CONSUMER PREFERENCE FOR BEEF RIB STEAKS FROM IMPLANTED AND NON-IMPLANTED BULLS, AND IMPLANTED STEERS COMPARED TO TRAINED PANEL AND WARNER-BRATZLER SHEAR EVALUATIONS

by

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DEDICATION

This thesis is dedicated to the author's parents, Elmer and Mary Pelton. Throughout my life, in all possible aspects, they have been a constant inspiration to me. They are the two most caring and generous people in my life, and they have set a wonderful example of attitude, achievement, perserverance, pride and moral character for myself, sister and brothers. I am very appreciative of their encouragement and support during my life, but I am most thankful for all their love.

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Introduction

The beef industry is a major part of U.S. agriculture and its welfare is of national importance. Nevertheless, few consumer studies have been done to determine the kinds and qualities of beef desired by the market. As a consequence, both, the beef production and marketing sectors of the beef industry have limited market guidance.

The American consumer likes beef, and on the average spends a higher percentage of their income for it than any other food item. It has become obvious that consumers are demanding leaner beef. They are resisting the purchase of trimmable fat, connective tissue, and bone. This resistance will become more pronounced as the price of meat increases. It is currently held that consumers prefers beef that is tender, flavorful, juicy, has minimum waste, and they want it at a reasonable price.

Shifts in consumer preferences to lean beef should make feeding intact males more attractive to the industry. The intact male grows more rapidly, utilizes feed more efficiently and produces a carcass with less fat and more lean meat than its counterpart-steers and heifers. In the past, meat production from intact males has encountered strong resistance from almost all segments of the industry, from producer to the retailer. This is due at least in part to lower USDA quality grades for bulls, and the belief that beef from the intact male has less consumer retail acceptance because of differences in color, texture, and palatability.

Recent interest in intact male production has stimulated attempts to improve the palatability and consequently the acceptability of meat from their carcasses. One method of potentially improving meat palatability in intact males is through the utilization of hormonal or other growth promoting implants.

Implant effect on beef palatability as measured by Warner-Bratzler shear, trained and consumer panels, is of great interest. If improvement of palatability is feasible through the use of implants on intact males, a major impediment to their production might be removed.

The following review of literature centers around four aspects that pertain to the feasibility of utilizing intact males for future red meat consumption. They include: 1.) palatability and the factors influencing it, 2.) tenderization methods available, 3.) taste panel evaluations-trained and consumer panels, together with Warner-Bratzler Shear Force evaluations and 4.) bulls vs. steer comparisons.

Review of Literature

Palatability

Consumer acceptance of a beef product is considered difficult to define because the extent of satisfaction from beef consumption depends on psychological and sensory responses that are unique to each individual.

Since the meat eating experience is subjective in nature, the same product eaten by different consumers will result in variable degrees of eating satisfaction. Responses as to eating satisfaction are also influenced by such factors as; consumer age group, environment, season of the year, ethnic background and individual differences in preference (Levie, 1970).

The characteristics of meat that contribute to its palatability are sensory in nature, in that they are agreeable to the eyes, nose and palate (Forrest et al., 1975).

The ultimate goal of the livestock and meat industry is to place a product on the consumers' table which will result in a high degree of eating satisfaction at the least possible cost (Jeremiah et al., 1970).

Beef available to the consumer is derived from a heterogeneous supply of cattle which vary in such factors as: maturity, sex, weight, breeding, body shape and nutritional regimes. Each of these characteristics affect the tenderness, juiciness and flavor of meat. With so much variation in the source of beef it is logical to discuss the factors known to have an effect on palatability or eating satisfaction (Jeremiah et al., 1970).

Factors Influencing Palatability

Maturity. Numerous research studies have indicated that the tenderness of bovine muscle decreases with increasing chronological age (Hiner and Hankins, 1950; Tuma et al., 1962a; Goll et al., 1963; and Field et al., 1966a). Zinn et al. (1970). These studies noted that this pattern of age related change in muscle tenderness is difficult to explain, but it could indicate that a structural change in the connective tissue collagen takes place as an animal matures or that there is an apparent interaction between time on feed and animal age. Forrest et al. (1975) considered it likely that the additional exercise experienced by older animals causes a strengthening of the connective tissue fiber structure.

According to Wilson et al. (1954), Goll et al. (1963), and Hill (1966), even though the quantity of connective tissue apparently changes little with increasing age, there is an increase in the number of intermolecular crosslinks in the collagen fibrils. This results in decreased solubility of the collagen, and probably explains the increased resistance to shearing or chewing action. Although, generally the muscles of the very young animal are more tender than those of the aged animal, the changes that occur as the animal ages are not considered linear with increasing age (Forrest et al., 1975). Substantial muscle toughening in beef animals becomes evident at about 30 months of age. Beyond this age, there is further toughening, but at a decreasing rate according to Kemp (1980).

This phenomenon was substantiated by Tuma et al. (1962b) who observed a greater decrease in tenderness between the 18- and 42-month age groups than between 42- and 90- months. This data illustrated that animal age may be more critical with regard to tenderness at a point between 18- and 42- months than at 90- months of age.

Maturity of the carcass seems to affect palatability according to McBee and Wiles (1967). They determined that steaks from A maturity carcasses were less juicy and less flavorful than those from the older maturity group. This study differs with the work of Goll et al. (1965) and Romans et al. (1965) who found no significant differences in juiciness beween maturity groups. McBee and Wiles (1967) also found that older carcasses and those with higher degrees of marbling were significantly firmer and possessed greater amounts of external fat.

Since all animals of a species, and even all the muscles within an individual animal, do not age at the same rate, the indicators of psysiological age in the animal body are generally recognized as being better predictors of tenderness than is chronological age (Forrest et al., 1975).

Marbling. The USDA standards for grades of carcass beef have been revised numerous times since their first use in 1926. However, the fundamental concepts regarding the assessment of beef quality have remained remarkably consistent. Marbling, along with maturity, continue to receive primary consideration in the assessment of quality in the current beef grading system (USDA, 1980).

Intramuscular fat, commonly referred to as marbling, is the intermingling of fat among the muscle fibers appearing either (1) as a fine webbing resembling a spider web (fine marbling), (2) as flashes of fat that are heavier and resemble streaks of lightning, referred to as coarse marbling, or (3) as flecks of fat giving meat a combination mottled and webbed appearance (Romans and Ziegler, 1977).

Marbling is found most abundantly in the flesh of highly finished animals that are approaching or have reached maturity. Its development is slower than the laying on of internal and external fat. For that reason higher marbling levels are normally found in carcasses of heavier, older cattle that have been fed longer and thus have more waste both externally and internally (Romans and Ziegler, 1977; Kemp, 1980).

Hiner (1956) and McBee and Wiles (1967) reported that tenderness, juiciness and flavor, increased with increasing degrees of marbling in a direct, linear relationship. However, Parrish (1981) reported that even though marbling is positively and significantly related to palatability, the relationship is of a low magnitude. Parrish's work agrees with previous research which has consistently demonstrated only low to moderate relationships between marbling and the palatability traits of beef (Blumer, 1963; Pearson, 1966; Jeremiah et al., 1970; and Jennings et al., 1978).

Several researchers have concluded that marbling does not not contribute to overall eating satisfaction in beef (Walter et al., 1963, 1965; Gilpin et al., 1965; and Goll et al., 1965). In a study involving young, grain-finished steers, Campion et al. (1975a) reported that marbling accounted for no more than 10% of the variation in any of the organoleptic properties of beef. Crouse et al. (1978) found that marbling accounted for 6-8% variation in taste panel acceptability. Regression analysis indicates that an increase of 30 units in marbling (scored: low Choice=10; average Choice=11; high Choice=12; etc.) would have been required to make a one-unit increase in taste panel tenderness. In addition, adjusted outside fat thickness and actual fat thickness were as highly correlated to taste panel traits as measures of intramuscular fat content. These workers (Crouse et al., 1978) concluded that marbling is more strongly related to juiciness than tenderness.

Tatum et al. (1980) showed that palatability of the steaks generally increased as marbling score increased; however, the difference in palatability associated with each successive increase in marbling score were not always directionally consistent, nor were they always statistically significant.

Two recent studies on rib steaks from A maturity carcasses (Campion et al., 1975b; Crouse et al., 1978) indicated that marbling accounted for 6 to 9% of the variation in juiciness.

Another important component contributing to overall acceptance or eating satisfaction rating is flavor. The contribution to flavor attributed to marbling is also is variable. A range of essentially no contribution (Dryden and Marchello, 1970) to 42% (Simone et al., 1959) has been reported.

Fat Thickness as a Predictor of Palatability. There is evidence suggesting that subcutaneous fat deposition may be closely associated with beef palatability (Tatum et al., 1982). These workers compared marbling to fat thickness as a palatability predictor. Fat thickness was ineffective as a predictor of cooked beef palatability, and therefore, would appear to be an unsuitable substitute for marbling. However, marbling, used in combination with a minimum subcutaneous fat thickness constraint of 7.62 mm for carcasses with a "slight" amount of marbling, facilitated more equitable stratification of carcasses according to their expected palatability than did marbling alone.

Variation in tenderness attributable to marbling varies from a high of 67% (Doty and Pierce, 1961) to a low of less than 1% (Goll et al.,1965; Suess et al., 1966). Marbling, as in indicator of palatability, has the distinct advantage of being clearly visible to the consumer at the time of meat purchase. It is also, consistently, positively related to all the attributes of palatability, even though the relationships are very low (Jeremiah et al., 1970).

To date, research has failed to establish marbling as a dependable predictor of cooked beef palatability.

Carcass Grade. Beef carcass maturity and marbling are generally regarded as important factors influencing the relative acceptability of the cooked meat. Due to this, these factors are accorded primary importance in the USDA federal grade standards for the determination of carcass beef grades (McBee and Wiles, 1967). USDA established standards for classes and grades of slaughter cattle and beef carcasses in 1926. Since that time the standards have been modified and revised numerous times (Jeremiah et al., 1970). Presently, the factors considered in assigning USDA quality grades to beef carcasses include; maturity or physiological age, marbling, texture, firmness and color of lean (USDA 1980).

According to Jeremiah et al. (1970) marbling, as included in the quality grade standards, is assessed by observation of the intramuscular fat within the longissimus muscle at the 12th rib. Maturity scores assess the apparent characteristics of physiological age of the carcass. These include primarily the hardening and ossification of the cartilage and bone of the vertebral column and the lean color of the longissimus muscle at the 12th rib. Texture, color and firmness of the lean are quality factors that may be used in certain instances to adjust the grade determined by combining maturity and marbling (Jeremiah et al., 1970).

