PHYSICAL AND CHEMICAL CARCASS CHARACTERISTICS AS INFLUENCED BY PROTEIN SOURCE, PROTEIN LEVEL, BREED TYPE, FRAME SIZE, AND MUSCLING

by

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ABSTRACT

Two hundred seventy two steers were selected to represent Okie 1 and Okie 3 type cattle. Okies are crossbred cattle with no Brahma breeding. The finishing diets contained cottonseed meal or dehydrated alfalfa as the protein supplement and diets were formulated to have either 10% or 11.2% protein. The steers were scored for frame size and muscling. After 162 days on feed, the cattle were evaluated weekly for slaughter as to when they reached an estimated choice grade.

Carcass data were obtained and the wholesale rib was analyzed for protein, lipid, and moisture. These data were used to predict whole carcass composition.

No significant differences in carcass characteristics or composition were found due to the dietary level of protein (10% vs. 11.2%). Hot carcass weight was increased ($P < .05$) by supplementing the diet with dehydrated alfalfa as compared to cottonseed meal. Okie 3 cattle were similar in carcass characteristics to Okie 1's; however, they did possess less fat ($P<.05$) and had a lower ($P<.05$) yield grade than Okie 1's. Degree of muscling had an effect ($P<.05$) on the carcass characteristics and composition, whereas frame size had no effect upon carcass composition. The larger framed cattle were heavier, more muscular, and lower in quality ($P<.05$) than the smaller framed cattle.

INTRODUCTION

Even though research concerning the effects on carcasses from animals fed different diet treatments is plentiful, not much has been done on the effects of diet treatment on Okie type cattle.

Okie's are crossbred cattle that have no Brahma breeding in them. These are typical of the cattle commonly fed in the Southwest. They are classified as Okie #1, Okie #2, and Okie #3 based on their frame size, muscling and thriftiness. Okie 1's are heavier and more thickly muscled than the Okie 3's. Okie 1's exhibit a more thrifty condition and are expected to perform better than Okie 3's. As a result of this, Okie 3 cattle can usually be purchased cheaper than Okie 1's.

Cattle feeders are concerned about costs and want to minimize any unnecessary feed costs. Cattle feeders have traditionally finished beef cattle on diets that contain about 11.2% protein. Commonly used protein sources include cottonseed meal and soybean meal, both of which are high priced protein supplements. Dehydrated alfalfa is increasing in availability and is a cheaper source of high quality protein. Supplemental protein is a costly item and should be studied in more detail to determine the best source and level of protein to be used in finishing rations.

The biological type of cattle is also a concern when minimizing costs. It is well known that different breeds have different feedlot performances. More information is always needed to evaluate feedlot performance of different breeds on different diets.

Frame size and muscling are also important factors to consider when feeding cattle. Both factors affect the final product that comes off the feedlot. It is possible that animals of different frame size and resulting different growth characteristics in the feedlot might utilize protein differently.

The purpose of this project was to determine the effects of cattle type, protein supplement, protein level, frame size, and muscling on carcass physical and chemical characteristics.

LITERATURE REVIEW

Days on Feed

The trend in the beef industry has been toward marketing at increasingly younger ages.

Epley et al. (1968) using 200 Angus and Hereford steers found that feeding beyond 139 days did not consistently increase or decrease flavor intensity, flavor desirability, tenderness, or overall desirability as determined by a trained sensory panel.

Moody et al. (1970) studied the influence of days on feed on the quantitative and qualitative characteristics of beef. There were no significant differences in average daily gains or diet intake over four different slaughter periods (28, 56, 84 and 112 days) when fed a high fat, roughage diet. Kidney, pelvic and heart fat, and subcutaneous fat did increase up to 112 days while conformation scores did not improve after 84 days. Marbling tended to increase with time but after 84 - 112 days this was not significant.

Zinn, Durham and Hedrick (1970) found that steers weighed more than heifers when fed longer than 120 days and that heifers required 30 to 60 days longer feeding period to attain a final feedlot weight comparable to their steer counterparts. No significant difference in average daily gain was found after 120 days on feed. Chilled carcass weight and dressing percent increased as days on feed increased.

Marbling score increased in a stepwise manner up to 240 days on feed. A similar increase in USDA Quality Grade was noted.

Epley et al. (1970) studied digestible protein:Mcal energy ratios and their effect on the number of days needed to reach a slaughter weight of 453 Kg. As the ratios increased, the number of days needed to reach 453 Kg. decreased. Most cattle are fed in feedlots, not to a time constant or weight constant basis, but to the estimated choice grade. Later maturing breeds may be at a distinct disadvantage in terms of degree of marbling if slaughtered at a time or weight constant basis compared to earlier maturing breeds. This was evident in a study by Dean et al. (1976a) using 213 straight and crossbred steers. These were progeny of Herefords, Hereford x Holstein, and Holstein cows. The Hereford and crossbred progeny had higher daily gains than did the Holstein progeny. As expected the Herefords required the shortest time on feed (141 to 203 days) to reach the anticipated grade of low Choice, whereas the Holsteins required 192 to 251 days on feed to reach the same endpoint.

Dinius and Cross (1978) and Harrison et al. (1978) observed that the dressing percent significantly ($P<.05$) increased as the period of feeding concentrate increased. Marbling scores also increased significantly ($P<.05$) with the days on feed. Average daily gain tended to increase with increasing days as did fat thickness, KPH % and USDA yield grade.

O'Mary, Martin and Anderson (1979) found that cattle of different growth and maturity rates should be compared at a certain level of fatness or compositional endpoint on the growth curve.

