.00	13.00	9.75	10.00
	19.00	21.50	11.50	13.25
Mean	<u>17.81</u>	16.625	11.25	11.125

Well done

	13.75	12.00	12.50	10.50
	13.75	17.75	11.00	16.25
	27.25	14.50	17.50	11.75
	24.00	14.00	15.30	10.25
	17.75	23.25	15.00	9.50
	12.50	26.00	14.25	12.75
	14.00	13.00	17.00	13.00
	20.75	18.50	12.50	13.50
Mean	<u>17.97</u>	17.375	<u>14.38</u>	12.19

The mean scores awarded by the trained panellists appear in Table 46. For tenderness the shear tests are substantially reproduced in that in both cases barley beef is distinguished from the mature beef and is judged significantly more tender. The one exception is for well done steaks cooked at a low heat. The degree of doneness does not appear to affect this conclusion although the grass-fed beef does receive a lower average score when cooked to a 'well done' state. The only other difference appears for flavour in the case of well done steaks. In neither case are the differences sufficient to affect overall preferences of the panel.

TABLE 46

Mean panel scores for steaks

non significant different (5%) treatments underlined

Well done steaks

	D	C	B	A
Tenderness	<u>2.6489</u>	<u>2.9661</u>	4.9600	4.9720
	A	B	C	D
Flavour	3.5750	<u>3.7935</u>	<u>3.8797</u>	4.0906
	D	C	A	B
Juiciness	<u>2.4891</u>	<u>2.7234</u>	<u>3.0516</u>	3.1609
	D	C	A	B
Overall Acceptability	<u>3.9825</u>	<u>4.4278</u>	4.4356	5.0137

Medium done steaks

	C	D	A	B
Tenderness	<u>3.6479</u>	<u>3.7773</u>	<u>4.6636</u>	4.7182
	B	C	D	A
Flavour	3.3035	<u>4.0562</u>	4.1969	4.2523
	B	C	A	D
Juiciness	<u>2.7441</u>	<u>2.9015</u>	2.9601	3.0187
	C	D	B	A
Overall Acceptability	4.9468	5.0836	5.1370	5.2480

D. Panel test summary

Both the high cooking temperature joints and well done steaks reached internal end temperatures above those used in conventional panel tests. High temperatures may lead to toughening of meats with greater amounts of fibrillas such as the mature grass-fed animals. These animals did relatively worse in the well done steak trial and for joints cooked at a high temperature.

The results from this relatively small test are far from conclusive. They suggest that cooking methods used by housewives, to the extent they are correctly modelled in the panel test, have a bearing on the results of standard panel tests. Panel distinction between barley and mature beef appears little affected by cooking methods for steaks except for

juiciness. The shear test, however, showed some failure to distinguish at higher cooking temperatures. In the case of joints, high cooking temperatures lead to a failure to distinguish the two meats on tenderness and juiciness. This high temperature cooking was, however, a more extreme technique.

In general the effect of cooking techniques appear to have less effect than might have been expected and in no case led to a distinction on overall preference.

If it is assumed that panel tests are employed to provide a sensitive test which errs on the side of type 1 error (detects differences that do not really exist) then current panel practice of using an internal end temperature closer to the low heat methods seems appropriate because they tend to emphasise differences of score between the meat types. Since, however, 58% of housewives appear to aim for a higher temperature, well done product, the standard test procedure is probably more critical than anticipated.