Within the younger maturity levels, variation in marbling scores is associated with approximately 72 percent of the variability in USDA quality grades (Jeremiah et al., 1970). These workers also stated that much of the promotional and educational literature related to USDA grades states that carcasses with higher grades are expected to provide cuts with more desirable palatability characteristics. However, there are conflicting scientific reports on the relationships between carcass grade and palatability of beef. Increases in overall palatability of beef have been reported to be highly related to increases in carcass grade (Cole et al., 1960; Doty and Pierce, 1961; and McBee and Wiles, 1967). However, other reports indicate no significant relationship between carcass quality grade and the overall palatability of the subsequent meat product (Satorius and Child, 1938; Kidwell et al., 1959; Campion et al., 1975; and Koch et al., 1979).

Palmer et al. (1958) found that changes in USDA grades accounted for only eight percent of the variation in tenderness. Doty and Pierce (1961) reported that beef from the Prime grade was superior in tenderness to that of the Good grade. Kropf and Graf (1959) reported high, but nonsignificant differences in tenderness within the higher grades.

McBee and Wiles (1967) concluded that highly significant differences in overall tenderness (by palatability panel and shear force), juiciness and flavor were present among the carcass grades of Prime, Choice, Good and Standard, with the Prime grade being most desirable and the Standard grade being the least desirable. These results support Lewis et al. (1964) who noted increases in tenderness as grade increased from Standard to Prime. However, Cover (1937) and McBee and Wiles (1967) reported that variation in tenderness were as great within grades as was the variation between grades.

Tatum et al. (1980) concluded that steaks from the higher grading (by one-third grade stratification) carcasses (high Choice and average Choice) were more juicy, more flavorful and more desirable in overall palatability than were steaks from the lower grading (by one-third grade stratification) carcasses (low Good and high Standard); however, steaks from low Choice, high Good and average Good carcasses did not differ in ratings for juiciness, tenderness and overall palatability. They also found that when steaks from carcasses of different grades (by full grades) were compared, grade was not associated with differences in palatability.

Texture. Texture is the appearance or feel of the cross section of the cut muscle surface (Kemp, 1980). It is defined sometimes as "mouthfeel", a property which relates to density, viscosity, surface tension, and other physical properties, according to Levie (1970). The grain or texture of meat is seldom given any thought by the consumer. It will vary more with the age of animal than it will between animals of the same species (Romans and Ziegler, 1977).

Some research indicates that tenderness is associated with individual size of the muscle fibers; the smaller the fibers and the finer the texture, the more tender the meat. As animals mature and the size of each muscle fiber increases, there would be an expected decrease in tenderness (Acker, 1983).

A fine texture indicates small muscle bundles and thin connective tissue (Kemp, 1980). A fine texture will give meat a smooth, velvety appearance, which is desired (Romans and Ziegler, 1977).

A coarse texture appears globular having large muscle bundles, thick connective tissue or both. The difference in coarseness is caused by the thicker cell walls. Since cell walls, made up of collagen are the least tender part of a cell, it follows that any abnormal amounts would affect the textural structure and appearance of the meat and make it less tender (Romans and Ziegler, 1977).

According to Forrest et al. (1975), the textural properties of cooked meat affects its appearance and impact sensory impressions related to its adhesion, mealiness, or fragmentation. Over-cooked meat that is stringy in appearance is associated, by previous experience, with dryness and lack of flavor. The texture of the cooked fat associated with meat cuts is a major appearance and palatability factor.

Days on Feed. The feeding and management of animals prior to slaughter can significantly affect the subsequent carcass quality (Jeremiah et al., 1970).

Black et al. (1949) reported little difference in palatability or tenderness between cattle finished on grass alone or finished on concentrates. This contradicts work by Wellington (1968) and Zinn et al. (1963) who found significant differences in carcass quality resulting from differences in length of time on feed. It appears that the length of time on feed and management is more important than the type of feeding regime for determining carcass quality (Jeremiah et al., 1970).

Zinn et al. (1970) reported that tenderness increased up to, but not beyond, 180 days on feed and that after 180 days on feed, increased maturity exerted an adverse effect on tenderness because of the accelerated maturation of connective tissue. In addition, these researchers found the first 180 days on feed did have a beneficial effect on tenderness. However, after 180 days, animal age appeared to exert a greater influence.

Tatum et al. (1980) reported that the percentage of Choice carcasses increased as a result of increased time on feed. The percentage of Commercial and Utility carcasses increased as time on feed increased from 100 days to 160 days. Other research indicates that as cattle are fed for longer periods before slaughter, there are increases in marbling scores and quality grades (Wellington, 1968; Zinn et al., 1970; Campion et al., 1975a). Work by Campion et al. (1975a) showed that feeding for longer periods increased subcutaneous fat thickness while Eply et al. (1968) and Zinn et al. (1970) also showed increased tenderness due to a longer feed interval.

Appearance. The color of beef muscle will vary with the age of the animal, ranging from the pink in veal to bright cherry-red in yearlings and two-year-olds to the deeper shades of red characteristic of older animals. Occasionally the meat from younger, animals, will have a very dark red color, so dark that it appears somewhat black (Romans and Ziegler, 1977). In general, darker color denotes meat from animals of advanced age, meat from stressed animals, bull meat or meat that has been exposed to air for too long.

Dark cutting beef is related physiologically to pale, soft and exudative pork. The occurrence of either muscle condition depends on the rate of muscle glycogen (starch) breakdown. Muscle has only about .5 to 1.0% glycogen, and when this glycogen breaks down in muscle, it forms acid. The acid condition in muscle alters the muscle protein structure and color in such a way that a very acid condition (low pH) produces pale, soft and watery muscle, while an alkaline condition (high pH) produces dark, firm, and dry muscle. When some animals are stressed, a break down of glycogen and acid formation in the muscle will occur. If the animals are not slaughtered during the time the muscle pH is in the acid condition, but at a later time, when the lactic acid has been removed from the muscle by the living animal's processes, but still before more glycogen is stored in the muscle, the muscle will be dark, firm and dry (Forrest et al., 1975).

Consumers expect raw materials to have an attractive color. A dark color is often associated by the consumer with a lack of freshness, even though it usually indicated an old animal, or stressed animal. Such an impression reduces the expectations for flavor when the meat is consumed. With respect to fat, the most desired color is a creamy white. Yellow fat is less appealing although it does not affect the palatability of the cooked product (Forrest et al., 1975).

According to Kemp (1980) color has little effect on eating quality, but greatly affects salability and appearance. Dark cutting beef has been shown to be equal in palatability to normal beef, althouh it is more susceptible to microbial action. Thus, discrimination against it in the market place is unfounded. Yet the consumers remain suspicious of any abnormality in muscle color (Romans and Ziegler, 1977).

Taste Panel Evaluations

Sensory evaluation has been defined as a "scientific discipline used to evoke, measure, analyze, and interpet reactions to those characteristics of food and materials as they are perceived by the senses of sight, smell, taste, touch, and hearing" (Institute of Food Technologists, 1975).

Psychological measurement tests can be classified according to the kind of psychological functioning required of the subject as:

(a) AFFECTIVE-tests based on preference, pleasure-displeasure, like-dislike;

(b) DISCRIMINATIVE-tests based on judgment which may be concerned with difference per se or difference on a specified dimension;

(c) DESCRIPTIVE-test requiring the sorting out of the many separable qualitative dimensions which explain peoples' behavior toward products (Peryam, 1964).

Preference testing as used in sensory evaluation has been defined by Amerine et al. (1965) as follows:

(1) Expression of higher degree of liking; (2) Choice of one object over others; (3) Psychological continuum of affectivity (pleasantness-unpleasantness) on which such choices are based. This continuum is also referred to as that degree of liking or disliking.

According to Ellis (1967), preference is sometimes used inter-changeably with acceptance. The two terms are related, but they are not the same. Acceptance has been defined by Amerine et al. (1965) as follows:

(1) An experience, or feature of experience characterized by a positive

attitude; (2) Actual utilization (purchase, eating), may be measured by preference or liking for specific a food item.

One factor that makes comparisons of results from one experiment to another, or from one laboratory to another, extremely difficult, is that sensory judgments are relative (Dikeman, 1977). When people are used as a measuring instrument, it is necessary to rigidly control all testing methods and conditions to overcome errors caused by psychological factors. "Error" is not synonymous with mistakes, but may include all kinds of extraneous influences. The physical and mental condition of the panelist and the influence of the testing environment affect sensory tests (Larmond, 1977).

Various rating scales have been developed for preference testing. The best known rating scale is the nine-point hedonic scale (from "like extremely" to "dislike extremely") developed at the United States Army's Quartermaster Corps for the purpose of determining preference as predictors of army food acceptability (Peryam et al., 1952).

Variations of the hedonic scale include five, six, seven and eight-point scales. Jones et al. (1955) determined:

(1) that longer scales up to nine intervals tend to be more sensitive to preference differences;

(2) that elimination of the "neutral" category seemed to be beneficial; and

(3) that balance (an equal number of positive and negative intervals) is not an essential feature of a rating scale.

Sensory evaluation panels can be grouped into three types: highly trained experts, laboratory panels, and large consumer panels. Morse (1951) clarifies a distinction between the taste panel and the consumer panel. The consumer panel is composed of a sample of consumers selected so as to represent a specified portion of the total population of consumers; the taste panel, of persons who are highly skilled in taste perception. Members of the taste panel, who admittedly are consumers, function only as a unique part of the laboratory equipment, performing taste tests which only the human organism can do, or which the human organism can do most satisfactorily.

Trained taste panel. Evaluations by trained laboratory panels can be useful for control purposes, for guiding product development and improvement, and for evaluating quality. The trained panel can be especially useful in the assessment of product changes for which there is no adequate instrumentation.

According to results of a questionnaire assembled by Cross (1977) institutions who conducted sensory evaluations used an average panel size of 7.8 members, with a range of 5 to 10 members. Also, he noted that the maximum number of sessions held per day by the institutions was 1.9, with 8.0 as the mean sessions per week, using an average of 6.3 samples per session.

Currently, meat flavor cannot be accurately evaluated by chemical or instrumental methods. Thus, taste panels must be relied on for meat flavor evaluation.

Consumer Panels. The fate of a food product has always rested on acceptance by the consuming public, but formal studies of consumer preference are a comparatively recent development, being especially emphasized in the 1970's.

Consumer studies are popular for they present a useful approach to estimating the marketability of a product (Morse,1951). Objectives of Consumer Preference investigations outlined by Morse (1951) include:

(a) To effect a better coordination of production and supply with consumption.

(b) To discover and to evaluate factors which influence consumer preferences.

(c) To establish a basis for appraising the adequacy of the market system.

One basis of classifying consumer studies by Morse (1951) is the extent of consumer-participation in providing the information. Four methods are commonly used: (1) Individual consumers are observed in the market. In this case the consumers in no way consciously participate in providing information. (2) The products actually found in homes are inventoried. In this case the consumer's cooperation must be secured for permission to ascertain what products are on hand. (3) A relatively fixed consumer panel is developed. This method requires complete cooperation of the consumer. (4) Consumers are interviewed as to their actions and their perceptions with regard to the product. This method calls for full participation of consumers, and is one which is very widely used.

