GROWTH, CARCASS, CHEMICAL AND PALATABILITY TRAITS OF CROSSBRED STEERS MANAGED FOR ACCELERATED BEEF PRODUCTION

By

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CHAPTER I

INTRODUCTION

Beef cattle are not native to the western hemisphere. According to historians, the first cattle were brought to the West Indies by Columbus on his second voyage in 1493. In the early 1500's, Cortez brought cattle from Spain to Mexico, and by the early 1600's these cattle were inhabiting what is now called the United States. The colonists first brought cattle from England in 1609. Although these cattle were not necessarily intended for lean beef production, they grazed the forage, helped work the land and served the colonists as a source of meat, milk and clothing.

Through the years, beef production management systems have changed a great deal. These changes are a result of many factors, such as, advanced technology, economics, consumer demands, as well as, changes in cattle type and the influence of new breeds (Cundiff, 1986).

Cattlemen today, along with beef producers of the future, all realize that the objective is to produce lean, high quality beef that is acceptable to the consumer, and to do this as efficiently as possible. Simply stated, beef producers must synchronize the genetic resources available with feed and other production resources in a fashion that meets marketing specifications and consumer demands

(Cundiff, 1986). Many of the terms used in the previous sentences, can be defined in a multitude of ways, for example, efficiency can be viewed in terms of economic efficiency, forage utilization efficiency, or energetic efficiency. At the same time, high quality beef that is acceptable to the consumer is becoming more segmented everyday. As American life styles change and diverge, so does the definition of consumer acceptable beef.

Many management systems have evolved to achieve the aforementioned objectives. These systems can be grossly categorized into traditional systems or accelerated systems. Traditional systems are best described as beef production systems that handle calves after weaning, in such a manner, that they are managed for growth, and not necessarily fattening. These cattle are typically "backgrounded" on some type of forage based nutritional program so as to assimilate frame and muscle growth for an average of 150-180 days. From the forage based program, these cattle are placed in the feedlot, for the fattening or finishing phase. There are a number of reasons why this traditional system has evolved. The primary reason is a means of marketing available forage. Moreover, some traditional types or breeds of cattle require the additional time to grow frame and muscle before being placed in the finishing phase in order to achieve an acceptable live weight and yield at marketing time (Bowling et al., 1978; Harrison et al., 1978).

One problem associated with the traditional system is cattle with a great genetic potential for rapid growth may gain too much weight during the backgrounding phase and are then penalized at slaughter for not meeting the desired carcass weight range to achieve the greatest economic return (Harrison et al., 1978).

Accelerated beef production systems differ from the traditional system, mainly in that the backgrounding or foraged based nutrition phase is omitted. Calves are placed directly into the feedlot at weaning where they are adjusted to and fed high concentrate diets for approximately 180-200 days. This system requires breeds of cattle that have the genetic potential to grow rapidly and assimilate frame and muscle much quicker than traditional breeds of cattle. Furthermore, these cattle are slaughtered at a much younger age than cattle following the channels of the traditional system; hence, the term accelerated beef production.

One problem associated with the accelerated system is that most of the cattle are too young to deposit enough intramuscular fat at the time of slaughter to attain the low choice quality grade. Under the current pricing system commonly used in the industry, the rapid-growing, high-performing cattle are penalized. Another problem is that it does require cattle types that have the genetic potential for very rapid growth (Bowling et al., 1978).

The wide variation in cattle types and/or breeds available in the world offers many opportunities for producers to select the cattle that best fit their production system. Cattle types must be compared under different production systems in order to determine which genetic resource matches a given production resource or marketing niche. These comparisons should include traits such as growth rate and carcass composition. Palatability studies along with chemical composition analyses are also helpful in determining which cattle types are best suited for a management regime (Cundiff, 1986).

It is also important to note that the variation within groups of cattle allows for characterization of many important traits to improve beef production. Illustrations of relationships between traits within groups of cattle would be beneficial to more rapid management decisions.

Ultimately, beef producers should be cognizant of the needs and demands of the consumer. Over the years these consumer demands have changed and have also become greatly segmented. One segment of the beef consumer that should be of major concern to producers is the health conscious consumer. This particular segment comprises nearly 25% of the total beef consumers in the United States and the trend seems to be that this segment is becoming a greater percentage of the population each day. This segment of consumers must become more aware of the nutritive value of beef, as well as, the components of beef that are implicated with diseases (National Live Stock and Meat Board, 1982).

The health conscious consumer is mainly concerned with cholesterol, fatty acids, calories, and the fat content in general. Different breeds or cattle types in conjunction with contrasting management systems may elicit different levels of these constituents of which the health conscious consumer is concerned.

The objectives of this study were to compare the growth, carcass, chemical, and palatability traits of differing crossbred steers managed for accelerated beef production, as well as to determine what relationships exist among initial phenotype, growth, carcass, chemical and palatability traits of these crossbred steers.

CHAPTER II

REVIEW OF LITERATURE

Breed Comparisons

Postweaning Growth Rate

Rate of weight gain from weaning to slaughter is a very economically important trait to the growing and feeding segments of the beef industry and is a very important component to the overall net efficiency of a beef production system (Cundiff et al., 1984; Smith et al., 1976). The available literature also reveals that postweaning rate of gain is one of the most common parameters measured in beef cattle experiments relating to the characterization of growth.

Early breed comparison experiments conducted using Hereford, Angus, and Shorthorn cattle revealed that Herefords slightly superior to Angus and Shorthorns in postweaning growth rate (Gaines et al., 1966; Gregory et al., 1966; Melton et al., 1966; Schwolst et al., 1968). Most researchers agree that the differences observed are due to the differences in milk production among the breeds; consequently, Herefords had a small advantage due to compensatory gains. Similar results were observed by Damon et al. (1961) for postweaning gain in Hereford and Angus cattle.

More recent results from Cundiff et al. (1984), in which many breeds were compared for postweaning growth rate using Hereford and Angus dams, reveals that Herefords exceed Angus in direct transmitted effects for postweaning growth, but Angus exceeds Herefords in preweaning maternal effects.

Considerable research has been conducted in the Southern region of the United States on crossing Brahman and British breeds. Kincaid (1962), and Cartwright et al. (1964) found that the postweaning growth rate of straightbred Brahman steers was lower than that of straightbred British steers. However, when Brahman X British steers were compared to British X British steers or straightbred British steers, the results were greatly different (Kincaid, 1962; Cartwright et al., 1964). The effect of heterosis on growth for the Brahman X British steers was approximately 7% above the gain of the British breeds.

Peacock et al. (1982) reported in a study utilizing Angus, Brahman, and Charolais cattle that Brahman breed effects were significantly negative for postweaning average daily gain. Peacock et al. (1982) also found that Angus were negative ($P>.05$) for growth effects, and Charolais were positive ($P<.05$) for average daily gain breed effects. The Germ Plasm Evaluation study reported by Cundiff et al. (1984) also compared the Bos indicus influence on postweaning growth rate. This study revealed that *Bos indicus* breed effects were varied, depending upon the season of the year. The breed by season interaction showed that *Bos indicus* X *Bos taurus* steers gained faster than Bos tarus X Bos tarus steers during the summer months, but the results were opposite during the winter feeding periods. These results are in agreement with other breed by environment interactions involving *Bos indicus* cattle that have been reported (Rollins et al., 1964; Young et al., 1978 a, b; Long et al., 1979).

Charolais cattle have rapidly increased in numbers in the past twenty years and are now recognized as an important beef breed in the United States. Early research on the growth rate of Charolais cattle was light due to inavailability of large numbers of Charolais (Cundiff, 1970). Some of the first top cross evaluation work involving Charolais were conducted in Louisiana by Damon et al. (1959 a, b, 1960). These reports indicated that Charolais crossbred cattle were superior to Hereford, Angus, Shorthorn, and Brahman crossbred cattle in postweaning growth rate. They et al. (1966) reported similar results from studies conducted in Great Britain. Edwards compared Charolais X British dairy breeds to British beef X British dairy breeds. These reports are in agreement with Peacock et al. (1982). Charolais cattle also ranked among the top in another extensive breed comparison study reported by Smith et al. (1976).

Smith et al. (1976) reported this extensive breed comparison as part of the Germ Plasm Evaluation Program. The study compared Charolais, Simmental, Limousin, South Devon, Jersey, Hereford and Angus. After 180 days on feed, Charolais and Simmental crosses were the heaviest; South Devon crosses were next heaviest, followed by Hereford, Angus and Limousin crosses; Jersey crosses were lightest. The ranking of breeds for average daily gain over 180 days was the same as final weight, except for a nonsignificant difference between Charolais crosses and Simmental crosses. It is important to note that when these cattle were analyzed based on relative growth rate , Simmental crosses and South Devon crosses were significantly faster growing. The relative growth rate analysis also revealed that Limousin crosses and Jersey crosses were the slowest growing (Smith et al., 1976). Dhuyvetter et al. (1985) reported that Charolais cross steers exhibited a 60 gram per day higher average daily gain than Limousin cross steers in a direct breed of sire comparison experiment. A study by Jenkins and Ferrell (1984), reporting on the characterization of postweaning growth traits of Simmental cattle, showed that Simmental bulls and heifers gained significantly faster during the postweaning period than Hereford bulls and heifers. Findings by Marshall and Frahm (1985) also indicated that Simmental crossbred steers had superior postweaning growth rates than a variety of other crossbred steer combinations.