SECTION 4 CONCLUSIONS AND IMPLICATIONS

1. There is little information available about housewives' cooking procedures for meat. Nor is there published information on the accuracy of the ovens they use.
2. Recommendations given in cooker books are expressed in terms of temperature and time; units acknowledged as of little use by scientific experimenters. The recommendations are also imprecise; vary markedly between texts; and relate often to larger than typical joints or steaks. There is little evidence that they draw on the scientific literature as a basis for recommendations.
3. The survey confirms other evidence that housewives have a very limited knowledge of the range of beef joints available.
4. Domestic cooks use a very limited range of beef cuts for cooking and a restricted range of cooking methods. Most could only describe the one method they generally used and in the few cases where more than one was used the range was typically for one quality and one non-quality procedure.
5. Most cooks aim for a "well done", or "medium done" product whether cooking joints or steaks. Substantial numbers exceed the recommended times as presented in cookery texts. Unfortunately, the temperature test used for survey ovens failed so that precise comment is not possible. There is, however, a strong suggestion that a substantial number of households cook their meat well beyond scientific end-points.
6. Laboratory panel tests which attempted to model some of the survey methods suggest that the apparent extended cooking times used by housewives would prevent them detecting differences between barley and mature beef.
7. It might be suggested that the M.L.C. should make specific efforts to co-ordinate the work in domestic science institutions and in research organisations. This would firstly seek to promote comprehensive and more standard suggestions for meat cooking. Secondly, it would try to obtain more certain procedures for producing meat of a required internal end temperature.
8. Both standard panel tests and cookery recommendations made by the M.L.C. need to take account of common household practice. To ensure this, greater information is required, particularly with regard to cooker temperatures and internal temperature reached by the meat. A further study would need to take particular care over these points and despite greater cost would likely have to provide respondents with thermometers.
9. Existing panel tests appear to be more sensitive than anticipated. Any failure to detect differences between meats may, therefore, be treated with even greater confidence.

A P P E N D I X 1

Household Questionnaire

UNIVERSITY OF NEWCASTLE UPON TYNE, Department of Agricultural Marketing

We are carrying out some research for Newcastle University into how different cooking methods affect beef. I wonder if you could help me by answering a few questions about your own method of cooking beef.

1. Do you ever eat roast beef in your home? YES NO
 (If No go to question 20)

2. Do you generally cook it yourself? YES NO
 (If NO, could I speak to the person who
 does; if No close interview)

3. When you roast beef how many people do you generally cook for?
 Total No Adults No of children

4. Do you use gas, electric, or other cooker? GAS ELECTRIC
 If other, what is it?

- If Electric, does the oven have a fan in it? YES NO

5. Could you please name the joints of beef you usually use for roasting?

Name of Cut	Bone in	Bone out	What is the usual weight	What is the usual total cost
A				
B				
C				
D				
E				

Are all these joints cooked in the same way? YES NO

If No, which 2 are cooked most differently?

1.
2.

TABULATION OF COOKING METHODS

Name of joint Name of joint

- A. When you roast beef do you turn on the oven before or after you put the meat in?
- B. If BEFORE; how long do you have the oven on before putting in the roast? Mins
- C. What utensil do you cook the beef in?
i) Closed Pan ii) Open Pan iii) Others:
- D. Do you wrap the meat in foil or other wrap?
- E. Do you add fat? (What type?)
- F. Do you add water?
- G. At the start what temperature is the oven at?
- H. Do you leave the meat to cook the whole time at this temperature? (If Yes, miss I)
- I. What and how many changes do you make to temp.?
- J. What position in the oven do you put the meat?
- K. Do you leave the meat to cook the whole time at this position? (If Yes, miss L)
- L. What and how many changes do you make to position?
- M. How many mins/lb do you roast beef for?
- N. How long is the total cooking on average?
- O. Do you stay in the house all the time the beef is cooking? YES NO
If No: What is the longest time you feel you can leave the joint without attention?
Hours Mins

6. If you stay in the house while the joint is cooking, what do you do during that time?

7. Do you do anything to the joint in any way during cooking?
YES NO If Yes, what do you do to the joint and how frequently during cooking?

- List each activity separately: 1) _____
2) _____
3) _____
4) _____

8. How do you know when the beef is done? List each separately.

- 1) _____
- 2) _____
- 3) _____
- 4) _____

9. Could you please describe how you like your joint of beef cooked and what colour is the centre of the joint?

After response, could you please ring the one most appropriate:

Underdone, Medium, Well done

10. Do you find that your joint shrinks with cooking? YES NO
If Yes, by how much: a little: quite a lot: a great deal.
If No, go to question 12.