Preference testing generally takes place in booths in stores, lobbies, fairs, transportation centers; in food markets; in church, school or club dining rooms; or in mobile units which operate in well-populated and travelled areas (Simone and Pangborn, 1957; Coleman, 1964).

Advantages of testing in such public places (rather than in the home) according to Morse (1951) include the following:

(1) The researcher can maintain control over product handling, preparation, serving and questioning of the consumer;

(2) Only the flavor characteristics under study can influence the consumer; and

(3) The chance of incorrect entries on questionnaires is minimized.

Home testing may be used for impartial appraisal of products when no labels or other company identification is used. In development guidance testing, pre-selected stratified family panels of fifty members each are usually large enough to give directional results. Instructions for preparation and use of products and questionnaires for each family member to evaluate the products are standard procedure in home testing (Morse, 1951).

An advantage noted by Morse (1951), of the home testing method is that factors (such as the package, appearance of the uncooked product, the cooking aroma, and behavior in handling) which may influence acceptance before the product is tasted can be evaluated. He also noted disadvantages which included; (1) loss of control in preparation so that improper handling or misunderstanding of directions may cause poor acceptability of a product on tasting, and (2) misunderstanding of the questionnaire may cause incorrect entries and thus lead to wrong conclusions (Coleman, 1964).

Cross (1977) summarized data received from 48 individuals representing 48 institutions or organizations that now conduct research on meat and concluded that 54% of the researchers use home consumer panels, 33% use controlled and 13% use other types of panels. Panel size for controlled panels averaged 96.9, while take home panel mean was 96.5.

Mechanical Evaluations. Most aspects of quality can be measured only by sensory panels, although advances are being made in the development of objective tests that measure individual quality factors. As instruments are developed to measure quality, sensory evaluations by this method will be used (Larmond, 1977).

Although sensory evaluation is the ultimate authority regarding the determination of the sensory properties of foods, it is a time-consuming and costly method of analysis. Development of instrumental methods to grade produce, monitor production on-line, and evaluate the effects of processing or storage treatments has progressed considerably from simple physical or chemical tests to sophisticated instrumental procedures which are correlated by several advanced statistical techniques with the sensory attribute (Noble, 1975).

Tenderness Measurement. Two instrumental methods have pre-dominated in tenderness measurement, the Warner-Bratzler meat shear and the Texture Test System (Dikeman, 1977). Shear force value is the most widely used objective method of measuring tenderness. Shear force values are obtained on a specially prepared sample of meat. A core of meat is prepared and then cut across the grain with a knife of the electrically powered Warner-Bratzler Shearing Device. The force needed to do the shearing (cutting) is registered in pounds. Higher shear force values indicate tough meat and low values indicate tender meat (Dikeman, 1977).

The Texture Test System, which was originally called the Kramer Shear Press is the other measure of tenderness. The accuracy of recording and the deformation control are not as good as those of Warner Bratzler machines.

Instrumental analysis of color, texture, and flavor can be grouped into two general categories outlined by Noble (1975):

(1) IMITATIVE MEASUREMENTS, in which the property is assessed by a device which imitates the way in which humans perceive the sensory property.

(2) NON-IMITATIVE MEASUREMENTS, in which any chemical or physical property of the food system which statistically correlated with the sensory

parameter is determined.

Generally speaking, texture and color have been successfully evaluated by both imitative and non-imitative instrumental methods, whereas flavor has only been investigated by non-imitative techniques (Noble, 1975).

Texture. Extensive research has been done on the use of instruments in meat texture evaluations with the correlations ranging from highly significant to nonsignificant. It is important to distinguish between a mechanical test applied to raw meat to predict the tenderness of the cooked product, and an objective method for measuring the tenderness of cooked meat. Despite the progress made so far, much additional work is needed before a satisfactorily predictive test can be established for raw meat (Dikeman, 1977).

Color Measurement. Noble (1975) noted in the assessment of color, instrumental determination of hue, purity, and lightness is extremely reproducible and correlated well with human perception of color. Colorimeters, which measure reflected or transmitted light, often are more sensitive than the human eye, except for very dark colors.

Flavor Measurement. For the evaluation of flavor, no imitative procedure is available to measure the chemical or physical properties of molecules that produce aroma or taste, primarily because the mechanism by which we taste and smell are not well understood (Noble, 1975).

Noble (1975) concluded that despite the advantage of instrumental techniques over sensory evaluation in providing consistent and high speed determinations without the attending problems of judge fatigue and fallibility;

valid and predictive techniques for the measurement of texture, color and flavor of foods can be developed only by correlation with the ultimate authority for the assessment of sensory properties of food (analytical sensory evaluation data).

Tenderization Methods

Electrical Stimulation. Improving the quality and palatability of meat by administering electrical stiumlation (ES) to carcasses during the slaughter-dressing sequence has been one of the most talked about innovations in the recent history of the U.S. meat industry (Savell and Smith, 1981). Use of electrical stimulation to increase meat tenderness is not a new idea, it's use for this purpose was first suggested by Benjamin Franklin in 1749 (Lopez and Herbert, 1975).

Harsham and Deatherage (1951) found that electrical stimulation increased the rate of postmortem glycolysis in beef. Carse (1973), Chrystall and Haggard (1976) and Davey et al. (1976) suggested that electrical stimulation could be used to prevent cold-shortening or to increase the rate of conditioning carcasses. Chrystall and Haggard (1975), Grusby et al. (1976) and Savell et al. (1976) reported substantial increases in tenderness of lamb and beef by the use of electrical stimulation. Savell et al. (1977, 1978a,b,c, 1979) and McKeith et al. (1981) established that electrical stimulation improves the palatability of beef steaks. Davey et al. (1976), Savell et al. (1979) and McKeith et al. (1981) found evidence that electrical stimulation brightens muscle color, improves lean maturity and decreases incidence of "heat-ring."

The consumer is probably the greatest beneficiary to the use of electrical stimulation. Palatability ratings for tenderness of steaks from electrically stimulated carcasses are improved, on the average, about 21% when compared to palatability ratings for tenderness of steaks from non-stimulated carcasses (Savell, 1979). In addition, flavor scores for steaks from electrically stimulated carcasses are improved about 10% when compared to their controls. Increasing tenderness and flavor while reducing the chances of obtaining a tough steak are significant factors in favor of the consumer realizing the optimum in eating satisfaction (Savell and Smith, 1981).

Although electrical stimulation is far from being fully utilized on a nationwide basis, several states-Texas, Colorado and California have many of their beef slaughter plants using this process. Electrical stimulators can be found in almost half of the states of the nation with commercial adoption becoming more widespread each month. Most meat industry personnel feel that electrical stimulation will become standard procedure during the decade of the 1980's and will become an integral step in the conversion of live animals into meat and meat products (Savell and Smith, 1981).

Aging. Aging is holding beef under refrigeration for 7-14 days postmortem (Olson, 1981). According to Kemp (1980) aging under controlled temperature and humidity affects tenderness and flavor and generally is used only for beef. Meat contains protelytic enzymes called cathepsins. These enzymes soften both muscle and connective tissues during cooler storage and improve tenderness. The tenderizing effect occurs faster at higher temperatures. However, bacteria also grow more rapidly at higher temperatures, so aging temperature is normally below 6° C.

Meat is aged both as hanging carcasses (dry aging) and as wholesale cuts in vacuum packages (wet aging). The trend is toward the latter, as more and more beef is being vacuum packaged and sold as "boxed" beef. (Kemp, 1980). Cooler space is generallly at a premium in an industry which depends greatly on turnover and volume to make a profit. Most primals usually move out within a week and long-time aging, as such, is not widely practiced (Romans and Ziegler, 1977).

Work at South Dakota by Romans and Tuma (1964) showed that 10 days aging primal ribs improved tenderness compared to 5-day aging, but that tenderness did not improve significantly from 10 to 15 days postmortem. Thus the present-day systems of marketing, which consume about seven days from slaughter to retail without a specified aging time, are probably allowing nearly the full expression of tenderness to develop (Romans and Ziegler, 1977).

High temperature aging of beef is one method which will accelerate the aging process from 7-14 days to 2-5 days (Olson, 1981). Holding beef at elevated temperatures prior to chilling has the additional benefit of reducing the extent of myofibril shortening due to cold temperatures. If muscles are subjected to cold temperatures (below 2°C) before rigor is developed, they will shorten drastically. High temperature aging pre-chilling assures rigor development while muscle temperature is still relatively high (Olson, 1981).

Electrical stimulation may also accelerate the aging process. Electrical stimulation accelerates the development of rigor which results in earlier release of calcium. Since calcium is released earlier by the use of electrical stiimulation, activation of the Calcium Activator Factor for the resolution of rigor and consequently the weakening of the myofibrillar structure should occur earlier. This effect may be most important for low collagen meats. Collagen, apparently, is affected very little by electrical stimulation (Olson, 1981).

Savell et al. (1981) found that electrical stimulation had the greatest impact on beef palatability if the period of aging was 8 days or less; with additional aging time, the effects of electrical stimulation on palatability are negated.

Mechanical Tenderizers. The mechanical disruption of the natural state of muscle as a means of improving meat tenderness has long been practiced. The mechanization of the process of using pins, blades, needles or knives in a reciprocating machine for that purpose has now achieved widespread use (Breidenstein and Carpenter, 1983). All cuts can be mechanically tenderized, but the tenderizer is mainly used on primal cuts (rib and loin) from lower quality grades and the less tender cuts (chuck, round, shank, etc.) of higher grading carcasses (Romans and Ziegler, 1977).

Olson (1981) reported that meat can be blade tenderized in either a fresh or a tempered state (meat brought from a frozen state up to -2--4°C). Because there is more rigidity to the meat in the tempered state, more tenderizing action occurs when meat is mechanically tenderized in the tempered state. However, larger blades are needed for tenderizing tempered meat than for fresh meat due to the greater resistance encountered with tempered meat. Quality of the meat is affected very little by the mechanical tenderizing process. Cooking time may be reduced due to mechanical tenderizing. Blade tenderized meat, also may appear to be more well done at the same cooked temperature as un-tenderized meat. Flavor and juiciness are not affected by the mechanical tenderizing process, however tenderness is improved tremendously. For these reasons, mechanical tenderizers are used extensively by meat purveyors that cater to institutional food services and restaurants.

Miller (1975) reported that meat purveyors used mechanical tenderization to insure that steaks and roasts will be acceptably tender when served to restaurant customers. Several studies have been conducted to determine the usefulness of mechanical tenderization (Goldner and Mandigo, 1974; Davis et al., 1975; Savell et al., 1977). However, when mechanical tenderization has been used on meat from cows and bulls (Tatum et al., 1978; Smith et al., 1979), this process did not improve the product enough to make it comparable to high-quality beef.

The only major disadvantage of mechanical tenderizing are the expense of of the equipmennt and the potential contamination of meat. Since these meats are not cured, large quantities of meat can be innoculated with microorganisms from the blades of the tenderizer from a contaminated piece of meat that has been passed through the tenderizer. Sanitation and quality control of the operation is very critical (Olson, 1981).