Marchello, Bennett and Gorman (1980a) tested three frame sizes of cattle on a 75% concentrate diet for varying number of days on feed and found that as days on feed increase, hot carcass weight, fat thickness at the 12th rib and yield grade all significantly increased. With respect to carcass merit, little was gained when cattle were fed past 166 days. Average daily gain decreased and conversion of feed to gain increased when cattle were fed beyond 166 days. Several conclusions were drawn: (1) Animals with small frames should be fed shorter periods than the larger framed cattle; (2) Cattle should be sorted by frame size for feeding similar length and (3) the practice of topping the pens should be used if cattle cannot be sorted by sizes.

Sex Differences

Sex influences the onset of fattening with heifers depositing more fat at lighter weights than steers and steers depositing more at lighter weights than intact males (Berg and Butterfield 1968). Wilson et al. (1969) evaluated growth and carcass differences between steers and heifers of similar ages and found that heifers had significantly ($P<.05$) lighter slaughter weights, greater amounts of subcutaneous fat, lower cutability and trimmed round, and higher marbling scores.

Meiske et al. (1970) compared performance of bulls, steers, and heifers. Bulls and steers had similar feedlot performances while heifers gained slower and less efficient. While nonsignificant, the bulls were heavier than the steers and significantly heavier than the heifers. The bulls had less fat thickness, less kidney, pelvic and heart fat (KPH), lower marbling scores, and higher yield grades than did the steers or heifers. The heifers had the smallest average ribeye areas.

Zinn et al. (1970) found that average daily gains were lower for Hereford hiefers than steers but this difference was not significant. Sex effects on chilled carcass weight were not significant during the first 90 days. However. carcasses from steers were heavier after 120 to 270 days on feed. Heifers required an additional 45 days on feed to reach a comparable carcass weight. The differences in dressing percent due to sex were small and nonsignificant. Marbling score was not affected by sex effect and steers and heifers deposited intramuscular fat at a similar rate. However, heifers matured at a faster rate than steers. Steers required 120 days on feed to increase one full grade from average Standard to average Good. Ninety additional days were required to reach low Choice. Heifers required 150 days on feed to reach a grade of average Good but failed to reach a Choice grade due to the Good grade conformation score assigned to them at 240 and 270 days.

Marian, Dikeman and Pope (1979) studied different feed efficiency endpoints and observed that steers from large and small type cattle had less fat and more water and similar yield grades than heifers at the same endpoint. Heifers had lower feed to gain ratios than steers.

Carcass Composition

Most of the weight gain in the feedlot over the normal mature weight will be in the form of fat. Weight at slaughter has an important influence on carcass composition. In normal slaughter ranges (800 lb - 1100 lb), as weight increases, muscle percentage decreases, fat percentages increase and bone percentage decreases (Berg and Butterfield 1968).

Martin, Walters and Whitman (1968) looked at the lean distribution in carcasses and found that little variation exists even among extreme types of cattle.

Dinkel et al. (1969) compared changes in composition of beef carcasses with increasing animal weight. For each kilogram gained in carcass weight the increase in trimmed retail cuts was the same regardless of the weight at which that kilogram of gain was added from about 300 to 600 Kg. live weight. In other words, the growth of trimmed-retail cuts in that weight range is essentially a straight line.

Breed Differences

Breed differences in carcass characteristics can be put to advantage in different situations and should be considered when maximum profits are at stake. Crossbreeding of cattle for commercial production of beef has become widely prevalent in past years.

Cole et al. (1963) conducted a study investigating the effects of type and breed of British, Zebu and dairy cattle on rate of gain, feed efficiency and carcass traits. The breeds consisted of Hereford and Angus (British), Brahman, Brahman crosses and Santa Gertrudis (Zebu), and Holstein and Jersey (Dairy). Both British breeds graded significantly higher, were fatter and had shorter carcasses than the other breeds. The Brahman cross and Santa Gertrudis were intermediate among all breeds in most carcass traits. The dairy breeds required the least amount of feed per 100 lb of gain. Zebu followed and the British breed required the most feed per 100 lb of gain.

Brahman and Hereford cattle were compared for different digestive powers on two levels of protein intake (Howes, Hentges and Davis 1963 and Kappel et al. 1972). The Brahman breed appeared to have a digestive advantage over breeds of British origin. On low protein diets, Brahmans digested more protein and consumed more dry matter than Herefords. There was no significant seasonal differences (mid-winter, mid-summer) in apparent digestibility of protein for either species.

Berg and Butterfield (1968) illustrated the breed differences in relative growth between dairy and beef types of cattle. The beef type steers showed a marked tendency to begin the fattening phase at a lower muscle plus bone weight than did the dairy type steers.

Moore, Essig and Smithson (1975) investigated the influence of breeds of beef cattle on ration utilization. The breeds were: Angus, Barzona, Brahma, Hereford, Santa Gertrudis and Shorthorn. Low, moderate and high energy rations were fed. Some of the notable results were that the digestible dry matter (DDM), digestible energy (DE), and energy digestion coefficient (EDC) values for Hereford bulls fed the high energy ration were higher than the Brahma bulls. No significant differences in DDM , DE, or EDC values were found among the breeds fed the medium energy ration. The DDM, DE, EDC values of Brahma bulls fed the low energy ration were higher than the values the Hereford bulls or Barzona bulls.

Dean et al. (1976a) found that dairy breeds require more feed per unit of gain than do beef breeds. Furthermore, Dean et al. (1976b) in studying the carcass traits of straight and crossbred progeny of beef and dairy breed suggested that total carcass merit was not greatly affected by the percentage of dairy breeding. Heavier carcass weight per day of age, more marbling and less external fat compensated for less muscling and poorer carcass conformation with increasing increments of dairy breeding.

Dinius et al. (1976) studied the relationship of feed intake and carcass composition between two different breeds of beef cattle, Angus and Santa Gertrudis. These researchers observed that daily gain and feed intake per unit of metabolic size and feed efficiency were similar between the two breeds. The Angus steers tended to have more marbling and tended to grade higher than the Santa Gertrudis steers. The Angus steers were earlier maturing as noted by the lighter slaughter weight, 450 Kg. for Angus vs. 550 Kg. for Santa Gertrudis.