11. Do you do anything to try and prevent it YES NO
If Yes, what 1)
2)
* list separately 3)

12. When the beef is cooked, is the majority eaten hot at one meal?
YES NO (If Yes, go to question 15)

13. Do you keep it warm? YES NO
If Yes, how long for? hours..... mins
How do you keep it warm?

14. Do you cook the joint and re-heat it later?
YES NO (If Yes, how do you re-heat it?

15. Do you ever make a sponge sandwich cake either yourself or from a cake mix? YES NO (If No, go to 18)

16. Can you remember what temperature you cook it at and how long for?
YES Temp Time mins.

17. NO, then do you refer to a book or use the packet and do you find that the cake is cooked after the recommended time and temperature? or do you have to:

- a) increase the temperature YES NO (if Yes, by how much)
- b) Cook it a little longer YES NO (if Yes, by how much)

18. Do you ever buy frozen joints of beef or use them from your deep freeze? YES NO (If No, go to Section B 19)
If Yes, do you leave them to thaw before cooking or cook them while still frozen?

Cook while still frozen Leave them to thaw hours

SECTION B

19. Do you ever buy frying or grilling steaks?
 YES NO (If No, go to Section C 35)
20. What steak cuts do you buy? Are these usually fried or grilled?

<u>Name of cut</u>	<u>Fry</u>	<u>Grill</u>	<u>Infra Red Grill</u>
1) _____	_____	_____	_____
2) _____	_____	_____	_____
3) _____	_____	_____	_____
4) _____	_____	_____	_____
21. How thick are the steaks you usually cook?
 Show card display: inches don't know
22. Do you ever buy steaks which have been tenderised?
 YES NO Don't know
23. Could you please describe how you like your steaks done?
 and what colour they are in the centre?
 (Please ring most appropriate statement)
 Well done Medium Underdone

GRILLING SECTION

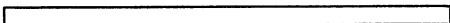
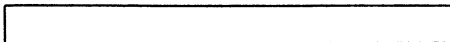
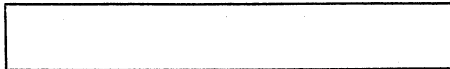
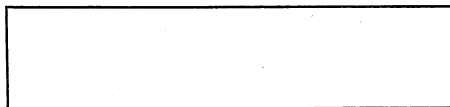
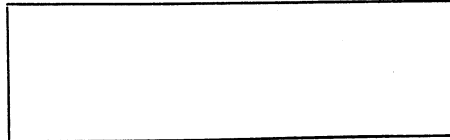
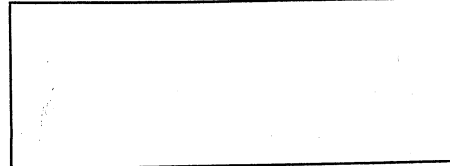
24. When grilling steaks do you put the grill on before putting the steaks under the grill? YES NO
 If Yes, how long do you have it on for before putting the steaks under the grill. Mins..... Until hot.....
25. Do you generally rub anything over the steaks before you cook it?
 If Yes, what? NO
26. About how near the top of the steak do you have the element or flame? inches is this as close as possible? YES NO
27. How high do you have the heat for cooking steaks?
 Gas flame: High Electric Ring No.
 Medium
 Low
28. How long do you cook the steaks for? Don't know
 1) first side mins. 2) second side mins.

A P P E N D I X 2

QUALITY JOINTS	OTHER JOINTS
Topside	Brisket
Silver side	Back or Top Rib
Sirloin	Shoulder
Rib	Shin
Standing Rib	Flank
Rump	Braising Steak
Fillet	Pot Roast
Isel	Stewed Rib
Hindquarter Joint	Forequarter Joint

A P P E N D I X 3

Card Used to Identify Steak Thickness

□	
△	
▭	
◇	
○	
▽	

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