Enzyme Tenderizers. Enzyme tenderizing is the application of exogenous enzymes that degrade or soften the myofibrillar and connective tissue proteins (Olson,1981). As a general rule, tenderizers have a three-fold effect: (1) the product is more tender;, (2) the tenderizer contributes to the flavor and can be detected;, and (3) the flavor of the initial product is not enhanced (Levie, 1970).

The enzymes approved for use by the USDA are ficin from fig, bromelin from pineapple, papain from papaya and aspergillus oryzae protease. These enzymes are broad spectrum proteases that will degrade many different proteins. Some enzymes have greater affinity for the myofibrillar proteins like A. oryzae protease and papain than the connective tissue proteins (Olson, 1981).

The application systems used in enzyme tenderizing include spraying the tenderizer on the steak surface, dipping steaks through a tenderizer solution and pumping the tenderizer solution into sub-primal cuts. Pumping is not universally used because present commercial pumping equipment can not pump beef at the 3% level continuously and uniformly. In spray and dip operations, the amount of pick-up is controlled by meat temperature and chain speed. Another process, which is patented by Swift, uses the injection of an enzyme solution into the blood stream of an animal just prior to slaughter, allowing the circulatory system to distribute the enzyme in the body uniformly. This method has not gained wide industry acceptance because there is no control of enzyme levels in all muscles, some carcass parts have enzymes applied that are not desirable such as livers and trimmings, and the expense of handling each animal is very high (Olson, 1981).

Enzyme tenderizers are usually applied to meat as a solution of water, salt, flavorings and enzyme(s). A 3% pick-up in added weight is allowed by the USDA (Romans and Ziegler, 1977; and Olson, 1981). This additional weight makes enzyme tenderizing economically beneficial to the processor. Enzyme concentration in the meat after application is generally less than 10 ppm. Salt concentration can be as high as 0.5% which has significant flavor enhancing properties at that concentration (Olson, 1981).

Salts in concentrations of two percent are effective. Applicatiion of this sort is what is commonly referred to as curing, corning, and sweet pickling (Levie, 1970). The use of weak acids, such as vinegar, lemon junice and lactic acid is a traditional marinade used for overcoming connective tissue toughness. These marinades promote the swelling of collagen, which requires some disruption of hydrogen bonds within the collagen fibril. These marinades are of questionable value as far as tenderizing is concerned, but they usually contribute to a flavor change in the final product (Levie, 1970).

The tenderizing action of enzymes actually occurs during cooking. A small range of 32°C-54°C is the range where the greatest enzyme activity occurs. Enzymes are essentially activated and denatured or destroyed during the cooking process. Only a couple of minutes in that temperature range is needed for maximum tenderization. If the meat with applied enzymes is held in that critical temperature range for even a few extra minutes, over-tenderization of the meat will occur. Over-tenderization and uniform tenderization are still the two major problems with enzyme tenderizing (Olson, 1981).

Bull versus Steer

Castration of male meat-producing animals, particularly cattle, sheep and swine, has long been a traditional practice in the United States. This practice is intended to produce an animal more acceptable to current management systems and provide a more desirable carcass for marketing. During the past four decades, a number of research studies have been conducted to assess the performance and meat characteristics of castrates versus non-castrates. In general, the results have indicated that intact males grow more rapidly, utilize feed more efficiently and produce a higher-yielding carcass (more retail product) with less fat and more red meat than castrates (Seideman et al., 1982).

According to Field (1971) the increased interest in meat production from intact males is related to the declining demand for animal fat, the increased emphasis on more efficient red meat production, and the need for greater amounts of animal protein for our increasing world population.

Increased production efficiency obtained through the use of intact males has often been offset by management problems, particularly with animal behavior. Meat production from intact males has encountered strong resistance from packers, in part because of the price difference between carcassses from bulls and steers. The price difference is a result of the lower USDA quality grade of bulls and the belief that beef from intact males has lower consumer acceptance at the retail level because of differences in color, texture, tenderness and fat distribution (Seideman et al., 1982).

Reviews done by Seideman et al. (1982) show that despite the presumed disadvantages, intact males are the chosen alternative in many countries for red meat production (Berg and Walters, 1983).

Growth Characteristics. Studies to quantify the differences between bulls and steers in feedlot performance generally have indicated that bulls show an advantage in average daily gain, are more efficient converters of feed to meat, and have decreased amounts of fat over the longissimus (Klosterman et al., 1954; Field et al., 1966b; and Field, 1971). Arthaud et al. (1977) reported that at all ages (12, 15, 18 and 24 mo of age), bulls gained faster on less feed per unit of gain and produced carcasses with lower fat percentages than steers.

Implantation Effect.Bailey et al. (1966) showed that synthetic estrogen implants of intact bulls increases the fatness of their carcasses. This effect is in contrast to that obtained in steers. Baker and Arthaud (1972) reviewed 40 research papers on this topic and found that one-third of the studies concluded that hormonal treatment had a negative affect on rate of gain while another one-third concluded that the effect was negligible. Bailey et al. (1966) found that hormone treatment increased fat deposition in bulls but decreased fat deposition in steers.

Stilbesterol treatment tends to increase fat deposition in bulls and under certain conditions improves carcass grade (Klosterman et al., 1955; Cahill et al., 1956; and Bailey et al., 1966); however, the hormone has little or no affect on tenderness of meat from bull carcasses. Cahill (1956) reported that carcasses of treated and untreated bulls were similiar in tenderness. Bailey et al. (1966) reported that stilbesterol implantation (60 mg) decreased percentage ether extract in the longissimus muscle of steers, but increased intramuscular fat slightly in bulls. Differences in tenderness and flavor between bulls and stilbestrol-treated steers were statistically nonsignificant.

Management Concerns. Hunsley (1971) and Seideman et al. (1982) concluded that a production problem associated with raising bulls is their aggressive manner and subsequent destruction of fences, feeders, etc. Some producers have reduced this problem by backgrounding calves and yearlings together in a pasture or in a large confinement area before placing them together in the feedlot. During this time period, they will "work out" a social structure order and become adapted to their diet. Once in the feedlot and until time of slaughter, bulls should never be mixed with strange animals, and the group should stay together through all phases of finishing and marketing. Oltgen (1982) advised to keep sick bulls within a pen to treat them since removal for a few days results in a re-establishment of the social order in the pen. Breed and seasonal changes in the weather could influence behavior but these effects have yet to be documented.

Price and Tennesson (1981) investigated the influence of social interaction among bulls before slaughter on the incidence of dark cutting muscle. They concluded that load size effects were not significant but mixing and re-grouping strange bulls together significantly increased the incidence of dark-cutting muscle from 2% to 73%. In addition, Field (1971) concluded that because of their temperment, bulls may be stressed more easily than steers. Therefore, they may need to be handled more carefully to prevent stress. Greater amounts of antemortem stress contributes to a darker colored lean.

Carcass Merit. Carcass quality is an important element in determining the feasibility of bull beef production (Bailey et al., 1966).

Young bulls produce carcasses that contain more muscle and less fat than steers (Bailey et al., 1966; Arthaud et al., 1969; and Jacobs et al., 1977). Also, young bull beef is slightly less palatable and slightly more variable in palatability than beef from steers (USDA, 1980). Therefore, when young bull carcasses are officially graded by USDA graders, the standards require the grade designation to also include the word "Bullock".

Dressing Percent. Work done by Field et al. (1964) and Field (1971) showed that differences in dressing percent for bulls and steers were not statistically significant.

Cutability Considerable research has shown that bull calves fed intact to slaughter weights, produce leaner carcasses if finished at a younger age (12-15 mo). In work done by Field et al. (1964), Arthaud et al. (1969), Hedrick et al. (1969), Jacobs et al. (1977) and Landon et al. (1978), results showed that bull carcasses yielded a higher percent of retail cuts. Champagne et al. (1969) found a difference of 4.8 percentage points in actual carcass cut out. Field (1971) reported that bulls had an average advantage over steers of 2.6 percentage points in estimated boneless chuck, rib, loin and round. In addition, bull carcasses were shown to have larger rib-eye areas by Field et al. (1964), Arthaud et al. (1969) and Jacobs et al. (1977).

✓ Jacobs et al. (1977) reported that, on a boneless basis, bull cacasses contained 58% less crude fat and 23% more crude protein than steer carcasses. Bull carcasses yielded 5.5% more boxed beef than steers, and cutting trim waste was 17% less than in steers. Bull carcasses had higher in-store retail yields and because of that increased yield were worth 15% more to the retailer than steer carcasses. Although carcass values were calculated using the same price per kilogram, differences in retail yield calculated by Jacobs et al. (1977) indicated that beef from bulls could have been sold for 22 cents per kilogram less and still have returned more than steer carcasses.

Fat Thickness. Bullocks usually have less subcutaneously and intramuscularly fat than steers fed for comparable periods (Smith, 1982). Work by Field et al. (1964), Arthaud et al. (1969) and Jacobs et al. (1977) supports the conclusion that bull carcasses have less trimmable outside fat.

Quality Grade. Seideman et al. (1982) concluded from their review of literature that bullocks would, on the average, produce carcasses with lower quality grades, darker lean color and coarser-textured lean with less marbling, lesser quantities of subcutaneous fat and a high incidence of "dark-cutting" lean.

Reports of Field (1971), Seideman et al. (1982) and Cross and Allen (1982) indicate that bullocks deposit less marbling and quality grade lower than steers when fed for comparable periods on the same diet. Cross and Allen (1982) presented data from 16 research studies. In their report, bullocks had a mean marbling score of "Slight-typical" and a mean USDA quality grade of Average-Good while steers had "Modest-minus" marbling and Low-Choice grade.

Results of Field et al. (1964), Bailey et al. (1966), Arthaud et al. (1969), Jacobs et al. (1977), Seideman et al. (1982) and Riley et al. (1983a) show higher marbling scores and a brighter, finer textured lean, thus a higher USDA quality grade for steers than bulls. Meat from bulls has been shown to be darker in color and coarser in texture than meat from steers (Arthaud et al., 1969; Champagne et al., 1969; and Field, 1971). In addition to having darker muscle color when muscle pH is in a normal range, bullocks are more likely to be "dark cutters" than are steers (Smith, 1982).

Tenderness

Maturity. Hedrick et al. (1969) and Arthaud et al. (1977) noted that chronological age did not seem to influence the flavor and juiciness scores of steaks from bulls. Field (1966) reported that flavor and juiciness scores were not affected significantly by age of bulls when marbling was held constant, but that roasts from older bulls were generally scored lower. Reagan et al. (1971) noted that steaks derived from bulls may acquire undesirable flavor traits between the ages of 385 and 484 days of age. Field (1971) indicated that slaughter age may be an important factor affecting tenderness of bull carcasses. The consensus among most researchers indicates that bulls should not be slaughtered later than 15 months of age (Jacobs et al., 1977).