The postweaning component of beef production is and has traditionally been an important segment of the cattle industry. The results of the many studies which show major differences among breeds of cattle for postweaning growth rate are directly applicable to the cattle feeding segment of the industry (Smith et al., 1976).

Carcass Evaluation

A superior carcass is characterized by a high proportion of muscle, a low proportion of bone and an optimal level of fatness. In the last 25 years major emphasis has been toward decreasing fatness, in order to achieve the endpoint of a superior carcass. As the amount of fat reaches a more moderate and acceptable level more emphasis will probably be placed on increasing the proportion of muscle (Berg and Walters, 1983). Carcass evaluation of attributes such as USDA quality and yield grades as well as more specific parameters like carcass weight, marbling, ribeye area, dressing percent, fat thickness, fat trim and percent retail product of different breeds are important in determining the potential value of these different breed resources for profitable beef production (Koch et al., 1982).

Most of the early published results involving carcass evaluation of different breeds of cattle compared Angus, Herefords, and Shorthorns. Damon et al. (1960) reported that Angus and Shorthorns were superior to Herefords in marbling and carcass grade. In contrast, Damon also indicated that Herefords contained a higher percent lean and less fat than Angus and Shorthorns. Butler et al. (1962) reported that Herefords contained a higher percent of retail product in the round and loin than Angus, but a lower percent in the chuck. Similar results were observed by Koch et al, (1976; 1982), with regard to fat and lean in Hereford and Angus crossbred steers.

Genetic influence of Brahman cattle has proven to be beneficial in crossbreeding programs in the Southern region of the United States (Kincaid, 1962); therefore, it is appropriate to illustrate the evaluation of carcass merit in Brahman cross cattle. Results have shown that when slaughtered as yearlings, steers of British breeding have higher carcass grades and had higher percentages of carcass fat than Brahman steers, while Brahman steers have higher percentages of lean and bone. Lean to bone ratios in the 9-10-11th rib sections slightly favor the British breeds (Kincaid, 1962).

Peacock et al. (1982) reported that for fat thickness over the rib eye, Brahman cattle were intermediate between Angus and Charolais. Peacock et al. (1982) utilized rib eye area/unit of carcass weight as a measure of the relative leanness of the carcass based on the area of preferred muscle. His results revealed a negative breed effect for Brahman cross steers and a positive breed effect for Charolais cross steers. Carcass quality grade data obtained by Peacock et al. (1982) showed significantly negative breed effects for Charolais and significantly positive breed effects for Angus. Koch et al. (1982) reported that influence of Brahman cattle on carcass merit was comparable to Hereford and Angus crossbred steers. The authors Koch evaluated many carcass parameters adjusted to a common age, carcass weight, fat thickness, and marbling score. In general, Brahman cross steers had slightly larger ribeyes, less fat thickness over the ribeye, less total fat trim, similar percent bone, and percent retail product, but lower marbling score and quality grades.

Another report by Koch et al. (1976) as part of the Germ Plasm Evaluation program involved the carcass evaluation of Jersey, South Devon, Limousin, Simmental, Charolais, Hereford and Angus crossbred steers. Results from this study were quite explicit and require careful analysis to interpret. Actual hot carcass weights reflect differences in growth rates and final weights of the steers. As expected, Charolais crossbred steers were heaviest and Jersey crossbred steers were lightest. However, when carcass weights were adjusted to 5% longissimus fat, Charolais, Simmental and Limousin crossbred steer carcasses were similar and much heavier than other breed groups. Steers of Angus lineage reached 5% fat in the longissimus dorsi muscle 12 to 14 kilograms lighter than Hereford crossbred steers. Dressing percent did not differ significantly among breed groups even though fatness, muscle conformation and hide weight differed significantly. Limousin crossbred steers had the highest dressing percentage while Jersey crossbred steers posted the lowest. Simmental crosses and Charolais crosses had significantly more bone than any other breed groups. However, differences in percent bone were small on a weight constant basis and even smaller when compared at equal fat in the longissimus muscle. Charolais and Limousin crossbred steers had the highest percent of retail product at a constant carcass weight, and Simmental was added to the group when compared at constant fat in the longissimus dorsi. Charolais, Limousin, and Simmental crossbred steers had the lowest quality grades and marbling scores when analyzed at constant age and weight. Yield grade and ribeye area were directly related to percent retail product. In general, this major study conducted by Koch et al. (1976) demonstrates that the large framed exotic breeds are leaner and heavier muscled, yet they do not deposit intramuscular fat as quickly as Hereford, Angus, Jersey, and South Devon crossbred steers.

Dhuyvetter et al. (1985) published studies that are in agreement with Koch et al. (1976), as well as, Marshall and Frahm, (1985). Charolais, Limousin, and Simmental crossbred steers are superior in leanness, but inferior in USDA quality grade.

The importance of carcass evaluation is realized by researchers and cattlemen alike; however, the reduction in fat results in lower USDA quality grade, which in turn, results in lower economic value of product based on the current price structure (Cundiff, 1986). Also, according to Cundiff (1986), it is apparent that producers can easily increase the proportion of muscle and reduce the amount of fat by using crossbreeding systems involving cattle with the appropriate genetic potential for carcass traits. However, the question of USDA quality grade, as well as, the suitability of these genotypes in the production environment still plagues researchers as well as producers.

Chemical Composition

True growth involves an increase in muscle, bone and organ weight and should be distinguished from the increase in weight resulting from fat deposition (Maynard and Loosli, 1969). Quantitatively, fat is the most variable tissue in the body (Berg and Butterfield, 1976). Within the last decade, changes in market demands have placed more emphasis on inherent muscling and freedom from excess fat. However, Ferrell et al. (1978) and Harpster, (1978) reported that when total lean muscle gain in cattle has been enhanced nutritionally or by the selection of larger framed cattle, the increased carcass protein gain has been accompanied by an increase in carcass fat gain.

Consequently, rapid and reliable methods of determining carcass composition are useful in evaluating carcasses of various genetic and environmental sources (Crouse and Dikeman, 1974). Hankins and Howe (1946) found the chemical composition and separable physical components of the 9-10-11th rib cut of slaughter steers to be highly associated with composition of the entire carcass. Further research as well as interpretation of previous literature may be needed in order to evaluate the relationship between carcass evaluation and chemical composition of the wide variation of genetic resources available (Cundiff, 1986).

Moisture, protein, and fat are the major factors of concern in reference to palatability, nutritive value, and cooking characteristics, thus, they should be important to value (Crouse and Dikeman 1974). Eversole et al. (1984) reported nonsignificant differences from the proximate analysis of semitendinosus muscles of four genotypically different steer groups when compared at a constant quality grade endpoint. However, when the data were analyzed based on a constant age or days on feed, significant differences were observed for differences in moisture, fat, and protein of the semitendonosus muscle. Charolais cross steers contained the highest protein content as well as the highest moisture, while the unselected Hereford steer group contained the greatest percent fat.

Chemical analysis of the soft tissue from 9-10-11th rib cuts of steers studied by Koch et al. (1976) and adjusted to a constant age and days on feed revealed significant breed differences. Percent moisture was highest for Limousin and Charolais crossbred steers and lowest for Angus, Jersey and Hereford cross steers. Percent chemical fat was inversely related to percent moisture; therefore, Angus, Jersey and Hereford crossbred steers were highest and Charolais and Limousin crossbred steers were lowest. Protein percentage was greatest for Charolais, Simmental and Limousin steers respectively and lowest for Angus, Jersey and Hereford. These results are in agreement with the carcass evaluation data covered by Koch et al. (1976) in terms of USDA quality and yield grades.

Henrickson et al. (1979) reported a study which described the effect of rate of gain of feedlot cattle on the chemical composition of the carcass. This study involved cattle of similar genetic potential for gaining ability, so gains were altered nutritionally. Marked treatment differences were evident in the physical separation of the 9-10-11th rib cut. Significant differences in fat, lean and bone were observed. The high energy rations resulted in higher rates of gain, which in turn resulted in carcasses containing 2.8% less lean and 4% more fat with 0.8% less bone than those steers fed lower energy rations. The same results were also reflected in chemical analysis of physically separable components of the 9-10-11th rib in terms of protein, moisture and ether extract percentages.

Interpretation of these results, along with other similar studies concerning the chemical composition of steer carcasses varying in genetic growth potential, indicates that there is an interaction between level of nutrition and genetic potential for growth rate relative to amounts of fat, lean, and moisture.

The composition of a meat animal at any given stage of development is of interest to the producer, packer, retailer, and especially the consumer. Protein , unquestionably, is the principle nutritive constituent of beef for which consumers purchase the product. Water is present in fresh beef in greater proportions than any other constituent, while ether extractable lipid percent appears to be the most variable constituent of the carcass.