McAllister et al. (1976) looked at growth rate and carcass quality in British and Continental sired crossbred steers. Polled Hereford (British) and Charolais, Limousin and Simmental (Continental) bulls were sired to Holstein and Angus cows. British breeding averaged less for slaughter weight per day of age, longissimus muscle area, and percent trimmed loin, but greater for fat thickness than did the

Continental breeding. There were no significant differences observed for percent KPH, cutability, marbling, or quality grade between either breed types.

Smith et al. (1976) observed that faster gaining breed groups tended to be more efficient than slower gaining breed groups in spite of the heavier weights maintained. Feed efficiency, when measured over a weight constant interval, is increased by a rapid growth rate due to fewer days of maintenance that are required. Charolais and Simmental crosses followed by South Devon crosses were the largest, fastest gaining breed groups; Hereford X Angus crossbreds and Limousin crosses were similar in average daily gain and in 405 day weight; and Jersey crosses were the smallest, slowest gaining breed group. Smith et al. (1977) reported that the biological type of cattle did not significantly ($P>.05$) influence feed efficiency at a weight constant or compositional constant endpoint.

Chenette et al. (1977) compared feedlot performances and carcass traits among various three-breed cross calves and found that, other than carcass weight, differences among breed groups with respect to carcass traits were small. Furthermore, Ellersiech et al. (1977) reported that the heterosis in crossbreeding was not significant with respect to feed efficiency.

Ferrell (1977) looked at feed utilization by various breeds of steers and their response to different levels of concentrate in the diet. Response of high concentrate and low concentrate diets in terms of metabolizable energy (ME) intake, rate of gain, feed efficiency, and carcass composition of the different breeds to increased dietary energy density were similar. This researcher suggested that there is little breed type X dietary energy level interaction.

Barber et al. (1977) studied two breed types - Angus and Charolais steers and found that diet energy did not significantly (P>.05) effect average daily gain or marbling score but it did affect cutability due to the Angus being fatter at the same quality grade.

O'Mary et al. (1979) compared crossbreds and straightbreds under comparable nutritional regimes. When slaughtered at a common age, some crossbred types, although heavier, did not reach a comparable finish to straightbreds. LeVan et al. (1979) had suggested that neither breed nor slaughter weight has a market effect on the relative distribution of retail lean, fat, and bone throughout the body. Breed differences in growth rate and retail lean distribution were relatively minor when cattle were slaughtered at similar percentages of the average mature weight of that particular breed.

Information on breeds and heterosis effect on growth, feedlot performance, and carcass characteristics are important in today's beef production system. Fat over the ribeye muscle is a characteristic known to be influenced by breed and type of cattle. Chilled carcass weight is positively associated with breed size. Ribeye area per unit of carcass weight gives a general indication of muscling in carcasses. Heterosis effects of crossbreeding for ribeye area are significantly negative. Crossbred carcasses are heavier, and heavier carcasses tended to be associated with a lower ribeye area per carcass weight ratio. Brahman breeding had a negative effect on estimated retail yield because Brahman and Brahman cross steers are associated with smaller ribeye area (Peacock et al. 1979).

Frame Size and Muscling

Prior et al. (1977) evaluated small type cattle and large type cattle with respect to three feed energy levels and three levels of dietary protein. These workers found that increasing energy intake increased average daily gain in both types of cattle. When adjusted to constant carcass weight, increasing dietary energy increased marbling scores, quality grade, fat thickness, kidney and pelvic fat, and yield grade in small type cattle but not in large type cattle. When fed up to 325 Kg. live weight, small type cattle increased in average daily gain and in feed efficiency with the high protein (13%) and the medium protein (11.5%) diets as compared to the low protein (10%) diets. With the large type cattle, average daily gain and feed efficiency increased up to 348 Kg. live weight with the high protein compared to the low protein diet.

Byers, Parker and Coady (1977) studied the relationship of mature size to Bovine protein requirements using average and large mature size steers and heifers. Two levels of protein were fed: 341 and 681 grams of soybean meal supplement. Large mature size steers and heifers gained 12% and 9.3% faster on the higher level of protein. The average mature sized cattle showed similar gains on both the high and lower level of protein. The large mature sized cattle took longer to reach the Choice grade than did the average mature sized cattle (121 vs. 170 days). Feed efficiency for the large mature sized cattle showed significant, positive response to the elevated protein level with an improvement of 3% for the heifers and 7.6% for the steers. Again, the average mature sized cattle showed no difference between the two protein levels in feed efficiency. However, the average mature sized cattle were more efficient in dry matter per unit of gain than the large sized cattle when fed the higher level of protein. The average mature sized cattle required 49 days less to reach similar body composition than the larger sized cattle. This is due to the average size cattle consuming more dry matter and gaining faster relative to their average metabolic size.

Byers, Parker, and Rampala (1978) showed that potential rates of protein and fat deposition, while determined genetically, are regulated by the nutritional plane. The rate of protein deposition was similar for small framed cattle fed either a medium or high energy diet and 4% to 6% higher for medium and large frame cattle on the medium and high energy diets. High energy diets accelerated that rate of fat deposition to a greater degree than protein deposition for all frame sizes.

O'Mary et al. (1979) suggested that scoring for muscling and wastiness is an attempt to distinguish differences in the major tissues of the body. By sorting, managing, and feeding feeder calves according to frame size and muscling thickness, cattlemen can produce slaughter cattle of desirable carcass compositions (Clayton, Bowling and Taylor 1979).

Marian et al. (1979) observed that large type cattle had a lower percentage of fat, lower yield grade, higher percentage of protein and water, and higher average daily gain than smaller type cattle.

Cundiff, Koch and Gregory (1979) used seven breed groups to study the effect of frame size, growth, and feed efficiency. They found that the larger, faster gaining breed groups were more efficient in weight and time constant intervals while the smaller, earlier maturing breed groups were more efficient in reaching grade and fat constant endpoints.