Flavor. Hood and Allen (1970, 1971) reported that the aroma of cooked beef differed significantly between the sexes. However, in general, very little difference, and no meaningful trends, have been reported in flavor of meat obtained from bulls versus steers (Field, 1971).

Palatability of Cooked Beef

The bulk of scientific evidence (Smith and Merkel, 1982) suggests that bullocks produce beef that is usually less desirable in flavor, less juicy, and less tender than beef from steers and heifers. Generally, the results of Bailey et al. (1966), Arthaud et al. (1969), Field (1971), USDA (1980), Jacobs et al. (1977) and Seideman et al. (1982) indicate that bulls are lower in tenderness and more variable in tenderness than steers or heifers. However, Cahill et al. (1956) observed that differences in tenderness disappeared after 13 days of aging.

Glimp et al. (1971), Albaugh et al. (1975), and Arthaud et al. (1977) reported that bull meat had acceptable tenderness ratings, but that ratings were slightly lower than those for steer meat. Landon et al. (1978) observed no differences in Warner-Bratzler shear force values due to sex condition. Hunsley et al. (1971) concluded that sex and chronological age may have a more adverse effect on tenderness in bull beef than in steer beef. Field (1971) reported that, in seven of seven studies, bull beef had higher shear force values than steer beef. Hedrick et al. (1969) reported that Warner-Bratzler shear force values and sensory panel scores indicated that steaks from bulls less than 16 months of age were comparable in tenderness to steaks from steers and heifers of similiar age, where as steaks from more mature bulls were less tender. Flavor and juiciness scores of cooked steaks were not significantly affected by sex condition.

Klosterman et al. (1954) reported only slight differences in tenderness between bulls and steers slaughtered at a relatively young age. Seideman et al. (1982) concluded that although lower and more variable tenderness of bullock beef was a decided disadvantage, bullock beef was not less desirable in flavor or juiciness than steer beef.

Alternatives

It is obvious from past research that meat from young bulls is tougher and more variable in tenderness and darker in color than that from steers. Differences in tenderness perhaps could be caused by myofibrillar shortening (cold shortening) or connective tissue. Perhaps some of the deficiencies could be corrected with altered antemortem and postmortem handling techniques. Pre-slaughter handling and feeding before slaughter could possibly influence the muscle glycogen level at death and eventually the ultimate pH and muscle color (Seideman et al., 1982).

Postmortem treatments might include electrical stimulation and control of the rate of temperature decline. Electrical stimulation is used widely by beef slaughters (Savell, 1979) and it is well established that electrical stimulation improves the palatability of beef steaks (Savell, 1977, 1978a,b,c, 1979; McKeith et al., 1981). Furthermore, subcutaneous fat thickness is related to beef tenderness through its action as an insulator which reduces the rate of chilling and muscle fiber cold-shortening (Smith et al., 1976; Dolezal et al., 1982; Tatum et al., 1982). If electrical stimulation could eliminate some of the variations in tenderness from young bulls and(or) if some minimum fat thickness could assure that beef from young bulls would have "acceptable" tenderness, their utilization would become more widespread (Cross and Allen, 1982).

Riley et al. (1983b) investigated the effects of electrical stimulation and subcutaneous fat thickness on tenderness of the longissimus muscle of bulls and steers. They found that electrical stimulation produced the greatest improvement in tenderness of steaks from young bulls with less than 6.5 mm fat thickness and essentially eliminated differences in tenderness of steaks from young bulls differing in fat thickness. They reported few differences in tenderness between bulls and steers when the fat thickness exceeded 7.62 mm. In contrast, Crouse et al. (1978) found no effects of electrical stimulation on tenderness of bulls but significant effects on steers. They also found that high temperature conditioning did improve tenderness.

Electrical stimulation improves lean color and texture and improves marbling development of steer and heifer beef (Savell et al., 1978a,b,c, 1979; McKeith et al., 1981). Further more, Savell et al. (1982) found that electrical stimulation improved lean maturity, overall maturity, marbling and USDA quality grades of young bulls. Additional work by Riley et al. (1983b) concluded that electrical stimulation decreased the variation in palatability of steaks from young bulls.

Consumer Acceptance. Research done by Field et al. (1964), Arthaud et al. (1966), Jacobs et al. (1977) and Seideman et al. (1982) conclude that consumers consistently preferred steer beef when compared to bull beef in terms of tenderness. Hawrysh et al. (1979) found only slight differences between beef from bulls and steers and found the bull beef to be well within the acceptable range for quality.

Jacobs et al. (1977) found that over 85% of consumers survey indicated that retail cuts from bulls were "as good" or "better" than beef they normally purchase. In-store questionnaires revealed that over 65% of the consumers interviewed were able to detect differences in tenderness. Over 44% of these consumers felt that "leanness" was most important in visual selection of retail cuts when color, leanness and marbling were considered, and over 47% felt that "marbling" was least important.

Although consumers can detect differences in palatability between bull and steer beef, this does not imply that beef from young bulls is "unacceptable". It is quite possible that present and future consumers have or will have a lower threshold of acceptability/unacceptability than did those of the past or that leanness is becoming more important than palatability (Cross,1977).

Introduction

It has become increasingly evident that the beef industry needs to present their product to the consumer in a form and quality consistent with consumers' dietary and nutritional preferences. Consumers are resisting the purchase of trimmable fat, connective tissue, bone and are demanding leaner beef. This shift in preferences will become more pronounced as meat prices increase.

Information concerning shifts in consumer preferences would be useful to cattle producers in determining the kinds of cattle they should produce, and in planning how the cattle should be managed and marketed in order to maximize production efficiency.

Consumer preference of lean beef should make the intact male more attractive to the industry. Studies by Klosterman et al. (1954), Field et al. (1966) and Field (1971) showed that bulls grow more rapidly and are more efficient converters of feed to meat. In additional work, young bulls produced carcasses that contain larger rib eyes, more muscle and less fat that steers (Field et al., 1964; Bailey et al., 1966; Arthaud et al., 1969; and Jacobs et al., 1977).

In the past, meat production from intact males has encountered strong resistance, from producer to the retailer. This is due, at least, in part, to lower USDA quality grades assessed to bulls, and the belief that beef from the intact males has less consumer retail acceptance because of differences in color, texture, and palatability. Reports of Field (1971), Seideman et al. (1982) and Cross and Allen (1982) indicate that bullocks deposit less marbling and quality grade lower than steers when fed for comparable time periods on the same diet.

Meat from bulls has been shown to be darker in color and coarser in texture than meat from steers (Arthaud et al., 1969; Champagne et al., 1969; and Field, 1971). In addition to having darker muscle color when muscle pH is in a normal range, bullocks are more likely to be "dark cutters" than are steers (Smith, 1982).

In a literature review by Smith and Merkel (1982), the bulk of scientific evidence suggests that, bullocks produce beef that is usually less desirable in flavor, less juicy, and less tender than beef from steers and heifers. Seideman et al. (1982) concluded that although the lower and more variable tenderness of bullock beef was a decided disadvantage, it was not less desirable in flavor or juiciness than steer beef.

Research done by Field et al. (1964), Arthaud et al. (1966), Jacobs et al. (1977) and Seideman et al. (1982) concluded that consumers consistently preferred steer beef when compared to bull beef in terms of tenderness. According to Cross (1977), although consumers can detect differences in palatability between bull and steer beef, this does not imply that beef from young bulls is "unacceptable". It is quite possible that present and future consumers have or will have a lower threshold of acceptability/unacceptability than did those of the past or that leanness is becoming more important than palatability.

Recent interest in intact male production has stimulated attempts to improve the palatability and consequently the acceptability of meat from their carcasses. One method of potentially improving meat palatability in intact males is through the utilization of hormonal or other growth promoting implants. If improvement of palatability is feasible through the use of implants on intact males, a major impediment to their production might be removed.

This study was designed with the following objectives: 1) Determine whether implanted steers and bulls, as compared to non-implanted bulls affected consumer preference ratings of beef rib steaks. 2) Evaluate how consumer preference ratings of beef rib steaks from treatment animals compared to the results obtained from trained panel and WB shear ratings. 3) Determine the effect of consumer demographics on preference ratings for beef rib steaks from treatment animals.

Experimental Procedure

Animal Allotment and Treatment Procedures. Rib steaks were obtained from fifty-five fall born Simmental crossbred male calves, which had been randomly allotted at birth, into zeranol-implant treatments of: steers, implanted from birth until slaughter (S); bulls, implanted birth until weaning (IBW); bulls, implanted birth until slaughter (IBS); bulls, implanted weaning until slaughter (IWS); and non-implanted bulls (B). Calves were implanted every 100 d with 36 mg zeranol during their respective treatment periods. Steers were castrated at 5 months and all calves were weaned from their dams at an average of 250 d, and then transported to the Beef Research Unit at Kansas State University. After weaning, calves were fed a high concentrate corn based diet until slaughtered at 17 months of age (259 d on feed).

Post-Slaughter Procedure and Source of Steaks. All animals were slaughtered at a commercial kill plant, electrically stimulated after evisceration, allowed to chill 24 hours and were then graded by USDA personel. The left primal rib from all carcasses was removed between 24-36 hours and delivered to the Animal Science Meats Laboratory at Kansas State University. Primal ribs were allowed to age 7 days postmortem at 4°C and were then cut into retail steaks 2.54 cm thick. Rib steaks utilized in this study were taken from the 9th and 10th thoracic vertebral region (appendix A).

Individual steaks were identified by animal number and wrapped and quick frozen at -18°C and subsequently stored at -14°C. Before delivery to the consumer panel, steaks were sorted and labeled according to randomized designs and identified with the appropriate household number. Individual steaks in each household package were identified using a tag and metal clip to designate steak

A, while the untagged steak was identified as steak B.

Take-Home Panel Selection Procedure. Consumer panel participants were selected on a random basis from academic and non-academic university employees. Individuals were contacted by phone and were required to meet the following guidelines to participate: 1) eat beef on a fairly regular basis, 2) have from two to 4 adults (age 14 years or older) in the household that would particpate, 3) prepare steaks within two weeks of delivery and 4) assure return of response sheet in designated time period. Participants were informed that they were receiving beef steaks comparable in quality to those normally purchased from any commercial retail food outlet.

Trained Taste Panel Procedure. The trained panel consisted of six members. Members evaluated cores of steaks from animals representing all treatment groups. Steaks were cooked, in a modified oven broiler, to an internal temperature of 69 C. Using an 8-point hedonic scale, panelist evaluated the cores for tenderness, juiciness, flavor and overall acceptability.

Warner-Bratzler Shear Force Procedure.Shear force evaluations were done on steaks representing all treatment groups involved.

Randomized Design. Distribution was accomplished using three randomized designs. They included: 1)Design to determine variation between households and animals, together with treatment comparisons on 40 households (appendix B), 2) Design to determine estimates of treatment comparisons for 10 households (appendix C), 3) uniformity trial design to measure steak to steak variation when treated alike using the remaining five households (appendix D). All three designs were used to establish individual differences within households (figure 1).