A review by Cundiff (1986) indicates that chemical composition of beef carcasses was highly related to USDA quality grades.

Palatability and Shear Force Determinations

Marbling and maturity have long been implicated as the major factors affecting the eating quality of beef. Official USDA Standards for Grades of Beef Carcasses have given equal consideration to both of these variables in evaluating beef eating quality (Waller et al., 1965).

Palatability attributes of beef are influenced by many factors (Epley et al., 1968). In early reports it was suggested that flavor may be influenced genetically (Black et al., 1931; Mackintosh, 1949). Moreover, other earlier published results indicated that breed of sire demonstrated effects on some palatability attributes of beef (Cartwright et al., 1958; Bradley et al., 1966).

Epley et al. (1968) reported nonsignificant differences in overall acceptability of steaks for Angus, Hereford and Polled Hereford steers evaluated by laboratory and consumer panel evaluations. However, significant differences were observed among steaks of all steers when compared at different days on feed. Epley considered only flavor and tenderness in the overall acceptability of the steaks.

A review in (1970) by Cundiff reported unpublished data from the Missouri Agriculture Experiment Station which indicated that Charolais cross steers were less tender than Angus cross steers when compared at two different days of feeding.

The published study by Koch et al. (1976) contained information comparing differing breed types of steers for taste panel evaluation and shear force determinations. Shear force, as kilograms per 12.7 mm core provides an objective measure of tenderness. Shear values are inversely related to tenderness. Means shear force values for Jersey and South Devon crosses were significantly lower while Limousin and Simmental crosses were significantly higher than other breed groups. Charolais crosses were intermediate in shear values for this study. Though differences in the study were statistically significant, the difference between the highest and lowest mean was only .47 kg and all were in the acceptable range of tenderness. Koch's study revealed a low correlation between shear and marbling among individual steers within a breed group, but a high correlation between breed group means. Taste panelists rated all breed group means significantly above the minimum level of acceptance. Differences among breed group means for tenderness were the same as the shear data in which Jersey and South Devon were significantly the most tender and Simmental and Limousin were least tender. Flavor and juiciness breed group means did not differ significantly. However, differences in mean breed group overall acceptability ratings were significantly and strongly correlated with tenderness.

Further literature reported as part of the Germ Plasm Evaluation program and published by Koch et al. (1982) illustrated the palatability and shear force characteristics of Brahman type cattle compared to Hereford and Angus crosses,as well as, Tarentaise and Pinzgauer crosses. Hereford, Angus and Pinzgauer crosses had significantly lower shear values and higher tenderness scores than other breed groups. Many reports in the literature rank Brahman type crosses less tender than British crosses on the basis of shear tests and taste panel evaluations. Hereford and Angus cross steers were among the top scoring breed groups in all cycles of the Germ Plasm Evaluation program, but the differences between high and low scoring breed groups were small. All breed groups rated acceptable or above, but the incidence of carcasses classified as unacceptable was highest for the Brahman type steers. Palatability evaluations in this study exhibited generally wider variations than previous studies in the Germ Plasm Evaluation Program. Most variation appeared to be associated with the differences between the Bos indicus and Bos taurus breed types.

Peacock et al. (1982) also realized negative breed effects for Brahman cross cattle when compared to Charolais and Angus crosses regarding tenderness of longissimus steaks. In addition, Peacock also indicated that Charolais breed effects were more favorable for tenderness than Angus breed effects. This is in agreement with Hedrick et al. (1975) who reported that Angus sires and dams produced carcasses less tender than Charolais. Peacock's results were also in agreement with Koch et al. (1982) regarding tenderness of Brahman type cattle.

Many of the palatability studies reviewed, have demonstrated differences in the degree of marbling and maturity of the cattle types mentioned; however, the lack of agreement regarding tenderness and overall acceptability of the beef from these divergent cattle types leads to a slightly controversial role of marbling and maturity as sole indicators of quality for beef carcasses. Recently, there have been efforts to identify alternative systems for segmenting the beef supply into expected palatability groups. According to Dolezal et al. (1982), a specific time on feed period along with a specified subcutaneous fat thickness may be possible alternatives to or additions for the existing quality grading system in order to more accurately predict beef palatability.

It is also important to note that in the study by Koch et al. (1976) muscle color, texture, and firmness were also evaluated along with marbling and maturity as a means of characterizing carcasses. Color and texture of lean change with maturity. Deviations in color or texture for a given degree of maturity contributed to differences in evaluation of lean quality. Differences in breed group means were primarily related to differences in color of lean. Hereford carcasses were slightly darker and coarser in lean texture than Angus carcasses. Simmental and Jersey crosses averaged slightly darker lean and coarser texture than Limousin and Charolais crosses, but these differences were not of practical importance. Firmness as a measure of lean quality is considered in relation to marbling and maturity. Differences between breed group means for firmness were closely correlated (r=.97) with differences in marbling.

According to Koch et al. (1976), color, texture, and firmness of lean are directly related to maturity and marbling; and hence, do not offer much additional aid to characterizing the eating quality of beef carcasses as measured by taste panel evaluations or shear force determinations.

Fatty Acid Profiles of Various Beef Tissues

Many health professionals have concluded that persons who are susceptible to heart attacks and strokes as a result of atherosclerosis should monitor their consumption of saturated fats, cholesterol, and total calories (Eichorn et al., 1985). It must be noted that there are consequential differences among fatty acids assigned to the "saturated" group in terms of their physiological effects; for example, (C18:0) stearic acid has negligible effects on serum cholesterol levels and should not be considered nutritionally equivalent to other saturated fatty acids known to be hyperlipidemic. Moreover, among the "unsaturated" group of fatty acids, distinction is made between those with a single double bond between carbons termed "monounsaturated" and those with two or more double bonds between carbons termed "polyunsaturated". The monounsatured fatty acids are considered to be blood cholesterol neutral, and in the case of oleic acid (C18:1), hypocholesterolemic (Smith et al., 1987). Consequently, certain fatty acids are important dietary factors that can decrease serum cholesterol levels and should therefore reduce the risk of heart disease.

Most studies conducted to determine the fatty acid composition of beef have involved comparing different sexes and degrees of total fatness of animals. Limited literature is available regarding the variation in fatty acid composition among breeds or genotypes of cattle.

Eichorn et al. (1985) reported that oleic acid (C18:1) was the most abundant fatty acid, comprising from 32.5 to 45.6% of the total lipid fraction of both steers and bulls experimentally slaughtered. Samples from steers contained higher levels of oleic acid than bulls. Palmetic acid (C16:0) comprised from 22.8 to 30.4% of the total lipid fraction, whereas stearic acid (C18:0) was the third most abundant fatty acid, comprising 11.1 to 15.1% of muscle and subcutaneous adipose samples. The observation that oleic, palmetic and stearic acids comprise at least 80% of the fatty acids in bovine tissue is in agreement with other published data (O'Keefe et al., 1968; Terrell et al., 1969; Clemens et al., 1973; Westerling and Hedrick, 1979).

Other studies indicate that diet has an important influence on the fatty acid composition of bovine tissues (Skelly et al., 1978; Westerling and Hedrick, 1979; Marmer et al., 1984). Animal age (Hornstein et al., 1961; Link et al., 1970 a, b,; Clemens et al., 1973) and breed (Yoshimura and Namikawa, 1983) are other factors that can produce fatty acid compositional changes.

Sex condition differences from the study by Eichorn et al. (1985) in the relative amounts of saturated fatty acids to polyunsaturated fatty acids is believed to be due to the differences in fat:lean ratios.

Animal age as a factor in producing compositional changes in fatty acids of beef tissues was studied extensively by Link et al. (1970 a, b). Two separate analyses were conducted, one characterized muscle lipids and the other subcutaneous adipose. The results of each trial were somewhat contrasting and in disagreement with the fat:lean ratio theory of Eichorn et al. (1985). Link et al. (1970a) revealed that as animals became older and possessed a higher degree of total fatness, the proportion of polyunsaturated fatty acids increased in subcutaneous adipose tissue. In contrast, the proportion of polyunsaturated fatty acids of muscle lipid decreased as animals became older. Link et al. (1970a,b) also observed a season X fatty acid composition interaction where saturated fatty acids were higher in the summer and lower in the winter for both beef tissues studied.

Yoshimura and Namikawa (1983) indicated that the fat:lean ratio influences the relative proportion of saturated and unsaturated fatty acids of cattle of different genotypes. Faster growing, later maturing, leaner breeds with larger mature sizes posted lower saturated to unsaturated fatty acid levels than slower growing, earlier maturing, fatter breeds with smaller mature sizes. Similar fat:lean ratios were observed from the carcasses of these cattle differing in genotype when compared at chronological ages. These results were in agreement with Eichorn et al. (1985) and suggested that there must be some physiological mechanism that controls the profile of fatty acids partitioned in bovine tissues.