Adams and Smith (1979) noted that larger frame size was associated with a higher rate of gain, less carcass fat, higher yields of lean meat and lower USDA quality grade than smaller frame sizes. Along with the higher rate of gain, higher muscling scores were noted. As frame size decreased, average daily gain decreased and USDA quality grade increased. Average daily gain decreased as the muscling score decreased.

Marchello et al. (1980a) studied the influence that frame size and days on feed had on feedlot performance and carcass merit of steers. Three frame sizes (small frame, medium frame and large frame) were fed a 75% concentrate diet for 166, 194, 214 days. Frame size had little influence upon feedlot performance except that large framed steers required more Mcal of metabolizable energy per pound of gain. Large framed cattle carcasses were significantly heavier, possessed less fat, had larger ribeye areas, and had lower yield grades than the other two frame sizes. The same holds true for medium framed cattle over small framed cattle.

Protein Source

Protein is an important nutrient in cattle finishing diets. Although needed in small amounts, compared to other nutrients, it is one of the most expensive supplemental ingredients in the diet. The source of the protein is a factor which must be considered. The microorganisms in the rumen breakdown some of the dietary protein into the individual amino acids and incorporate them into microbial protein. This process results in poor quality proteins being improved and good quality proteins being reduced in quality (Purser and Buechler 1966).

Beeson, Mohler and Perry (1964) indicated that the addition of dehydrated alfalfa meal to high urea diets improved the utilization of urea by steers. Urea can be successfully used as a nitrogen source as long as it does not provide more than one third of the protein equivalent.

Haskins et al. (1967) fed steers different protein sources consisting of soybean meal, urea, and a mixture of the two. Average daily gains and carcass characteristics were not significantly influenced by protein sources.

Albin and Durham (1967) conducted a study on the addition of dehydrated alfalfa to an all concentrate diet consisting primarily of milo and cottonseed meal. The addition of 5% dehydrated alfalfa or 3% alfalfa and 2% fat reduced the efficiency of feed utilization. The 5% dehydrated alfalfa level produced less fat covering over the ribeye, reduced growth rate and reduced efficiency of feed utilization. Dressing percent, USDA carcass grade and marbling were not affected.

Van Slyke, Beeson and Perry (1971) found no significant differences in weight gain when groups of heifers and steers were fed a soybean meal protein supplement vs. dehydrated alfalfa.

Burris et al. (1974) fed 80 yearling steers for 146 days on diets varying in source of protein. Corn, soybean, fish and linseed were used as protein sources. Carcass quality grade, marbling score, ribeye area, fat thickness and dressing percent were not altered by source of protein supplementation. Average daily gains were lowest for the steers fed corn as the only protein source. Steers receiving no protein supplementation tended to grade higher and have more marbling as is sometimes the characteristic of slower growing cattle.

Burris et al. (1977) fed sixty-six yearling steers a corn silage diet that was supplemented with either cottonseed meal or soybean meal. Average daily gain, carcass weight, fat thickness, and ribeye area were significantly ($P<.05$) higher with supplementation with soybean meal than with cottonseed meal.

Utely and McCormick (1980) concluded that supplemental protein degradation and solubility differences existed due to protein source. Large differences in protein degradation existed between raw cottonseed (73.7%) as a high to dehydrated bermudagrass pellets (17.4%) a low with a urea-cottonseed meal supplement in between. No differences were found in carcass characteristics or average daily gains when different protein sources were fed.

Protein Level

It is well recognized that low protein diets do not produce weight gains as efficiently as diets high in protein. Carroll et al. (1964) fed 40 weanling heifers on two different diets. Twenty heifers were fed a maintenance level of energy and a submaintenance level of protein while the other 20 were fed a maintenance level of energy with an excess allowance of protein. The average live weight gained by heifers receiving the smaller amount of protein was only 3 1/2 lbs. compared to 30 lbs. for the liberally fed protein heifers. Cattle with similar treatment to the submaintenance level of protein were allowed liberal feeding to fatten and showed little difference from the excess protein heifers in carcass quality based on marbling scores and carcass grades. This is the result of compensatory growth.

Haskins et al. (1967) studied the effect of level of protein supplementation and found that steers consuming a 14% protein diet had the higher daily gains than steers fed an 11% protein diet. The carcass characteristics of these steers were not significantly affected by the level of protein in the diet.

Mies et al. (1979) fed steers diets consisting of 9%, 11% and 13% protein levels. Steers fed the 13% crude protein gained faster and were more efficient than those fed 9% or 11% or the 13%, 11%, 9% (reduced protein level every 56 days) diets. Rumesin was added to these diets and improved protein efficiency for all but the reduction diet. The Rumesin improved the protein efficiency with a decreasing effect as the crude protein levels increased. These results indicate that Rumesin has a protein sparing effect for steers fed 9% to 13% crude protein.

Epley et al. (1971) and Epley et al. (1970) studied the effect that three digestible protein:digestible energy ration diets had upon various quantitative and qualitative carcass characteristics of beef. Fat thickness, longissimus muscle area, hot carcass weight, conformation score, marbling score, quality grade, and yield grade were not affected by increased digestible protein:digestible energy ratios. Average daily gain and feed consumption increased as the digestible protein: digestible energy ration increased.

Peterson, Hatfield and Garrigus (1973) fed 160 Angus x Hereford steer calves diets containing four different crude protein levels (9, 11, 13 and 15%) with four different dietary energy concentrations. Increased dietary protein levels showed the greatest response in average daily gain during the first 55 day period and thereafter did not show as great a response. There was not a significant increase in average daily gain when protein levels were increased for cattle fed a high corn silage diet. Gain to feed ratios increased linearly as protein increased.