Response Sheets. A total of 55 households containing 129 adult panel members participated in this study during June, 1983. A one-page instruction sheet was distributed along with the response sheets (appendix E). The instruction sheet presented the following information: 1) steak preparation guidelines, 2) method of cookery, 3) steak identification, 4) steak sampling instructions, 5) preference rating instructions, and 6) response return instructions.

A two-page sheet was used to record demographic household and individual information (appendix F). Individuals cooking the steaks were also asked to give a visual preference of the uncooked steaks, define cookery method and approximate degree of doneness (appendix G). Individual participants were asked on a one-page response sheet (appendix H), using a 8-point hedonic scale, their specific eating preferences for tenderness, juiciness, flavor and overall acceptability without any consultation between participants. After individual responses were completed, questions concerning household eating preference, based on overall quality, and questions regarding their households buying decisions in reference to steaks of similiar quality were addressed.

Statistical Analysis. Treatments were compared by use of ANOVA, which was constructed using information from all three randomized designs.

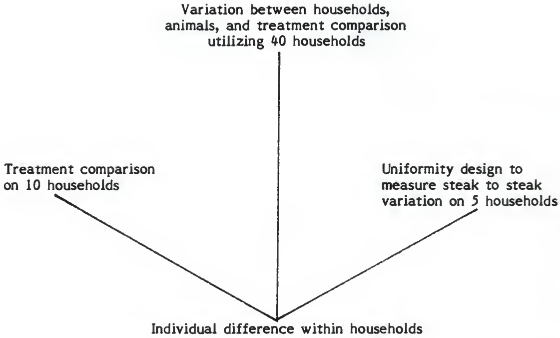


figure 1. Three randomized designs were utilized in this study to establish individual differences within households.

RESULTS AND DISCUSSION

Implanting bulls, using zeranol, to enhance overall palatability, is a viable alternative in livestock and meat production if used for the correct time period and at proper implant dosages.

Findings of this research suggest that implanting bulls from birth to slaughter made steaks from bulls as acceptable to consumer panels as those from steers. Implanting bulls from weaning to slaughter resulted in the least desirable consumer panel ratings for all palatability traits rated. These results were determined on data collected from a 100 percent response from 55 households surveyed.

I. Take-Home Panel Results

Take-home panel results showed that steaks from bulls IWS were rated significantly less desirable for panel juiciness than those of all other treatments. These bulls, as a group, averaged Slight 60 in marbling (which was the lowest degree of marbling of the five respective treatments). Panel ratings of steaks were not different for juiciness between S, IBS and B or between B and IBW (table 1). This results agrees with Champagne et al. (1969) who found no difference in juiciness ratings between longissimus steaks from bull and steer carcasses. These conclusions disagree with Smith and Merkel (1982) who reported from a review of literature that bullocks produce beef that is usually less juicy than beef from steers and heifers.

Differences in evaluation of juicnessness, when comparing bull versus steer meat, could be due to several variables, including; fat thickness, feeding regimes, extent and degree of marbling.

Ratings of panelists showed steaks from bulls IWS were rated significantly ($P<.05$) less desirable in flavor than all other treatments, except Bulls (table 1). This somewhat agrees with Bailey et al. (1966) who found consumer panelists tended to favor steers in terms of flavor. But, the above findings, are in contrast with the reports of Field (1971) who found no meaningful trends and very little flavor difference in meat obtained from bulls versus steers. Flavor desirability scores were similiar for steaks from bull and steer carcasses even when marbling scores were lower for bull carcasses (Glimp et al., 1971 and Jacobs et al., 1977).

It is generally agreed that lipids (fat particles) also act as flavor precursors, but the exact role that they play and the extent to which they affect meat flavor are unclear. Assuming that amount of marbling present affects flavor, it supports the finding that bulls IWS were the least preferred by panelist, as they had the lowest amount of marbling (Slight 60), while other treatments were ranked as not different in flavor. It now appears that in most cases, there is sufficient lipid material in lean meat (and beef, in particular) to allow development of normal flavor and that quantities of fat in excess of this are of little benefit (Wasserman and Spinelli, 1970).

Steaks from steers were rated as being more tender ($P<.05$) than all other treatments, except IBS. Steaks from Bulls and IBW were not significantly ($P<.05$) different, but those from bulls IWS were rated as less tender ($P<.05$) than all other treatments (table 1). These finding partially agree with those of Arthaud et al. (1969), Jacobs et al. (1977), and Seideman et al. (1982) who reported that bulls were lower in tenderness than steers and heifers.

In ratings for overall eating satisfaction, steaks from bulls IWS were the least preferred and were significantly (P<.05) different from all other treatments. Panelist ratings showed no significant (P<.05) difference in overall eating satisfaction between steaks from S, IBS and B or between B and IBW (table 1).

There was a clear trend for take-home panelists to rank steaks from bulls IWS as the least preferred and ranked steers and bulls IBS as the most preferred treatments. This is supported partially by Lamm et al. (1980) who reported that meat from bulls implanted with 36 mg of zeranol every 100 d, from birth to slaughter, tended to be more desirable in taste panel evaluations compared with non-implanted bulls.

Zeranol implants have been shown to inhibit semen production and development of sex organs (Fink et al., 1979). This may explain why bulls implanted from birth to slaughter were found to be similiar to steers in palatability, because implanting from birth to slaughter would have a castration-like effect, depressing produciton of testosterone. Those bulls not implanted until weaned would not be effected to the same degree, because implanting at an older age would suppress sexual development less, so thus bulls IWS would be more comparable pysiologically to non-implanted bulls.

II. Trained Panel Results

Trained panel members found steaks from steers were significantly more juicy than those from all other treatments (table 2). In flavor analysis, trained panelists rated steaks from steers significantly (P<.05) more flavorful than those from B and IWS (table 2). These results partially disagree with Field (1971) who reported panel differences for juiciness and flavor were small or nonexistent.

In ranking overall tenderness, trained panelist significantly (P<.05) preferred steaks from steers over all treatments, except IBS. Steaks from bulls IBS were significantly (P<.05) preferred over those from bulls IBW or IWS, but were not rated differently from non-implanted bulls. Non-implanted bull steaks were significantly (P<.05) less tender than those from steers but were not different from those of bulls IBW or IWS (table 2). These findings partially agree with work of Klosterman (1954), Bailey et al. (1966) and Field (1971) who reported that bull meat was slightly less tender than meat from steers.

Trained panel results largely agree with the finding of the take-home panel, but found more significant differences in evaluations of palatability traits, especially in juiciness and flavor. This would be partly expected as if differences did exist in flavor and juiciness, a trained panel would be more apt to detect apparent differences. In tenderness, both panels preferred steaks from steers and bulls IBS by significant amounts, indicating that large differences in tenderness did exist.

III. Warner-Bratzler Shear Force Results

When treatment steaks were subjected to Warner-Bratzler (WB) shear analysis, those from steers were significantly (P<.05) more tender than all other treatments. Non-implanted bull steaks had the highest WB shear values, but were not different (P<.05) than those from bulls IBS and IWS. Steaks produced from implanted bulls were not different (P<.05) in WB shear values (table 3). Work by Arthaud et al. (1977) and Jacobs et al. (1977) supports these findings that WB shear values for bulls were slightly less tender (P<.05) than from steers.

A difference exists in ranking in the WB shear that differed from the take-home and trained panel. The four groups of bulls IBW, IBS, IWS and B were evaluated as not different, but were significantly different from steers. Bulls IBW had a lower (non-significant) rating than did bulls IBS. This could be due to the depression of sexual development and masculinity at an early age thus resulting in an improvement in steak shear ratings. It is difficult to explain why a difference was not detected by either panels.

IV. Visual Preference by Consumers of Rib Steaks Prior to Cooking and Overall Eating Satisfaction After Cooking.

Comparison across treatments, from take-home panelist preferences, prior to cooking, are illustrated, by percentages, in figure 2. Prior to cooking, bull IBS steaks were ranked as the most desirable, having the highest percentage (50%) preferred when compared to all other treatments. Steaks from Steers were the least preferred visually, prior to cooking (35%), while panelist found bull IBW, B, and IWS steaks all to be preferred 40% of the time when compared individually to all other treatments.

Steaks from non-implanted bulls and bulls IBW had the smallest percentage of panelists (10%), finding no difference visually between them and all other treatments, while steaks from Steers and bulls IBS had the largest portion (25%), of panelist finding no difference prior to cooking between them individually and all other treatments.

Overall, a higher percentage of panelists preferred bull IBS steaks prior to cooking, and those from steers were ranked as the least preferred visually before cooking.

After cooking (figure 3), bull IBS steaks were preferred in overall eating satisfaction by the largest percentage (55%) of panelists, followed closely by steaks from Steers, preferred 50% of the time, when compared to those of all other treatments. Steaks from Bulls were ranked the least preferred, by panelists (30%).

A noticeable difference exists in panel eating satisfaction ratings after cooking, for steaks from individual treatments. Steaks from Steers and non-implanted Bulls had the greatest percentages of panelists finding no differences (25 and 20% respectively), while those from bulls IBS, IBW and IWS had only 5% of the panelists rating steaks as being non-different when compared to all other treatments.

Prior to distribution, all steaks were trimmed to approximately .75 cm outside fat, to help diminish differences in fatness. Even though external fat was similiar on all steaks, differences did exist in marbling. Steaks from Steers had the greatest amount of marbling, averaging Small 30, followed by; Bulls averaging (Slight 90); IBW (Slight 80); IBS (Slight 75); and IWS (Slight 60). Take-home panelist might possibly of equated the greater amount of marbling with excess fat, when ranking the steaks from Steers visually prior to cooking.

In evaluation of steaks prior to cooking, take-home panelist probably equated greater amounts of marbling with that steak being fatter. Since the current trend in consumer studies, has been toward leaner beef and consumption of less fat in the diet, panelists evidently discriminate against beef with greater amounts of marbling. With this reasoning, since steers had the highest degree of marbling, they would be the least preferred visually prior to cooking but due to marbling contribution to eating satisfaction, steer steaks are preferred after cooking and consumption. However, bulls IBS are still the most preferred treatment when sampled after cooking.

V. Demographic Information

No significant trends existed in demographic information analysis for age, sex, job or educational level. A trend did exist between income and all palatability traits.

Participants in the take-home panel were analyzed by their income class, according to their reported household total income category on the survey form (appendix F).

Those individuals in the income category of $30,000-$39,000 showed an interesting trend in their evaluations. This specific class, in evaluating the steaks for all the palatability traits, showed a definite trend toward not liking the steaks. As noted by figures 4, 5, 6, and 7 each palatability trait showed a similiar trend when this particular income class was graphed.

Explaining this trend is somewhat difficult, but could be tied into socio-economic variables. This class of people ($30,000-$39,000) is associated by marketing specialists as being a very average middle-income group. According to Coleman (1983), middle class Americans are becoming more interested in doing the right thing, what is considered to be popular (or in fashion). They are becoming more health conscious and are rejecting red meat as they believe its absence will help improve their diets. Levy and Mholakia (1984) have found the middle-class group does more comparison shopping, being more aware of the changing economic condition, and thus they may be cutting down on their meat consumption. All of the above factors may play a part in the middle-class group being more critical in their evaluation of red meat products.