The differences between bulls and steers in fatty acid composition may be due largely to the testostrone-induced increase of lean muscle development in bulls (Eichorn et al., 1985), and the difference in metabolic hormones responsible for the different levels of growth, mature size and body composition of genotypically different cattle (Yoshimura and Namikawa, 1983).

Waldman et al. (1968) reported on the association of fatty acids of certain bovine tissues with palatability traits. The study involved the same cattle used by Link et al. (1970 a,b) which were Angus steers and heifers of similar age and genetic potential for growth. The cattle were grown at different rates within sex class and fatty acid compositional differences were reported by Link et al. (1970 a,b). Even though, significant differences were observed in fatty acid composition among growth rates and season of year, no differences were observed by Waldman et al. (1968) in palatability, flavor, juiciness, and overall acceptability relative to the differences in fatty acid composition.

The variation in fatty acid composition of bovine tissues is not clearly understood with reference to age, sex, degree of fatness or breed type. Differences have been observed in many comparison studies, yet not all studies are in agreement. Most researchers will agree that the relative proportion of saturated, unsaturated and polyunsaturated fatty acids of bovine tissues are important to the health conscious consumer and therefore, important to the beef industry.

Relationships of Initial Phenotypic Measures and Age

Growth Rate

Initial phenotypic measures can be described as measurements on an individual at an early age, and are generally thought to be easily attainable. Weaning weight is a very common measurement recorded on individuals and if birth weights are not recorded, then weaning weight is the earliest phenotypic measure taken for an animal. Frame score, or hip height relative to age is another relatively easy measure to attain early in an animal's life. These factors in conjunction with age and along with the relationships that exist between these parameters and growth rate and carcass merit allow for some predictability in these important beef production components.

Linear body measurements have been collected on beef cattle since the early 1900's, primarily to objectively describe cattle, to estimate live weight, to describe normal changes taking place during growth and to determine slaughter grades and carcass compositional characteristics on cattle prior to slaughter. Due to continuous changes in beef type brought about by the changing market demands, several studies have been conducted to compare performance and carcass traits of different breed types or within breeds utilizing easily measured parameters; such as, weaning weight and hip height. Hip height measurements have been taken on cattle of various breed types and breed combinations at different ages, subsequently slaughtered at various endpoints. It is generally accepted that the height relative to age, or frame score, does have an influence on growth rate and composition at a given weight or age end point (USDA, 1979).

It is important to note that Lush et al. (1930) reported that the growth of the head and long bones was minimally affected by environment. Lush concluded that skeletal development may be associated with increase in flesh, but skeletal development may occur without an increase in flesh under certain environments, as well as, being highly dependent on age of the animal.

Age, weight and frame are related; however, this relationship can be manipulated by the management environment of growing cattle. The age-height relationship as described by Lush is less easily manipulated than weight-height or age-weight relationships. Relative degrees of fleshiness influence the latter two relationships more strongly and therefore nutritional level plays a very important role (Hendrickson, 1961).

Batre et al. (1973) indicated that in order to utilize prediction equations based on phenotypic measurements, composition at the time the measurements are made must be taken into consideration. This is in agreement with Lush et al. (1930) with regards to fleshiness. The USDA Standards for Grades of Feeder Cattle, (1979) recommend that the frame and muscle thickness by appraised among cattle managed under normal circumstances.

Frame size at a given age is highly correlated with mature size, and consequently if managed under normal environments, larger framed cattle should be faster growing at a younger age (Cundiff, 1987). A summary of the data obtained from the Germ Plasm Evaluation program justifies these thoughts. Large framed breeds, such as, Chianina, Charolais, Maine Anjou and Simmental tended to post the highest average daily gains in this study. In addition, Limousin, Gelbvieh and Brahman cross cattle were intermediate in frame size and in general intermediate in growth rate.

It is important to realize that there is a trade off between growth rate and mature size with reference to frame size. Furthermore, breeds of cattle that are larger framed at weaning tend to be heavier at weaning as well as at slaughter if killed at ages comparable to smaller and lighter cattle at weaning.

The factor of age becomes important from the standpoint that larger framed, heavier cattle at weaning have the potential to grow more rapidly; so therefore, if they are killed at younger ages, their slaughter weights are similar to moderate weight and frame-sized cattle (Koch et al., 1982). Koch et al. (1976) indicated that among data regressed to a specific final weight, larger framed, initially heavier cattle were significantly younger.

Maino et al. (1981) characterized postweaning growth traits of various frame-sized steers on forage systems. The results of these data are similar to those reported by Koch (1976), yet the magnitude of the relationship of frame and growth rate were not as strong for steers grown on a forage based system. Nutritional level influences rate of gain, as well as, ultimate frame accretion. Explanation for the slight difference in results may be due to the forage based feeding program in that it did not meet the nutrient requirements of the larger framed steers which actually had greater potential for growth. More specifically, energy intake may have been the rate limiting factor in the experiment of Maino et al. (1981). Initial weight, frame-sized and age also has a tremendous impact on carcass merit.

Carcass Merit

Early reports (Knapp and Cook, 1933; Black et al., 1938; Kohli et al., 1951) indicated differences in carcass or slaughter grade depending on breed type and frame size. Smaller framed, more compact type steers had higher dressing percentages than larger framed, rangier type steers. These extreme differences generally appeared largest when the differing frame-sized cattle were compared at similar final weights. When attempts were made to make comparisons at similar degrees of finish, differences in dressing percent and other carcass traits tended to disappear. In general, the results of these early reports suggested that with weight held constant, those steers of smaller frame size had more fat, more edible product, less bone and higher carcass grades than those described for the large framed cattle. It is important to note that yield grade was not mentioned in these studies; however, the differences in yield could be interpreted due to the differences in fat.

The phenotypic correlation between height and final weight appears to be very strong according to most data. This tends to agree with data relating height to growth rate and initial weight. Data obtained by USDA on 944 feeder steers revealed that the larger the frame size, the higher the rate of gain, the longer the feeding period required to fatten, and the greater the live weight necessary to attain a given slaughter quality grade.

Variation in frame size among feeder cattle primarily affects the composition of their gain. The gain in weight of large framed cattle normally consists of more muscle and less fat than smaller framed cattle. Indirectly, at a given weight, large framed animals will have a lesser degree of fatness than small framed cattle and will also have carcasses with more desirable yield grades, but lower quality grades. This means that if cattle are fed to produce the same quality grades, choice for example, large framed cattle must be fed to heavier weights than smaller framed cattle (USDA, 1979).

In contrast to the data of the USDA, (1979), Smith et al. (1981) reported that cattle of similar feeder grade classification vary extensively in marbling levels during a 140 day finishing period. Marbling patterns appear more highly dependent on breed-type and stage of growth than on mature size classification. Therefore, inferences concerning projected marbling levels at live weight endpoints based on frame size alone should be re-evaluated. Smith et al. (1981) further indicated that feeder grade classifications adequately identify compositional endpoints if prior nutritional history is known, or can be assessed. Rates of physiological maturation and marbling deposition over a 140 day finishing period appear highly dependent on their respective levels at the onset of the finishing phase. In general, feeder steers obtained from moderate to high nutritional backgrounds were more advanced in physiological maturity and marbling deposition and proceeded through the finishing phase at slower rates than feeder steers obtained from limited nutritional environments.

The variation that exists in biological traits of economic importance to beef production, including growth rate and carcass merit appears to be vast and under a high degree of genetic and environmental control. Genetic variation found between breeds is of comparable magnitude to that found within breeds for most growth and carcass traits. By environmental manipulation and the proper use of genetic resources, beef producers should be able to select individual cattle that will meet the specifications necessary to produce profit under a given management system. According to Cundiff, (1982), cattle type should be matched with the proper environment and management program.

CHAPTER III

GROWTH, CARCASS, CHEMICAL AND PALATABILITY TRAITS OF CROSSBRED STEERS MANAGED FOR ACCELERATED BEEF PRODUCTION: BREED TYPE COMPARISON

Abstract

Data were collected from 41 steers representing 7 different breed groups (A = purebred Angus, B = Brahman percentage crossbreds, C = Charolais -sired crossbreds, S = Simmental - sired crossbreds and A X H = Angus X hereford crossbreds. Steers were weaned, transported to a commercial feedlot and fed a series of 4 rations ranging from 50% to 90% concentrate. The feeding period, based on an estimated fat thickness of 0.5 inches or low Choice quality grade endpoint, was 162 days for A, B, H and A X H and 176 days for C, L and S. Initial weights (IW) ranged from 260 to 320 kg for B and C respectively. C steers were initially heavier (P<.05) than all steers whereas B,H,L and S steers were the lightest (P<.05) in IW. Final weights (FW) were heaviest (P<.05) for C and AxH, 555 and 552 kg respectively, and lightest (P<.05) for B steers (500 kg). Cumulative average daily gain (CADG) was greatest for S and H (1.69 and 1.64 kg/d) while B steers performed the lowest (1.38

kg/d)(P<.05). Carcass data revealed that USDA quality grades were highest for A, AxH and H steers and lowest for S steers (P<.05), while L,C, and B steers were intermediate and similar. Mean quality grades ranged from low Select to low Choice. USDA yield grades were superior for C,L and S, 1.4, 2.2 and 2.4 respectively and moderate for A,B,H and AxH, 3.1, 3.2, 3.2 and 3.6, respectively. Proximate chemical analysis of the carcasses were closely related to USDA quality and yield grade measures regarding the amounts of fat and lean. Palatability comparisons indicated that all breed-types were similar and acceptable in eating quality. Growth rate among breed-types appears to have the largest effect on carcass desirability during accelerated beef production.