Braman et al. (1973) fed eighty steers for 140 days to determine the effects of different dietary protein levels. Higher dietary protein concentrations significantly improved daily gains and feed efficiency for the first 56 days with little advantage in the later phase of feeding. Dietary protein levels had little effect upon carcass parameters. Haskings et al. (1967) reported this also.

The effects of protein withdrawal on steer calves were investigated by Thomas et al. (1976). A control ration contained 7.5% crude protein and the protein supplemented ration contained 10.8% crude protein. Withdrawal of supplemental protein early in the finishing period had the most detrimental effect on performance while there was no effect of supplemental protein withdrawal on performance after 84 days on test (an average weight of 419 Kg.).

Fenderson and Bergen (1976) studied the effect of feeding excess dietary protein on feed intake in Holstein steers. Four rations were fed consisting of 10%, 20.2%, 32.5% and 40% protein. Feed intake of the two higher levels of protein (32.5% and 40%) were depressed the first 5 to 10 days on trial. These animals on the high protein diets tended to nibble their feed more frequently while the lower protein diet made the animals consume the major portion of the feed immediately after feeding.

Gill et al. (1977) looked at protein withdrawal for feedlot steers. The steers were fed 11.3% protein to 345 Kg. then the protein level was reduced to 10.3% and fed until 380 Kg., then the feed was further reduced to 9.5% protein and the cattle were fed to slaughter. Feedlot performance and carcass characteristics were not altered. Feed intake was not reduced due to this withdrawal treatment. This study suggests that the protein requirement for steers is below 9.5% if the steers have gained well at lighter weights. With a previous history of marginal protein intake, higher levels may be needed for compensatory gains. This is in agreement with work done by Thompson and Riley (1979). Crickenberger, Fox and Magee (1978) indicated that when cattle reach about 410 Kg., supplemental protein could be withdrawn if the basal ration contained above 8.5% crude protein.

Gates, Embry and Bush (1977) supplemented corn silage diets (10.4% protein) with soybean meal to 13.1% protein, and with urea to 12.6% protein. The supplemental protein improved the daily gains and the feed efficiency compared to the unsupplemented diet. In another study, Gates and Embry (1977) used soybean meal supplementation to bring up the percent protein in the diet from 10% to 12% protein. Small but unsignificant increases in weight gain were noted.

In a study of protein levels for feedlot cattle, Gill et al. (1977) fed four different protein levels: 9.5, 10.3, 11.2 and 12.3% protein on a dry matter basis. As protein levels increased, rate of gain and feed efficiency increased. The gains were increased by the higher protein levels only for steers under 386 Kg. The use of Monesin improved rate of gain at the two lowest levels. The results suggest a sparing effect of Monesin on protein.

Walker et al. (1977) experimented with protein withdrawal and its effect upon feedlot performance. Average daily gains were not influenced by the protein withdrawal (down to 9.5% protein). Protein withdrawal significantly improved the efficiency of protein utilization but did not have an effect on carcass characteristics.

Martin et al. (1978) fed 141 weanling Angus bulls three levels of dietary protein (11.1%, 13.3%, 15.5%) for 168 days. Due to an apparent compensatory growth phase in the last 84 days for bulls on the 11.1% protein diet, the gain for all bulls was essentially the same for bulls fed the low and high levels of protein. Subsequently, protein efficiency favored bulls fed the lowest level of protein. Continuous levels of dietary protein higher than 11% cannot be justified for beef bulls. The only carcass trait that was significantly affected by protein levels was fat thickness. Carcasses of bulls on the higher protein diets had more fat covering than did the cattle fed the lower dietary protein level.

Martin et al. (1979) concluded that the minimum protein level for optimal growth of young bulls below 400 Kg. body weight was greater than 10%. In fact, 11.5% protein was cited as required for optimal gains between 220 and 300 Kg. body weight. Carcasses from bulls on lower levels of protein supplementation had less fat thickness and higher cutability than those on higher levels of protein supplement. More rapid daily gain is often associated with greater fat deposition as is pointed out by Williams et al. (1975) who reported that higher dietary protein levels increased carcass fat content.

Thompson and Riley (1979) fed finishing steers diets with varying protein levels: 9%, 11%, 15% also 12% - 10.5%, and 13%-11%-9% protein withdrawal. Steers on the 9% diet gained least and were the least efficient. Average daily gain and feed efficiency were similar for the other four levels of protein. Feed intake and carcass traits were not significantly affected by protein levels.

Willms and Ames (1977) looked at protein adjustments during heat stress and found that average daily gain and protein efficiency ratios were not affected by protein reduction.

Ames, Brink and Williams (1980) suggested that under practical conditions, protein adjustments during thermal stress will improve PER (protein efficiency ratio) and in turn reduce feed cost per unit of gain as a function of the difference between cost of dietary protein and energy. When feedlot animals are exposed to stressful temperature conditions such as extreme summer heat or cold winters, their average daily gains are known to go down as is their efficiency of converting feed into tissue. This is due to increased maintenance energy requirements which reduce energy available for growth. When energy is limited, protein levels beyond that used for maintenance are used as an energy source. In a feeding trial, dietary protein was adjusted in proportion to the expected reduction in daily live weight gain as a function of thermal stress. Average daily gain did not differ between the adjusted and constant protein levels. The calorie to protein ratio is lowered because temeprature increases the maintenance energy requirement but does not affect protein needed to maintain nitrogen equilibrium.

MATERIALS AND METHODS

General

This research was part of an ongoing Regional W-145 Research project with joint cooperation between The University of Arizona, New Mexico State University, Utah State University, American Dehydrators Association, and the Chaves County Cattle Cooperation at Roswell, New Mexico.

A comparison of cattle types (Okie #1 vs. Okie #3) and protein sources and levels was made according to the following design on Table 1. Two hundred seventy two head of cattle were obtained in Mason, Texas to represent a type of cattle commonly fed in the Southwest. These cattle are crossbreds that have no Brahma breeding and are called Okies.