TABLE 1. TAKE-HOME PANEL RESULTS[a]

	Treatments				
	S	IBS	IBW	B	IWS
Juiciness	6.94^{b}	6.60^{b}	6.24^{c}	6.39^{bc}	6.06^{d}
Flavor	6.90^{b}	6.61^{b}	6.61^{b}	6.45^{bc}	6.22^{c}
Tenderness	7.03^{b}	6.78^{b}	6.23^{c}	6.12^{c}	5.96^{d}
Overall	7.10^{b}	6.69^{b}	6.25^{c}	6.34^{bc}	6.13^{d}

[a]Panel ratings are based on an 8-point hedonic scale, with 8=most preferred and 1=least preferred.

[b,c,d]Means within rows with different superscripts differ ($P<.05$).

TABLE 2. TRAINED PANEL RESULTS[a]

	Treatments				
	S	IBS	IBW	IWS	B
Juiciness	6.33^{b}	5.91^{c}	5.85^{c}	5.83^{c}	5.73^{c}
Flavor	6.18^{b}	$6.08^{b,c}$	$5.93^{b,c}$	5.92^{c}	5.92^{c}
Tenderness	6.68^{b}	$6.46^{b,c}$	5.96^{d}	5.86^{d}	$6.03^{c,d}$

[a]Panel ratings are based on an 8-point hedonic scale, with 8=most preferred and 1=least preferred.

[b,c,d]Means within rows with different superscripts differ ($P<.05$).

TABLE 3. WARNER-BRATZLER (WB) SHEAR FORCE RESULTS[a]

	Treatments				
	S	IBW	IBS	IWS	B
WB Shear Evaluations	5.97[b]	7.22[c]	7.33[c,d]	7.67[c,d]	8.53[d]

[a]Panel ratings are based on an 8-point hedonic scale, with 8=most preferred and 1=least preferred.

[b,c,d]Means within rows with different superscripts differ ($P<.05$).

figure 2

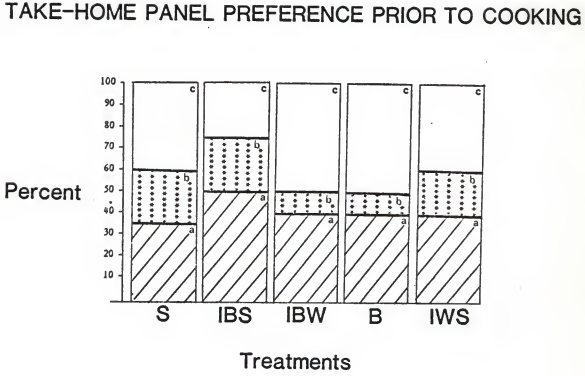

TAKE-HOME PANEL PREFERENCE PRIOR TO COOKING
Percent
100
90
80
70
60
50
40
30
20
10
a
b
c
S
IBS
IBW
B
IWS
Treatments

figure 3

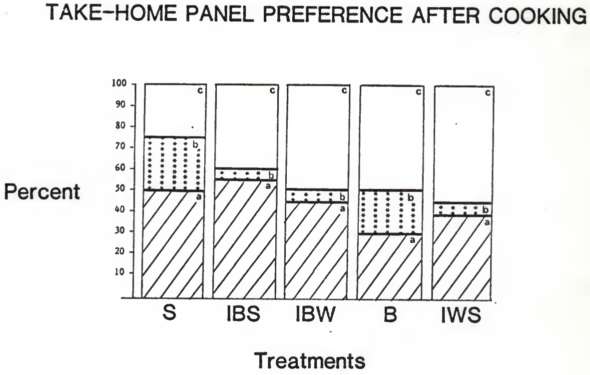

TAKE-HOME PANEL PREFERENCE AFTER COOKING
Percent
100
90
80
70
60
50
40
30
20
10
a
b
c
S
IBS
IBW
B
IWS
Treatments

figure 4
Effect of income class on tenderness perception

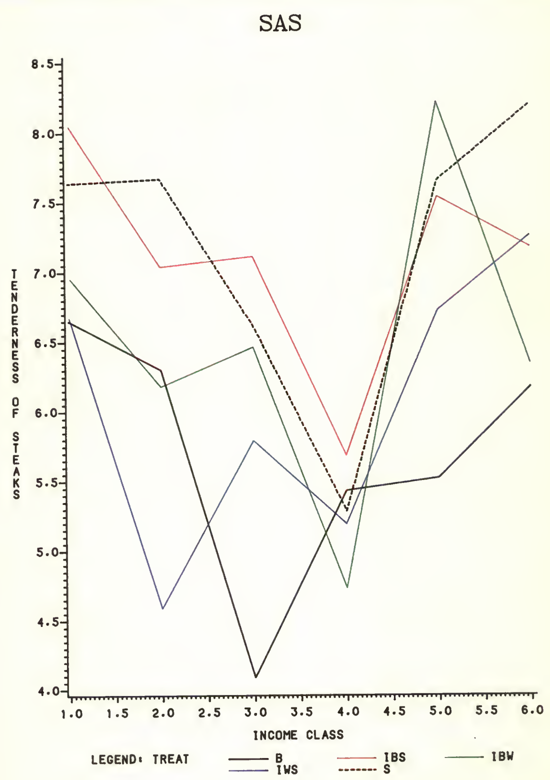


figure 5
Effect of income class on juiciness perception

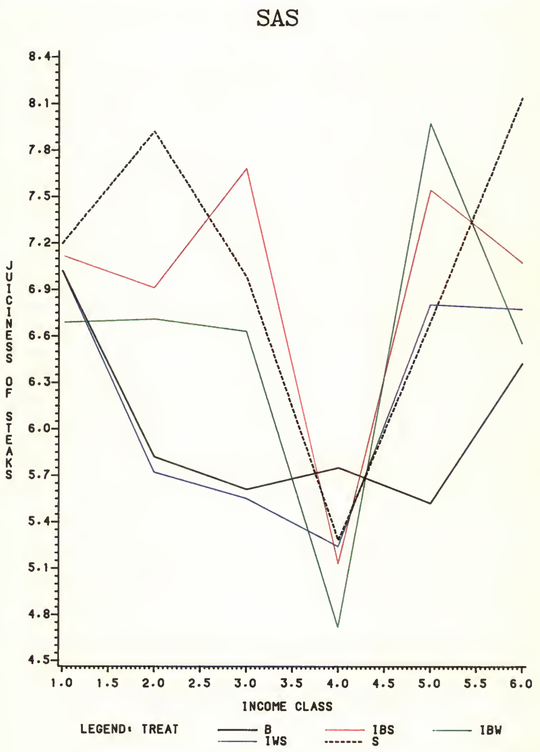


figure 6
Effect of income class on flavor perception

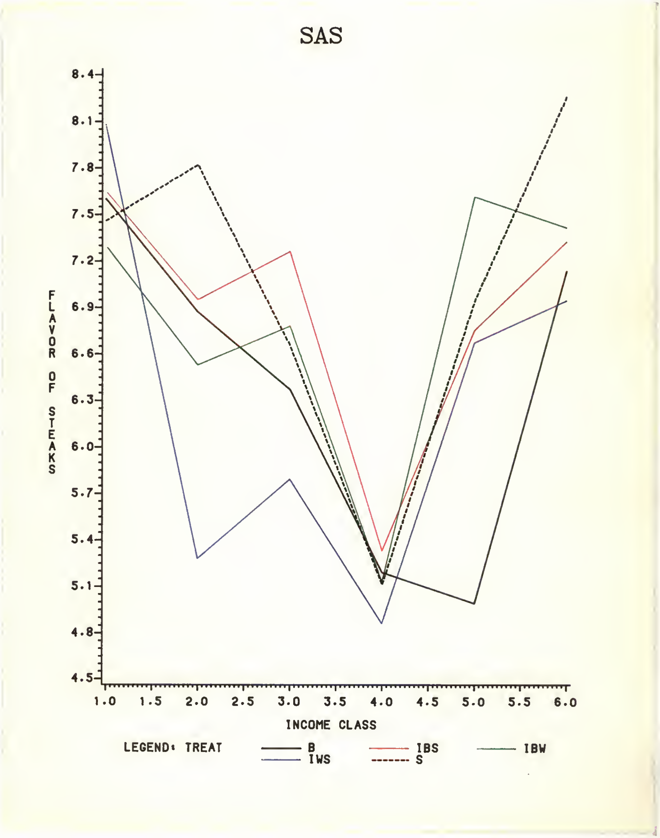
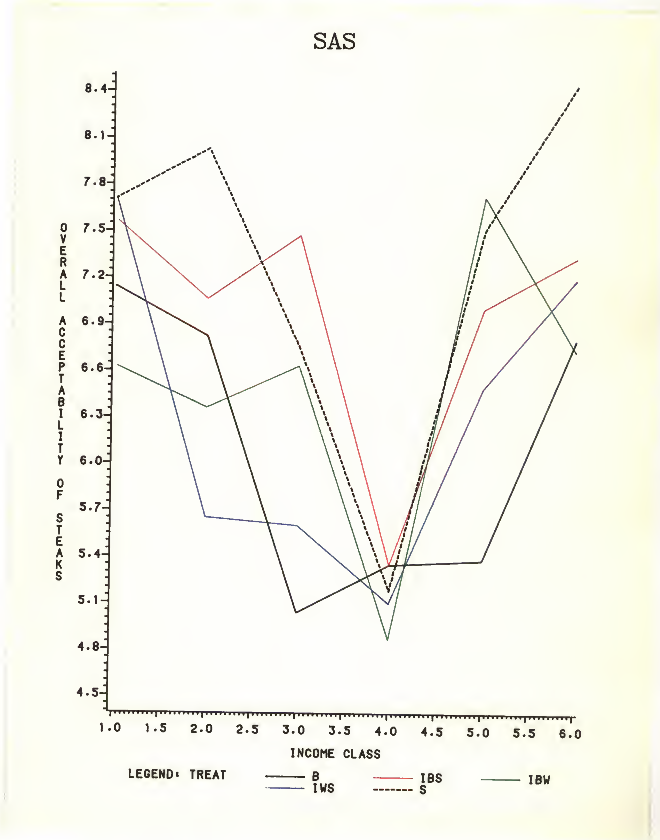


figure 7
Effect of income class on overall acceptability



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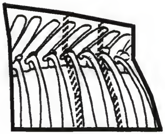
APPENDICES

APPENDIX A

anterior end



posterior end

Steaks were removed from the 9th and 10th thoracic vertebral region, as indicated by the area between the shaded lines.