Introduction

Through the years, beef production management systems have changed due to advanced technology, economics, consumer demands, as well as, changes in cattle type and the influence of new breeds (Cundiff, 1986). Total production efficiency can be greatly increased by increasing the efficiency of the post-weaning growth phase of cattle production. Traditional post weaning systems typically involve some type of forage based nutritional program which allows the cattle to assimilate muscle and frame prior to placement on a high concentrate diet for fattening (Harrison et al., 1978). Changes in grain and forage resources have prompted many producers to eliminate this phase of production and instead go directly to the fattening phase with their cattle. Accelerated beef production systems such as this require cattle that have the genetic ability to grow rapidly, without becoming excessively fat. Additionally, these cattle should yield carcasses of acceptable palatability.

Cattle following the channels of a accelerated system are much younger at slaughter and consequently do not typically deposit enough intramuscular fat to meet the specifications for the USDA choice quality grade. Dolezal et al, (1982) indicated in a palatability study that days on feed and/or subcutaneous fat thickness could be used as alternatives to the present USDA quality grading system for predicting beef palatability. Feeding younger cattle in accelerated production systems may require alternative methods for marketing and subsequent value determination.

The objectives of this study were to compare the growth, carcass, chemical and palatability traits of differing crossbred steers of known history managed for accelerated beef production.

Materials and Methods

Forty-one steers representing seven different breed groups were selected from the Oklahoma State University Cooperative Extension Steer Feedout Program. Breed groups represented were purebred Angus, percentage Brahman crossbreds, Charolais - sired crossbreds, purebred Hereford, Limousin - sired crossbreds, Simmental - sired crossbreds and Angus X Hereford. Six steers from each group were evaluated except for the percentage Brahman group which contained only five steers.

At approximately three weeks post-weaning, the steers were placed in a commercial feedlot (November 12, 1986). The average age of the steers at this time was 252 days with a range of 226 to 294 days. All steers were dewormed, poured for lice and grubs, vaccinated with four-way blackleg and leptospirosis, as well as, implanted with Ralgro, a commercial product containing 36 mg of zeronal. A second implant was administered at mid-test (approximately 75 days).

Four rations, ranging from approximately 50% to 90% concentrate, were used during the feeding period (table 1). The goal of the feeding strategy was to adjust the steers to the high concentrate ration as quickly as possible while minimizing digestive problems. Steers were fed ad libitum in bunk line feeders and managed under normal feedlot conditions.

All steers were individually weighed and measured for hip height at the beginning of the feeding period. A second weight was obtained after a fourteen day warm up period to equalize pre-delivery management effects. Check weights were obtained on all steers on day 78 of the feeding period. Final weights were obtained on Angus, Brahman, Hereford and

A X H steer groups on day 162 while Charolais, Limousin and Simmental steers were weighed off test on day 176 of the feeding period. All weights reported are actual weights with no shrink.

The intent was to slaughter the steer groups when it was estimated by feedout management that 60% of the cattle should grade USDA low choice (12.7 mm fat); however, the maximum feeding period was deemed 180 days regardless of grading potential.

All steers were transported to a commercial packing plant and slaughtered under normal procedures. Hot carcass weights were obtained at the time of slaughter. Additional carcass data were obtained 48 hours postmortem. Adjusted fat thickness, ribeye area and kidney, heart and pelvic fat percent were obtained and used to calculate USDA yield grade (yield grade=2.50 +(2.50 X adjusted fat thickness) + (0.20 X % kidney, heart and pelvic fat) + (0.0038 X hot carcass weight) - (0.32 X ribeye area)). Forty-eight hour marbling scores, quality grade, skeletal maturity, lean maturity and overall maturity scores were also assigned to individual carcasses according to specifications outlined by USDA (1980). Distribution and texture scores were given for marbling; color, firmness and texture scores were appraised for the longissimus muscle. The left side of each carcass was used for compositional and sensory data.

Sixth through the twelfth wholesale ribs (IMPS 103) were removed from each carcass following procedures outlined by Hankins and Howe, (1946). Rib cuts were vacuum packaged and transported to Oklahoma State University Meats Laboratory for further analysis. In addition, a 6 mm slice of each ribeye was removed, frozen, packed in dry ice and shipped to the Texas A & M University Meat and Muscle Biology Laboratory for cholesterol analysis.

At the Oklahoma State University Meats Laboratory, 9-10-11th rib cuts were removed from the IMPS 103 rib according to procedures of Hankins and Howe (1946). Physical separation of the 9-10-11th rib involved subcutaneous fat, seam fat, muscle, other soft tissue and bone plus ligamentum nuchea removal. Chemical analysis of the soft tissue as well as 6 mm slice of the longissimus muscle was conducted following procedures of A.O.A.C. (1965) where Ether extractable lipid and moisture determinations for each sample were obtained and used in conjunction with the physically separated components to determine the percentages of subcutaneous, intermuscular and intramuscular fat, as well as, percentage of muscle and bone for the 9-10-11th rib cuts.

Two 2.54 cm steaks were obtained from the longissimus muscle starting at the 12th rib end and vacuum packaged and frozen for (-30C) subsequent taste panel evaluation and Instron shear tests. Each pair of steaks was removed from the freezer, thawed (2C) and broiled on a Farberware Open-Hearth broilers to an internal temperature of 70C. Samples of one cooked steak were evaluated by a six member trained sensory panel (AMSA, 1978). Panelists individually scored samples from each steak for juiciness, ease of fragmentation, amount of connective tissue, overall tenderness, flavor intensity and off-flavor using eight-point, descriptive rating scales (8 = extremely juicy, etc.). The second steak from each rib cut was cooled to 25C and six 1.27 cm cores were removed, parallel to the longitudinal orientation of the muscle fibers, for Instron shear force measurements. An average shear force value based on a minimum of six measurements was recorded for each steak.

Data analyses were conducted using ordinary least squares. The model included the main effect of breed and all other traits evaluated were considered dependent variables. Least squares means and standard errors were calculated.

Results and Discussion

Growth Traits

Analyses of variance revealed significant breed effects for hip height, initial weight, 14 day weight, average daily gain for the first weigh period (adg 1), 162 day weight, cumulative average daily gain to 162 days on feed as well as cumulative average daily gain to 176 days on feed (table 2). Charolais steers were taller at the hip ($p<.05$). Initial weights were greatest for Charolais steers ($P<.05$) while Angus, H X A , and Limousin type steers were intermediate and Hereford, Brahman and Simmental steers were lightest (P<.05). After the 14 day warm-up period to allow for pre-feeding management differences, Simmental steers were still significantly lighter (P<.05); however, other breed groups were more similar. Brahman and A X H steers ranged from 500 to 552 Kg. A X H steers were significantly heaviest at 162 days. Cumulative average daily gain up to 162 days was greatest for Simmental, Hereford, Charolais and A X H steers. Cumulative average daily gain for Charolais, Limousin and Simmental steers after 176 days on feed was greatest for Charolais and Simmental steers (P<.05).

<u>Carcass Traits</u>

Table 3 shows least squares means and standard errors for carcass traits. Significant breed differences were observed for hot carcass weight, fat thickness, longissimus muscle area, marbling score, USDA quality and yield grades, as well as dressing percentage. Charolais, Limousin and A X H steers had significantly heavier carcass weight (P<.05) than what? It is important to note the exceptionally high dressing percent of the Limousin and Charolais steers (64.5 and 63.7%, respectively). Fat thickness was thinnest for Charolais steers (P<.05) and thickest for A X H and Angus type steers. Longissimus muscle area was significantly larger for Charolais steers while smallest and similar for Brahman, A X H, Hereford, and Angus steers. Limousin steers had larger ribeye areas than Simmental steers (p<.05).

Marbling scores and USDA quality grades were highest for Angus, A X H and Hereford type steers and lowest for Simmental steers. USDA yield grade was significantly lower for Charolais steers, highest for A X H, Brahman, Hereford and Angus steers. Skeletal maturity, lean maturity and overall maturity scores did not differ significantly due to breed type. Distribution and texture scores for marbling along with color, firmness and texture of the ribeye muscle also did not differ significantly.