When the cattle arrived at the feedlot, they were weighed and then scored for frame size and degree of muscling by a Federal Grader according to Feeder Grade Standards (USDA 1980). The cattle were fed approximately 162 days and the pens were then topped each week for four weeks for those cattle that had reached an estimated choice grade. Eleven cattle died during the experiment from respiratory diseases.

Slaughter

The animals were slaughtered at two commercial packing plants: Glover Meat Packing Company, in Roswell, New Mexico and Payton's Packing Plant in El Paso, Texas. Upon slaughter, the carcasses were tagged

Table 1. Experimental Design.

	Protein Source							
	Cottonseed Meal Premix				Dehydrated Alfalfa Premix			
Protein Level of Diet	11.2%		10%		11.2%		10%	
Pen	1	2	1	2	1	2	1	2
CATTLE TYPE								
Okie #1								
Number of Cattle Per Pen	16	17	17	17	17	17	17	17
Okie #3								
Number of Cattle Per Pen	18	17	17	17	17	17	17	17
Total Number of Cattle per Treatment	68		68		68		68	

for identification, then chilled 24 hours, ribbed between the 12th and 13th ribs and evaluated by a USDA Grader for quality and yield grades. The carcass data collected consisted of hot carcass weight, ribeye area, marbling score, fat thickness and kidney-pelvic and heart fat.

Processing

The left side forequarter was broken to obtain the wholesale rib cut. This section was then tagged and shipped to The University of Arizona by refrigerated truck. Upon arrival, the rib was cut to specifications by removing the tails at a point 15.2 cm opposite the chine bone. The rib was then completely boned out and the soft tissue was ground through a 1.25 cm plate. A representative sample was taken and chopped thoroughly in a Hobart silent cutter. These samples were stored in plastic bags at -20 C until analysis for protein, lipid and moisture.

Chemical Analysis

The samples were analyzed for crude protein by the Kjeldahl method according to the A.O.A.C. (1980). The samples were analyzed for lipid by chloroform-methanol extraction following the modified procedure of Ostrander and Dugan (1961) as outlined by Wooten et al. (1979). This procedure makes it possible to determine total lipid and moisture from the same procedure.

Prediction of Whole-Carcass Composition

Using chemical composition data from the rib and carcass cooler traits, total carcass composition on a boneless basis was determined by using prediction equations which were developed at The University of Arizona as a part of the W-145 Regional Beef Marketing Project. The equations are as follows:

Percent Lipid =

19.5225 + (0.2973 x rib percent lipid) + (1.3467 x yield grade) + (1.0362 x Kg of kidney fat) - (0.4770 x rib percent protein) - (0.0172 x Kg of hot carcass weight) + (0.2313 x marbling score).

Percent Protein =

26.3963 + (0.165 x rib percent protein) - (0.2299 x yield grade) - (0.1584 x rib percent lipid) - (0.1426 x rib percent moisture) - (0.0014 x quality grade) - (0.4263 x fat thickness in cm) + (0.0094 x ribeye area).

Percent Moisture =

58.4128 - (0.2677 x rib percent lipid) - (1.1715 x Kg of kidney fat) + (90.0332 x rib area in cm) + (0.3455 x rib percent protein) + (0.0104 x kg of hot carcass weight).

The quality Grades used in the calculation of Percent Protein were given a numerical number as follows:

Standard -	525	Good +	675
Standard	550	Choice -	725
Standard +	575	Choice	750
Good -	625	Choice +	775
Good	650	Prime -	800

Statistical Treatment of Data

The data were analyzed by analysis of variance according to Nie et al. (1975). Duncan's multiple range test and main treatment interactions were performed to compare treatment means. After it was determined that there were significant differences in the main treatments (cattle type, frame size and muscling) the carcass characteristics were statistically analyzed by using nesting procedures.

RESULTS

Carcass Characteristics

Cattle Type

Diets and performance data are given in Appendix Tables A1 and A2. Differences in carcass characteristics as influenced by cattle type are given in Table 2. Fat thickness was significantly affected by the type of cattle with Okie 1's being fatter than Okie 3's (1.39 cm vs. 1.09 cm). As a result of this difference in fat thickness, USDA yield grade was also significantly ($P<.05$) higher for Okie 1's (3.4 vs. 3.1). Hot carcass weight, marbling, USDA quality grade, ribeye area and kidney, pelvic and heart fat were not different ($P>.05$) by cattle type.

Protein Source and Level

Source of supplemental protein in the finishing diets had no effect upon carcass characteristics of the cattle (Table 3). All quality and quantity traits were similar regardless of protein supplement. These data provide a definite advantage to dehydrated alfalfa since it can be purchased at a lesser price per ton than cottonseed meal.

Carcass traits for the cattle fed the 10% and 11.2% protein diets are compared in Table 4. Protein level of the diet did not influence carcass characteristics. Quality factors were very similar and yield grade factor differences were almost non-existent. Based

Table 2. Carcass Characteristics Means Compared by Cattle Types.

	Okie 1's	Okie 3's
Number of Animals	128	133
Hot Carcass Wt. (Kg)	302	301
Marbling[a]	12	12
Quality Grade[b]	11	11
Fat Thickness (cm)	1.39[c]	1.09[d]
Ribeye Area (cm^2)	71.6	72.4
KPH %	3.0	3.0
Yield Grade	3.4[c]	3.1[d]

[a]Score of 11 = Slight, 12 = Slight plus, 13 = Small minus.

[b]Score of 10 = Good, 11 = Good plus, 12 = Choice

[c,d]Values within same line having unlike superscripts differ significantly ($P<.05$).

upon these data, one could assume that the generally used 11.2% protein level in finishing diets may be higher than necessary.

Data in Table 5 compare dietary protein level within protein supplement source. Again, no differences in carcass traits were observed. These data further support previous observations that the type of protein supplement as well as the level of protein used in the diet has little influence on carcass traits.