APPENDIX B

Household Numbers	Treatment Comparison	Paired steaks from animal numbers by household
1 (21)	S vs B	1, 12 (5, 16)
2 (22)	S vs B	1, 12 (5, 16)
3 (23)	S vs IBS	2, 23 (6, 27)
4 (24)	S vs IBS	2, 23 (6, 27)
5 (25)	S vs IWS	3, 34 (7, 38)
6 (26)	S vs IWS	3, 34 (7, 38)
7 (27)	S vs IBW	4, 45 (8, 49)
8 (28)	S vs IBW	4, 45 (8, 49)
9 (29)	B vs IBS	13, 24 (17, 28)
10 (30)	B vs IBS	13, 24 (17, 28)
11 (31)	B vs IWS	14, 35 (18, 39)
12 (32)	B vs IWS	14, 35 (18, 39)
13 (33)	B vs IBW	15, 46 (19, 59)
14 (34)	B vs IBW	15, 46 (19, 59)
15 (35)	IBS vs IWS	25, 36 (29, 40)
16 (36)	IBS vs IWS	25, 36 (29, 40)
17 (37)	IBS vs IBW	26, 47 (30, 51)
18 (38)	IBS vs IBW	26, 47 (30, 51)
19 (39)	IBW vs IWS	37, 48 (41, 52)
20 (40)	IBW vs IWS	37, 48 (41, 52)

Randomized design #1, utilizing 40 households, to determine the variation between households and animals, together with treatment comparisons. The first household listed in each line received the first pair of steaks listed, while the second household number in the same line received the second pair of steaks, etc.

APPENDIX C

Household Numbers

Animal Number		41	42	43	44	45	46	47	48	49	50
(S)	9	X	X								
	10			X	X						
(B)	20	X				X					
	21						X	X			
(IBS)	31		X						X		
	32						X			X	
(IWS)	42			X						X	
	43					X					X
(IBW)	53				X			X			
	43								X		X

Randomized design #2, utilizing 10 households, to determine estimates of treatment comparisons. Household numbers received steaks from the treatment animal numbers, as designated by the X in specific blocks. This design is a continuation of design #1, using a smaller group of households.

APPENDIX D

Household Number	Comparison
51	S vs S
52	B vs B
53	IBS vs IBS
54	IWS vs IWS
55	IBW vs IBW

Uniformity trial design #3, on remaining 5 households, to measure steak to steak variation of ratings when given steaks from the same treatment animal.

APPENDIX E

INSTRUCTION SHEET

Please read thru instructions carefully before preparing the steaks.

1.) You are receiving two beef rib steaks, at not cost, as part of a research project to evaluate acceptability of steaks from different animals that may have been fed differently.

2.) The rib steaks that you have been provided with are from beef produced at Kansas State University. The beef should be of comparable quality to beef that is purchased at any major food store.

3.) We request that the steaks be prepared within two weeks of delivery. Also, please keep the steaks frozen until preparation day.

4.) Prepare the steaks in any method you desire, but prepare both steaks using the same method of cookery.

5.) The steaks are marked with a tag in one steak, which will be steak A. Leave the tag in the steak until sampled. The other steak is steak B.

6.) Each adult member of the family (up to four adults) should sample each steak during the same meal.

7.) Fill out the response cards immediately after you have sampled both steaks. Please return thru campus mail in the addressed envelope as soon as possible.

8.) Any questions concerning procedures and/or instructions will be answered by Connie Pelton, Department of Animal Science, 532-6131, Weber Hall.

9.) If participant wishes to withdraw from the study, they may do so at any time by contacting the party named in 8. A participant may discontinue participation at any time without penalty or loss of benefits to which the subject is otherwise entitled.

Participants in this survey have agreed to take part in this by oral agreement over the phone. There are no risks to the participant over those normally occuring when purchasing and cooking rib steaks from any commercial retail outlet.

Comparisons should not be made between household members until individual responses have been completed. The survey participant who prepared the steaks should be sure to fill out all special questions on household and cooking response sheet.

APPENDIX F
Household Demographic Information

Household and Cooking Response Sheet

Household No. ________
Steak ID No's. ________
Delivery Date ________ Return Date ________

*Information above to be completed by KSU Animal Science Personnel.

The information collected in this survey is strictly confidential. Its only purpose is to provide an overall summary of the demographics of all survey participants. All information collected will be coded by one graduate student in such a manner that individual households cannot be identified.

The information below should be filled out by an adult member of the household, preferably the person who cooks the steak.

I. Age of household members (circle nearest age group for each survey participant:

	Age Group						
A. Individual 1	under 20	20-29	30-39	40-49	50-59	60-69	over 70
B. Individual 2	under 20	20-29	30-39	40-49	50-59	60-69	over 70
C. Individual 3	under 20	20-29	30-39	40-49	50-59	60-69	over 70
D. Individual 4	under 20	20-29	30-39	40-49	50-59	60-69	over 70

II. Sex of Household Members - (circle appropriate answer)

A. Individual 1	Male	Female
B. Individual 2	Male	Female
C. Individual 3	Male	Female
D. Individual 4	Male	Female

III. Education Level - (circle the highest educational level obtained for each survey participant):

A. Individual 1	Grade School	High School	College	Post-College
B. Individual 2	Grade School	High School	College	Post-College
C. Individual 3	Grade School	High School	College	Post-College
D. Individual 4	Grade School	High School	College	Post-College

IV. Kind of work or occupation of each survey participant (ex: lawyer, plumber, homemaker, student, retired, etc.)

A. Individual 1: ____________________
B. Individual 2: ____________________
C. Individual 3: ____________________
D. Individual 4: ____________________

V. Household Income Level (circle the approximate income level for the total combined family annual income):

A. Under $10,000
B. $10,000 to $14,999
C. $15,000 to $19,999
D. $20,000 to $24,999
E. $25,000 to $29,000
F. $30,000 to $39,000
G. $40,000 to $49,000
H. $50,000 and over.

APPENDIX G
Preferences by Household

*To be completed by survey participant who cooks the steaks

VI. Prior to cooking the steaks which steak do you prefer by visual appraisal? (Circle the appropriate answer.)

Steak A   Steak B   No difference

VII. Cooked by (method used):

____ Broiling on a grill in the house.
____ Broiling on a charcoal grill outside.
____ Cooked in broiler section of kitchen oven.
____ Pan broiled or fried in skillet on top of the stove.
____ Other (please describe).

VIII. Approximate degree of doneness:

____ Rare (very pink inside color)
____ Medium rare (considerable pink inside color)
____ Medium (moderately pink inside color
____ Medium well done (slight pink inside color)
____ Well done (no pink inside color)

*After the steaks have been sampled and individual responses completed, the participant who cooks the steak should answer the following questions.

IX. The current price per pound of rib steaks like these is $3.09/lb. After having sampled the steaks you've prepared:

1. What would you most likely do if you had the opportunity to buy steaks of the same quality? Check the response that corresponds to your opinion.

Steak A	Steak B	
______	______	a) would buy
______	______	b) would probably buy
______	______	c) undecided
______	______	d) would buy onl;' at reduced price

2. Circle which of these two steaks your household preferred:

Steak A   Steak B   No difference

3. If you were to buy steaks such as these and you knew what their eating qualities were, how much per pound less would the steak your household didn't prefer have to sell for for you to consider buying it:

A. Would buy at same price per pound
B. 15¢ per lb. less
C. 30¢ per lb. less
D. 45¢ per lb. less
E. 60¢ per lb. less

APPENDIX H
Individual Response Sheet

Taste Response Survey

Each survey participant should complete an individual taste response survey. Comparisons should not be made between household members until individual responses have been completed. Initial individual responses are usually most accurate, thus changes in initial responses are discouraged.

Individual Taste Response Survey form number should correspond to identified Individuals in Household and Cooking Response Sheet (ie: Individual 1 in household survey form identified as to age group, education level, etc. should complete the task survey form marked - Individual 1).

*Circle Appropriate Individual Number:

1 2 3 4

Using the following rating scale, please rank both steaks according to your evaluation of tenderness, juiciness, flavor and overall acceptability.

8 = extremely desirable
7 = very desirable
6 = moderately desirable
5 = slightly desirable
4 = slightly undesirable
3 = moderately undesirable
2 = very undesirable
1 = extremely undesirable

Circle your rating according to the above rating scale for each steak and in each category.

Tenderness		Juiciness		Flavor		Overall Acceptability	
Steak A	Steak B	Steak A	Steak B	Steak A	Steak B	Steak A	Steak B
8	8	8	8	8	8	8	8
7	7	7	7	7	7	7	7
6	6	6	6	6	6	6	6
5	5	5	5	5	5	5	5
4	4	4	4	4	4	4	4
3	3	3	3	3	3	3	3
2	2	2	2	2	2	2	2
1	1	1	1	1	1	1	1

Thank you for your cooperation!

CONSUMER PREFERENCE FOR BEEF RIB STEAKS FROM IMPLANTED AND NON-IMPLANTED BULLS, AND IMPLANTED STEERS COMPARED TO TRAINED PANEL AND WARNER-BRATZLER SHEAR EVALUATIONS

by

CONNIE D. PELTON

B.S., Kansas State University, 1981

AN ABSTRACT OF A MASTER'S THESIS

Submitted in partial fulfillment of the

requirements for the degree

MASTERS OF SCIENCE

Department of Animal Science and Industry

KANSAS STATE UNIVERSITY

Manhattan, Kansas

1984

Rib steaks were obtained from fifty-five fall-born Simmental crossbred male calves which had been randomly alloted at birth to one of five treatments: steers, implanted birth to slaughter (S); bulls, implanted birth to weaning (IBW); bulls, implanted birth to slaughter (IBS); bulls, implanted weaning to slaughter (IWS); and control bulls (B). Implanted calves were given 36 mg zeranol implants every 100 days. Animals were slaughtered at a commercial plant, electrically stimulated after evisceration, chilled 24 hours and graded. Left primal ribs were removed and delivered to the Kansas State University meats laboratory. Ribs were aged 7 days at 4 C and cut into 2.54 cm steaks. Steaks from the 9th and 10th thoracic vertebral region were used. Fifty-five households with 129 adult panel members were randomly selected from KSU academic and non-academic employees. Steaks were distributed based on randomized designs. Response sheets were given to each household requesting demographic information and preference ratings. Inconsistency of individuals within families and variation between households provided the greater part of variation. Effect of demographic information, preference before and after cooking, cookery method and doneness, buying and pricing decisions on consumer panel ratings were analyzed. Comparison of consumer ratings to trained taste panel evaluations and Warner-Bratzler shear force values were also done. Steaks from bulls IWS were significantly ($P<.05$) different from all other treatments in juiciness, tenderness and overall acceptability. Steers and IBS steaks were significantly ($P<.05$) more tender than all other treatments. Panel flavor ratings showed no difference ($P<.05$) on steaks from S, IBS, IBW and B, but IWS were not different ($P<.05$) than Bulls in flavor. These findings suggest that implanting bulls from birth to slaughter made steaks from bulls as acceptable to consumer panels as steers. Implanting bulls from weaning to slaughter resulted in the least desirable consumer panel ratings for all palatability traits rated.