Physical and Chemical Composition

Physically separable components combined with chemical analysis of tissues from the 9-10-11th rib reveal the percentages of subcutaneous fat, intramuscular fat, intermuscular fat, bone and muscle (table 4). Subcutaneous fat and percent muscle breed groups. A X H steers contained the highest percentage of subcutaneous fat in the 9-10-11th rib section, while Charolais steers contained the least subcutaneous fat. Percentage of muscle from the 9-10-11th rib cuts was inversely related to the percentage of subcutaneous fat; whereby, Charolais steers contained the highest percentage of muscle and A X H steers contained the lowest in the 9-10-11th rib. Intramuscular fat percentage was greatest for Angus steers and is in agreement with much of the literature which indicates that Angus cattle have an advantage in marbling ability. Total fat percentage of the 9-10-11th rib cut indicates that Charolais steers were significantly trimmer while Angus X Hereford steers were fatter and other breed groups were intermediate.

Taste Panel Evaluation and Warner Bratzler Shear Force

Sensory panel evaluation of cooked steaks indicated little or no differences due to breed group (table 5). Juiciness was rated highest for Angus and Limousin steers, but not significantly different from any other breed group except Charolais, which received the lowest juiciness rating. Steaks from Angus and Angus X Hereford steers received significantly higher when compared to steaks from Charolais and Limousin steers. Flavor intensity was greatest for Angus type steers and lowest for Brahman type steers. Instron shear force values are an objective measure of tenderness, whereby, the kg of force used to sever a 1.27 cm core of meat is measured. This study indicates that the amount of force required to sever cores from Angus steers was significantly less than the force required to sever cores from Simmental and Angus X Hereford steers. Significant differences were observed as a result of breed in one cooking property measured. Cooking time was significantly less for Angus steers when compared to Hereford Limousin and Simmental steers.

Cholesterol Analysis

The cholesterol content of raw beef longissimus muscles revealed few differences attributable to breed group. The mean cholesterol content was 59.14 mg/100 grams of raw steak while the standard deviation was 6.14 mg/100 grams of raw steak. It appears, based on the information obtained in this study, that the variation in cholesterol is not large enough to allow for the selection of low cholesterol beef due to breed type.

Growth and carcass traits appear to be the two main areas that display the most difference among breed group compared in this study. The results of these data are generally in agreement with much of the previously published literature. The larger framed European breeds such as Charolais were heavier initially and throughout the trial, while also posting carcass traits that were generally trimmer and more muscular than other breed groups. Limousin steers posted exceptionally high dressing percentages, especially when compared to Brahman steers. Limousin steers were also trimmer and more muscular. Angus steers were superior in marbling score and USDA quality grade as well as having a slight advantage in flavor intensity. Hereford and A X H steers were very similar to Angus type steers in marbling score and USDA quality grade, which is in agreement with much of the literature that these breed types are somewhat earlier maturing and fatten quicker than the larger framed, later maturing breeds.

No wide range in cholesterol content was found nor was there an apparent breed group relationship for cholesterol content. Most importantly, all of the cholesterol values found in this study were low enough to fit into American Heart Association dietary guidelines for controlling cholesterol intake by individuals. There may be other factors, such as fat content or fatty acid composition, that would be more important on which to place selection pressure than cholesterol content.

It is important to note that measures of palatability were significantly different in certain areas; however, all breed groups ranked acceptable in eating quality. Consequently, the higher yielding carcasses may be the more feasible type in an accelerated beef production system. Present carcass price structures may however, the feasibility, even though, eating quality and production rates are very acceptable.

TABLE 1

FEEDLOT RATIONS NUTRIENT COMPOSITION

	1	2	3	4
NEm Mcal/kg	1.80	1.98	2.09	2.16
NEg Mcal/kg	1.10	1.25	1.30	1.40
% Crude Protein	12.0	11.0	10.0	9.50
% Calcium	.73	.63	.57	.53
% Phosphorus	.36	.29	.28	.24

TABLE 2

LEAST SQUARES MEANS FOR GROWTH TRAITS

	Breed-Group						
Trait	A[a]	B	C	H	L	S	AXH
Hip Ht(cm)	112.7 (1.16)[b] $_{ce}$	114.8 (1.27) $_{cde}$	121.4 (1.16) $_{g}$	112.2 (1.16) $_{c}$	115.5 (1.16) $_{ef}$	117.2 (1.16) $_{df}$	111.8 (1.16) $_{c}$
Frame Score	4.1 (.25) $_{c}$	4.2 (.28) $_{cd}$	6.0 (.25) $_{e}$	4.0 (.25) $_{c}$	4.8 (.25) $_{d}$	5.7 (.25) $_{e}$	3.9 (.25) $_{c}$
In Wt (kg)	289.8 (7.56) $_{c}$	259.7 (8.28) $_{d}$	318.2 (7.56) $_{e}$	261.8 (7.56) $_{d}$	269.8 (7.56) $_{cd}$	260.7 (7.56) $_{d}$	282.2 (7.56) $_{cd}$
14d Wt (kg)	297.4 (7.25) $_{cdef}$	294.6 (7.94) $_{cdef}$	303.8 (7.25) $_{d}$	279.2 (7.25) $_{c}$	288.3 (7.25) $_{ef}$	254.6 (7.25) $_{c}$	314.8 (7.25) $_{d}$
ADG1 (kg/d)	0.54 (.41) $_{cf}$	2.50 (.45) $_{d}$	-1.30 (.41) $_{e}$	1.24 (.41) $_{fg}$	1.32 (.41) $_{cde}$	-0.43 (.41) $_{e}$	2.33 (.41) $_{dg}$
162d Wt (kg)	515.7 (11.7) $_{cde}$	499.9 (12.8) $_{eg}$	541.4 (11.7) $_{cf}$	520.2 (11.7) $_{cdef}$	504.7 (11.7) $_{dg}$	504.7 (11.7) $_{dg}$	552.0 (11.7) $_{f}$
cummulative 162adg (kg/d)	1.47 (.05) $_{cd}$	1.39 (.06) $_{d}$	1.60 (.05) $_{ce}$	1.65 (.05) $_{ce}$	1.46 (.05) $_{cd}$	1.69 (.05) $_{e}$	1.60 (.05) $_{c}$
176d Wt (kg)			554.6 (12.8) $_{c}$		516.4 (12.8) $_{d}$	525.1 (12.8) $_{cd}$	
cummulative 176adg (kg/d)			1.54 (.06) $_{cd}$		1.41 (.06) $_{c}$	1.67 (.06) $_{d}$	

[a]A=purebred Angus, B=Brahman percentage crossbreds, C=Charolais-sired crossbreds, H=purebred Hereford, L=Limousin-sired crossbreds, S=Simmental-sired crossbreds and AXH=Angus X Hereford crossbreds).

[b](standard errors).

[cdefg]means on the same line bearing a common subscript are not different (P>.05).

TABLE 3

LEAST SQUARES MEANS FOR CARCASS TRAITS

	Breed-Group						
Trait	A[a]	B	C	H	L	S	AXH
Hot carcass Wt (kg)	317.2 (1.57)[b] cd	304.8 (1.72) d	353.2 (1.57) e	313.4 (1.57) cd	332.9 (1.57) ce	321.2 (1.57) cd	327.3 (1.57) cd
Fat thickness (mm)	14.4 (1.6) c	11.7 (1.7) cd	5.7 (1.6) e	14.0 (1.6) cf	9.7 (1.6) def	8.5 (1.6) de	15.5 (1.6) c
Ribeye area (cm^2)	75.0 (3.12) c	70.6 (3.42) c	100.2 (3.12) d	74.1 (3.12) c	87.8 (3.12) e	77.4 (3.12) c	72.9 (3.12) c
Marbling Score[g]	451.7 (25.9) c	354.0 (28.4) def	341.7 (25.9) e	418.2 (25.9) cd	375.0 (25.9) def	328.3 (25.9) dec	450.0 (25.9) c
Quality grade[h]	9.7 (.52) c	8.0 (.57) de	8.0 (.52) de	9.2 (.52) cd	8.7 (.52) cde	7.5 (.52) e	9.7 (.42) c
Yield grade	3.1 (.22) c	3.2 (.24) c	1.4 (.22) e	3.2 (.22) c	2.3 (.22) d	2.4 (.22) d	3.6 (.22) c
Dressing %	61.5 (.78) cde	61.0 (.86) d	63.7 (.78) ef	60.2 (.78) cd	64.5 (.78) f	61.2 (.78) cd	59.3 (.78) cd

[a]A=purebred Angus, B=Brahman percentage crossbred, C=Charolais-sired crossbreds, H=purebred Hereford, L=Limousin-sired crossbreds, S=Simmental-sired crossbreds and AXH=Angus X Hereford crossbreds.
[b](standard errors).
cdefmeans on the same line bearing a common subscript are not different (P>.05).
[g] 300 = slight; 400 = small; 500 = modest;
[h]7,8,9 = select; 10,11,12 = choice;

TABLE 4

LEAST SQUARES MEANS FOR 9-10-11TH RIB COMPOSITION

	Breed-Group						
Trait	A[a]	B	C	H	L	S	AXH
Subcutaneous fat %	12.6 (1.06) bc	11.3 (1.16) bcd	8.3 (1.06) f	14.0 (1.06) de	11.7 (1.06) cd	10.7 (1.06) bcf	15.6 (1.06) d
Intramuscular fat %	.94 (.10) b	.67 (.11) bc	.63 (.10) c	.73 (.10) bc	.70 (.10) bc	.59 (.10) c	.68 (.10) bc
Intermuscular fat %	23.9 (1.20) bc	25.4 (1.31) b	16.6 (1.20) d	23.2 (1.20) bc	22.4 (1.20) bc	21.3 (1.20) c	24.2 (1.20) bc
Muscle %	46.6 (1.62) bc	46.6 (1.77) bc	58.5 (1.62) d	46.8 (1.62) bc	50.2 (1.62) b	50.2 (1.62) b	43.9 (1.62) c
Bone %	14.9 (.62) bc	14.9 (.68) bc	15.6 (.62) bc	15.0 (.62) bc	14.2 (.62) c	16.6 (.62) b	15.6 (.62) bc
Total fat %	37.4 (1.9) bc	37.4 (2.1) bc	25.5 (1.9) d	37.9 (1.9) bc	34.8 (1.9) c	32.5 (1.9) c	40.5 (1.9) b

[a]A=purebred Angus, B=Brahman percentage crossbred, C=Charolais-sired crossbreds H=purebred Herefored, L=Limousin-sired crossbreds, S=Simmental-sired crossbreds and AXH Angus X Hereford crossbreds.