Table 3. Carcass Characteristics Means Compared by Protein Source.

	Protein Source	
	Cottonseed Meal	Dehydrated Alfalfa
Number of Animals	129	127
Hot Carcass Wt. (Kg)	299	303
Marbling[a]	12	12
Quality Grade[b]	11	11
Fat Thickness (cm)	1.22	1.27
Ribeye Area (cm^2)	71.7	72.1
KPH %	3.0	3.0
Yield Grade	3.2	3.3

[a]Score of 11 = Slight, 12 = Slight plus, 13 = Small minus.

[b]Score of 10 = Good, 11 = Good plus, 12 = Choice.

Frame Size

Carcass characteristics are compared by frame size in Table 6. Hot carcass weight, marbling, USDA quality grade and ribeye area were all significantly different ($P<.05$). As frame size increased from small to large framed, hot carcass weight increased ($P<.05$) from 280 Kg. to 315 Kg. The smaller framed cattle had more ($P<.05$) marbling than did the medium or large framed cattle; Small minus, Slight plus and Slight, respectively. USDA quality grade decreased ($P<.05$) with increased size. The smaller framed cattle had higher ($P<.05$) quality

Table 4. Carcass Characteristic Means Compared by Level of Protein.

	Dietary Protein Level	
	10%	11.2%
Number of Animals	127	129
Hot Carcass Wt. (Kg)	301	302
Marbling[a]	12	12
Quality Grade[b]	11	11
Fat Thickness (cm)	1.23	1.26
Ribeye Area (cm^2)	71.9	71.8
KPH %	3.0	3.0
Yield Grade	3.2	3.3

[a]Score of 11 = Slight, 12 = Slight plus, 13 = Small minus.

[b]Score of 10 = Good, 11 = Good plus, 12 = Choice.

grades than either the medium or large framed cattle. No differences between the medium and larger framed cattle were noted in quality grade. The large framed cattle had larger ($P<.05$) ribeye areas than either the medium or small framed cattle with the latter two frame sizes having similar ribeye size. Although nonsignificant ($P>.05$) slight increases in fat thickness, kidney, pelvic and heart fat, and USDA yeild grade were observed for the medium framed cattle compared to the small or large framed cattle. The large framed cattle had

Table 5. Carcass Characteristic Means Compared by Different Protein Levels and Protein Sources.

	Cottonseed Meal		Dehydrated Alfalfa	
	10%	11.2%	10%	11.2%
Number of Animals	64	67	65	65
Hot Carcass Wt. (Kg)	298	300	301	304
Marbling[a]	12	12	12	12
Quality Grade[b]	11	10	11	10
Fat Thickness (cm)	1.23	1.20	1.22	1.30
Ribeye Area (cm^2)	71.3	72.3	72.6	71.9
KPH %	2.9	3.0	3.0	3.0
Yield Grade	3.3	3.2	3.2	3.3

[a]Score of 11 = Slight, 12 = Slight plus, 13 = Small minus.

[b]Score of 10 = Good, 11 = Good plus, 12 = Choice

slightly lower (P>.05) values for fat thickness and yield grade than did the small framed cattle.

Muscling Score

The only carcass characteristics that were found to be significantly different (P<.05) were fat thickness and USDA yield grade when compared by muscling score (Table 7). Both characteristics were higher for the heavily muscled cattle than for the medium muscled cattle. The heavily muscled cattle had .32 cm more backfat and .3

Table 6. Carcass Characteristics Means Compared by Different Frame Sizes.

	Frame Size		
	Small	Medium	Large
Number of Animals	46	167	47
Hot Carcass Wt. (Kg)	280[c]	303[d]	315[e]
Marbling[a]	13[c]	12[d]	11[d]
Quality Grade[b]	11[c]	10[d]	10[d]
Fat Thickness (cm)	1.24	1.26	1.17
Ribeye Area (cm^2)	70.5[c]	71.6[c]	74.9[d]
KPH %	3.0	3.0	2.9
Yield Grade	3.2	3.3	3.1

[a]Score of 11 = Slight, 12 = Slight plus, 13 = Small minus.

[b]Score of 10 = Good, 11 = Good plus, 12 = Choice.

[c,d,e]Values within same line having unlike superscripts differ significantly ($P<.05$).

higher yield grade than the lightly muscled cattle. Frequently a grader will grade finish as muscling and thereby give a heavier muscling score to an animal that is fleshier and looks to be in better condition as a feeder steer. This might explain why these results show that the heavily muscled cattle have more fat covering than the medium muscled cattle.

Table 7. Carcass Characteristics Means Compared by Different Muscling Scores.

	Muscling Score	
	Medium	Heavily
Number of Animals	141	120
Hot Carcass Wt. (Kg)	299	304
Marbling[a]	12	12
Quality Grade[b]	11	11
Fat Thickness (cm)	1.12[c]	1.40[d]
Ribeye Area (cm^2)	71.9	72.2
KPH %	3.0	3.0
Yield Grade	3.1[c]	3.4[d]

[a]Score of 11 = Slight, 12 = Slight plus, 13 = Small minus.

[b]Score of 10 = Good, 11 = Good plus, 12 = Choice.

[c,d]Values within same line having unlike superscripts differ significantly ($P<.05$).

Protein Level and Source within Cattle Type

The carcass characteristics were compared (Table 8) by diet treatment within cattle type. The Okie 1's had heavier ($P<.05$) hot carcass weights than the Okie 3's. No other traits were significantly affected by protein level or source regardless of cattle type. The use of dehydrated alfalfa in the diet increased ($P<.05$) the hot carcass weights in Okie 1 cattle compared to cottonseed meal (Table 9).

Table 8. Carcass Characteristics Means Compared by Protein Level and Protein Source within Cattle Type.