[bcdef]means on the same line bearing a common subscript are not different (P>.05).

TABLE 5

LEAST SQUARES MEANS FOR SENSORY PANEL EVALUATION AND SHEAR FORCE

	Breed-Group						
Trait	A	B	C	H	L	S	AXH
Juiciness[a]	5.06 (.26) c	4.43 (.28) cd	4.18 (.26) d	4.66 (.26) cd	4.95 (.26) c	4.55 (.26) cd	4.88 (.26) cd
Ease of fragmentation[a]	5.66 (.28) c	5.99 (.31) c	5.33 (.28) c	5.69 (.28) c	5.62 (.28) c	5.58 (.28) c	5.80 (.28) c
Connective tissue[a]	6.22 (.22) c	6.18 (.24) cd	5.54 (.22) de	6.24 (.22) cf	5.87 (.22) ce	5.65 (.22) df	6.37 (.22) c
Flavor intensity[a]	5.19 (.11) c	4.64 (.12) df	4.87 (.11) de	5.07 (.11) ce	4.82 (.11) def	5.00 (.11) ce	4.81 (.11) de
Overall tenderness[a]	5.75 (.25) cd	6.15 (.28) c	5.18 (.25) d	5.89 (.25) cd	5.80 (.25) cd	5.38 (.25) cd	5.83 (.25) cd
Off flavor[b]	3.75 (.10) c	3.93 (.11) c	3.78 (.10) c	3.93 (.10) c	3.92 (.10) c	3.67 (.10) c	3.90 (.10) c
Shear force (kg)	4.04 (.35) c	4.22 (.39) cd	4.43 (.35) cd	4.51 (.35) cd	4.43 (.35) cd	5.14 (.35) d	5.26 (.35) d
Cooking time (minute)	16.67 (.99) c	18.00 (1.08) cd	19.50 (.99) cd	19.83 (.99) d	20.00 (.99) d	20.33 (.99) d	18.50 (.99) cd
Cooking loss %	22.93 (1.62) c	26.81 (1.77) c	25.27 (1.62) c	26.01 (1.62) c	25.22 (1.62) c	27.36 (1.62) c	26.01 1.62) c

[a]means based on 8-point rating scales (8 = extremely juicy, easy, low in connective tissue, intense, tender).
[b]means based on 4-point rating scale (4 = none; 3 = slight; 2 = moderate; 1 = intense).
[cdef]means on the same line bearing a common subscript are not different (P>.05).

TABLE 6

MEANS AND (STANDARD ERRORS) FOR ALL TRAITS

Trait	Mean	Standard Error
Age in Days	421	2.50
Hip Height (cm)	115	.65
Initial Weight (kg)	278	4.11
Final Weight (kg)	527	5.37
Average Daily Gain (kg/d)	1.45	.03
Carcass Weight (kg)	325	3.75
Fat Thickness (mm)	11	.76
Longissimus muscle area (cm^2)	80	1.90
Quality Grade[a]	9	.22
Yield Grade	2.7	.14
Dressing Percent	62	.39
% Muscle 9-10-11th rib	49	.90
% Total Fat 9-10-11th rib	35	.99
Cholesterol (mg/100g)	59	.96
Overall Tenderness[b]	5.7	.10
Juiciness[b]	4.7	.10

[a] 7, 8, 9, = Select; 10, 11, 12, = Choice;
[b] Means Based on 8-Point Rating Scale (8 = extremely tender, juicy)

CHAPTER IV

THE RELATIONSHIPS OF INITIAL PHENOTYPE AND AGE WITH GROWTH CARCASS CHEMICAL AND PALATABILITY TRAITS OF CROSSBRED STEERS

Abstract

Data were collected from 41 steers representing 7 different breed groups (A=purebred Angus, B=Brahman percentage crossbreds, C=Charolais-sired crossbreds, S=Simmental-sired crossbreds and AXH=Angus X Hereford crossbreds. Initial weight, hip height, frame score and age were evaluated and correlations were calculated between these traits and other growth, carcass, chemical and palatability traits. A significant correlation of 0.35 was revealed between age and fat thickness (P<.05). Correlations between hip height and average daily gain, final weight and carcass weight were 0.42, 0.47 and 0.36 respectively (P<.05). Frame score was similarly correlated with average daily gain and final weight; 0.44 and 0.42, respectively (P<.05). Initial weight was significantly correlated with average daily gain, final weight, carcass weight and ribeye area; 0.34, 0.60, 0.59 and 0.33, respectively (P<.05). No significant correlations were found between the initial phenotypic measures and age with

regard to USDA quality and yield grades or composition of the 9-10-11th rib sections of the carcasses. Palatability studies indicate that off-flavor ratings are correlated with age (-0.40) and initial weight (0.35) ($P<.05$). It appears that growth rate, final weight, and gross carcass parameters are the primary traits that are related to initial phenotypic measures and age. The relationship between these parameters and palatability traits are unclear.

Introduction

Initial phenotypic measures can be described as measurements on an individual at an early age, and are generally thought to be easily attainable. Weaning weight is a very common measurement recorded on individuals and if birth weights are not recorded, then weaning weight is the earliest phenotypic measure taken for an animal. Frame score, or hip height relative to age is another relatively easy measure to attain early in an animal's life. These factors in conjunction with age and along with the relationships that exist between these parameters and growth rate and carcass merit allows for some predictability in these important beef production components.

Frame size at a given age is highly correlated with mature size, and therefore if growing cattle of differing frame sizes are managed the same, the composition of these cattle should be different at similar ages (USDA, 1979). In a summary reported by Cundiff (1987), larger framed younger cattle grew more rapidly and were leaner in composition than smaller framed, older cattle.

Maturity or age has long been known to be a factor influencing the eating quality of beef. The question often occurs as to how much variation in age can be tolerated in order to still maintain consistency and quality in beef. The relationship between age and composition as well as composition and eating quality have been well studied and documented (Berg and Walters, 1983).

The objectives of this study were to evaluate the relationships that exist, if any, between initial phenotypic measures and age with growth, carcass, chemical and palatability traits of crossbred steers managed for accelerated beef production.

Materials and Methods

Forty-one steers representing seven different breed groups were selected from the Oklahoma State University Cooperative Extension Steer Feedout Program. Breed groups represented were purebred Angus, percentage Brahman Crossbreds, Charolais - sired crossbreds, purebred Hereford, Limousin - sired crossbreds, Simmental - sired crossbreds and Angus X Hereford. Six steers from each group were evaluated except for the percentage Brahman group which contained only five steers.

At approximately three weeks post-weaning, the steers were placed in a commercial feedlot (November 12, 1986). The average age of the steers at this time was 252 days with a range of 226 to 294 days. All steers were dewormed, poured for lice and grubs, vaccinated with four-way blackleg and leptospirosis, as well as, implanted with Ralgro, a commercial product containing 36 mg of zeronal. A second implant was administered at Mid-test (approximately 75 days).

Four rations, ranging from approximately 50% to 90% concentrate, were used during the feeding period (table 1). The goal of the feeding strategy was to adjust the steers to the high concentrate ration as quickly as possible while minimizing digestive problems. Steers were fed *ad libitum* in bunk line feeders and managed under normal feedlot conditions.

All steers were individually weighed and measured for hip height at the beginning of the feeding period. A second weight was obtained after a fourteen day warm-up period to equalize pre-delivery management effects. Check weights were obtained on all steers on day 78 of the feeding period. Final weights were obtained on Angus, Brahman, Hereford and A X H steer groups on day 162 while Charolais, Limousin and Simmental steers were weighed off test on day 176 of the feeding period. All weights reported are actual weights with no shrink.

The intent was to slaughter the steer groups when it was estimated by feedout management that 60% of the cattle should grade USDA low choice (12.7 mm fat); however, the maximum feeding period was deemed 180 days regardless of grading potential.

All steers were transported to a commercial packing plant and slaughtered under normal procedures. Hot carcass weights were obtained at the time of slaughter. Additional carcass data were obtained 48 hours postmortem. Adjusted fat thickness, ribeye area and kidney, heart and pelvic fat percent were obtained and used to calculate USDA yield grade (yield grade=2.50 +(2.50 X adjusted fat thickness) + (0.20 X % kidney, heart and pelvic fat) + (0.0038 X hot carcass weight) - (0.32 X ribeye area)). Forty-eight hour marbling scores, quality grade, skeletal maturity, lean maturity and overall maturity scores were also assigned to individual carcasses according to specifications outlined by USDA (1980). Distribution and texture scores were assigned for marbling; color, firmness and texture scores were appraised for the longissimus muscle. The left side of each carcass was used for compositional and sensory data.

Sixth through the twelfth wholesale ribs (IMPS 103) were removed from each carcass following procedures outlined by Hankins and Howe, (1946). Rib cuts were vacuum packaged and transported to Oklahoma State University Meats Laboratory for further analysis. In addition, a 6 mm slice of each ribeye was removed, frozen, packed in dry ice and shipped to the Texas A & M University Meat and Muscle Biology Laboratory for cholesterol analysis.

At the Oklahoma State University Meats Laboratory, 9-10-11th rib cuts were removed from the IMPS 103 rib according to procedures of Hankins and Howe (1946). Physical separation of the 9-10-11th rib involved subcutaneous fat, seam fat, muscle, other soft tissue and bone plus ligamentum nuchea removal. Chemical analysis of the soft tissue as well as 6 mm slice of the longissimus muscle was conducted following ADAC (1980) procedures Ether extractable lipid and moisture determinations for each sample were obtained and used in conjunction with the physically separated components to determine the percentages of subcutaneous, intermuscular and intramuscular fat, as well as, percentage of fat-free muscle and bone for the 9-10-11th rib cuts.

Two 2.54 cm steaks were obtained from the longissimus muscle starting at the 12th rib end, vacuum packaged and frozen for (-30C) subsequent later taste panel evaluation and Instron shear tests. Each pair of steaks was removed from the freezer, thawed (2C) and broiled on a Farberware Open-Hearth broilers to an internal temperature of 70C. Samples of one cooked steak were evaluated by a six member trained sensory panel (AMSA, 1978). Panelists individually scored samples from each steak for juiciness, ease of fragmentation, amount of connective tissue, overall tenderness, flavor intensity and off-flavor using eight-point, descriptive rating scales 8 = extremely juicy, etc). The second steak from each rib cut was cooled to 25 C and six 1.27 cm cores were removed, parallel to the longitudinal orientation of the muscle fibers, for Instron shear force measurements. An average shear force value based on a minimum of six measurements was recorded for each steak.

Data analyses were conducted using ordinary least squares. The model included the main effect of breed and all other traits evaluated were considered dependent variables. Relationships among traits were evaluated by utilizing pooled within breed correlations.

Results and Discussion

Correlation coefficients associated with age, hip height, frame score and initial weight with respect to other growth, carcass and palatability traits are presented in Table 7.

Of all traits measured in this study, fat thickness over the ribeye and off flavor sensory ratings were the only traits significantly correlated with age. The respective correlation coefficients were 0.35 and -0.40 ($P<.05$). The average age of these steers at the beginning of the trial was 252 days; thus the average age at slaughter was approximately 14 months, with the oldest individual being less than 15.5 months of age. Previous literature indicated that all cattle under 24 months of age are typically classified similar with regard to carcass merit in the A maturity category (USDA, 1980). In addition, numerous other studies indicate that growth rate and final weight is primarily a function of genotype and environment.

Hip height was significantly correlated with average daily gain, final weight and carcass weight. The correlation coefficients were 0.42, 0.47 and 0.36, respectively. The average initial hip height was 115 centimeters.

Parameters significantly correlated with initial weight include average daily gain, final weight, carcass weight, off flavor sensory ratings and rib eye area; 0.34, 0.60, 0.59, 0.35 and 0.33 respectively. The average initial weight was 278 kilograms.

Frame score, or hip height relative to age, was correlated with average daily gain and final weight; 0.44 and 0.42 respectively. The average frame score was 4.7. According to previous literature, frame score should give some indication of composition (USDA, 1979). As expected, frame score was significantly correlated with age and hip height; -0.45 and 0.83, respectively.

No significant relationships were revealed with regard USDA quality and yield grade, 9-10-11th rib composition, Instron shear force, tenderness and juiciness ratings or cholesterol content of the longissimus muscle.

It appears that the most useful relationship that exist between initial phenotype and age are with growth traits.

The review of literature indicates more relationships exist among these traits; however, due to the nature of this experiment, these relationships have not been expressed.

TABLE 7

CORRELATION COEFFICIENTS FOR PRODUCTION AND CARCASS TRAITS.

	Age	Hip Height	Frame Score	Initial Weight
Final Weight		0.47	0.42	0.60
Average Daily Gain		0.42	0.44	0.34
Carcass Weight		0.30		0.59
Off Flavor	-0.40			0.35
Rib Eye Area				0.35
Fat Thickness	0.45			

Significance level: P<.05

CHAPTER V

SUMMARY AND CONCLUSIONS

Through the years beef production management systems have changed due to advanced technology, economics, consumer demands, as well as, changes in cattle type and the influence of new breeds (Cundiff, 1986). This experiment was conducted to study the growth, carcass, chemical and palatability traits of various crossbred steer groups managed for accelerated beef production.

Accelerated beef productions systems differ from traditional systems in that the backgrounding or forage-based nutritional phase is omitted from the nutritional program of growing cattle. This type of production system should require cattle types that have the genetic potential for rapid growth, as well as, the ability to produce a relatively lean carcass. The reasoning for the historical forage-based nutritional program is that traditional cattle should be grown at a slower rate initially in order to allow for the assimilation of frame and muscle; thus preventing overly fat carcasses. In addition, this forage feeding program also allows for a means to utilize available forage at a relatively cheap cost. There are inherent problems associated with both types of systems. The accelerated system requires very rapid growing lean cattle which will be young when they reach acceptable slaughter weights and consequently, these cattle typically do not grade choice and are, therefore, discounted due to the current carcass price structure. If traditional cattle types are used in an accelerated system, they typically become overly fat and have undesirable USDA yield grades. In contrast, rapidly growing, leaner cattle placed in a traditional system often reach excessive and undesirable final weights which translate into unacceptable carcass weights. In order to meet the requirements of the narrow marketing window, producers must synchronize the genetic resources available with feed and management resources.

This experiment included 41 steers consisting of seven different breed groups. Angus, Brahman, Charolais, Hereford, Limousin, Simmental and Angus X Hereford steers were utilized. At approximately three weeks post weaning, these steers were placed on a series of concentrate diets designed to acclimate the steers to high (90%) concentrate as quickly as possible. All steers were individually weighed and measured on test. Check weights were obtained at specified intervals during the trial. Final weights were obtained prior to slaughter. Carcass data were taken, as well as, the removal of IMPS 103 rib sections. 9-10-11th rib composition, taste panel evaluations, Instron shear force and cholesterol content was determined. Least square means were calculated and compared by breed group, as well as, correlation coefficients for all traits with respect to age, hip height, frame score and initial weight.

The results of these data are generally in agreement with much of the literature reviewed. European crossbred cattle were generally heavier and more rapid in growth. In addition, these cattle were leaner and more muscular, with lower USDA quality grades and more desirable USDA yield grades. 9-10-11th rib composition was related to USDA quality and yield grade with respect to lean and fat. No practical differences were found in regard to taste panel evaluations or shear force determinations. Cholesterol content of raw steaks did not differ (P >.05) with respect to breed group. Growth traits and final weights were the primary parameters related to hip height, initial weight and age as indicated by correlation coefficients. Off flavor ratings, fat thickness, rib eye area and carcass weight were also related to the initial phenotypic measures and age; however, the practical significance of these relationships is questionable.

In conclusion, growth, carcass, chemical and palatability traits vary among crossbred steer groups as well as, specific relationships among traits. Growth rate appears to show the most differences with respect to breed group and initial phenotypic measures. It is important to note that palatability and shear force ratings were all acceptable; therefore the faster growing, leaner breeds should be the superior individuals in an accelerated system.

However, the beef cattle industry bases its carcass price structure around USDA Choice quality grade; consequently, penalizing the rapid growing, lean cattle that do not deposit enough intramuscular fat to grade USDA choice. In order for producers to benefit from an accelerated production system, specialized marketing strategies must be incorporated whereby the carcasses can be marketed to the health conscious and fat conscious consumers at a comparable price to USDA Choice. The other alternatives may include such techniques as hot fat trimming, retail trim or the ultimate selection of a breed type or types that are rapid growing and lean, but have the ability to marble at an earlier age.

Further research should be conducted utilizing these rapid growing lean breeds of cattle to further document their carcass eating quality. Furthermore, additional studies should be conducted to evaluate alternative procedures for determining the eating qualities of beef.

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