Diets[a]	Okie 1's				Okie 3's			
	CSM 10%	CSM 11.2%	DEHY 10%	DEHY 11.2%	CSM 10%	CSM 11.2%	DEHY 10%	DEHY 11.2%
Number of Animals	33	33	31	31	31	34	34	34
Hot Carcass Wt. (Kg)	293[d]	299[d]	312[e]	303[de]	303	302	292	305
Marbling[b]	12	12	12	12	12	12	12	12
Quality Grade[c]	11	10	11	10	11	11	10	11
Fat Thickness	1.36	1.36	1.37	1.51	1.09	1.05	1.09	1.13
Ribeye Area (cm^2)	71.6	69.5	73.2	72.1	70.9	75.0	72.1	71.7
KPH %	2.9	3.0	3.0	3.0	3.0	3.0	2.9	3.0
Yield Grade	3.3	3.5	3.3	3.5	3.2	3.0	3.0	3.2

[a]CSM = Cottonseed Meal, DEHY = Dehydrated Alfalfa

[b]Score of 11 = Slight, 12 = Slight plus, 13 = Small minus.

[c]Score of 10 = Good, 11 = Good plus, 12 = Choice.

[d,e,f]Values within same line and within each diet having unlike superscripts differ significantly ($P<.05$).

Table 9. Carcass Characteristic Means Compared by Protein Source within Cattle Type.

	Okie 1's		Okie 3's	
	CSM	DEHY	CSM	DEHY
Number of Animals	66	60	63	67
Hot Carcass Wt. (Kg)	296[c]	307[d]	302	299
Marbling[a]	12	12	12	12
Quality Grade[b]	11	11	11	11
Fat Thickness (cm)	1.36	1.45	1.07	1.11
Ribeye Area (cm^2)	70.6	72.5	72.8	71.7
KPH %	2.9	3.0	2.9	2.9
Yield Grade	3.4	3.4	3.1	3.1

[a]Score of 11 = Slight, 12 = Slight plus.

[b]Score of 11 = Good plus, 12 = Choice

[c,d]Values within same line and within same cattle type with unlike superscripts differ significantly ($P<.05$).

This was not shown in Okie 3's. There was no advantage in carcass characteristics by using the 11.2% protein level in the diet compared to the 10% level (Table 10). The cattle fed the lower protein level diet performed equally as well as the cattle fed the higher level.

Table 10. Carcass Characteristic Means Compared by Protein Level within Cattle Type.

	Okie 1's		Okie 3's	
	10%	11.2%	10%	11.2%
Number of Animals	63	63	64	66
Hot Carcass Wt. (Kg)	302	300	299	303
Marbling [a]	12	12	12	12
Quality Grade [b]	11	11	11	11
Fat Thickness (cm)	1.37	1.43	1.09	1.09
Ribeye Area (cm^2)	72.4	70.6	71.5	73.0
KPH %	2.9	2.9	2.9	2.9
Yield Grade	3.3	3.5	3.1	3.1

[a]Score of 12 = Slight plus.

[b]Score of 11 = Good plus.

Protein Level and Source within Frame Size

As shown in Table 11, no carcass trait, when compared within frame size was significantly affected by the source of protein or the level of protein in the diet. Although nonsignificant ($P>.05$), hot carcass weights were heavier at the same level of protein when dehydrated alfalfa was fed to the small and medium framed cattle. This was also evident in the large framed cattle at the 10% level but not for the 11.2% level.

Table 11. Carcass Characteristic Means Compared by Protein Levels and Protein Sources within Different Frame Sizes.

Diets	Small				Medium				Large			
	CSM 10%	CSM 11.2%	DEHY 10%	DEHY 11.2%	CSM 10%	CSM 11.2%	DEHY 10%	DEHY 11.2%	CSM 10%	CSM 11.2%	DEHY 10%	DEHY 11.2%
Number of Animals	12	11	11	12	40	42	43	42	12	13	11	11
Hot Carcass Wt. (Kg)	274	273	288	285	305	298	302	306	299	328	314	315
Marbling[a]	13	14	14	12	12	11	12	12	12	11	11	11
Quality Grade[b]	11	12	12	11	11	10	11	11	10	10	10	10
Fat Thickness (cm)	1.15	1.15	1.29	1.38	1.29	1.25	1.23	1.29	1.11	1.10	1.15	1.33
Ribeye Area (cm^2)	69.1	70.5	71.4	71.0	72.7	70.8	71.7	71.3	68.7	78.6	77.3	75.0
KPH %	3.0	2.8	3.1	2.9	3.0	3.0	2.9	3.0	2.7	2.9	2.9	2.9
Yield Grade	3.1	3.2	3.3	3.3	3.3	3.3	3.2	3.3	3.2	3.0	2.9	3.3

Frame Size spans all columns.

[a]Score of 12 = Slight plus, 13 = Small minus, 14 = Small.

[b]Score of 10 = Good, 11 = Good plus, 12 = Choice.

Frame Size within Cattle Type

When the carcass characteristic means were compared by frame size within the two cattle types (Table 12), hot carcass weight, fat thickness and yield grade were significantly different ($P<.05$) within Okie 1 cattle by frame size, while marbling and quality grade were the only two characteristics affected ($P<.05$) by frame size within the Okie 3 cattle.

The small framed Okie 1 cattle were lighter ($P<.05$) than either the medium or large framed cattle with no significant ($P>.05$) difference between the latter two (283 Kg., 306 Kg., and 304 Kg., respectively). Fat thickness and yield grade decreased as frame size increased with the medium and small framed Okie 1 cattle having significantly more fat and higher yield grades than the large framed Okie 1 cattle.

In the Okie 3 cattle large and medium framed cattle, although not significantly different from each other, both had lower ($P<.05$) marbling scores and quality grades than the small framed cattle. Although nonsignificant ($P>.05$) as frame size increased from small to large, ribeye area increased from 69.1 cm^2 to 74.1 cm^2, respectively in the Okie 1's and from 71.8 cm^2 to 75.6 cm^2, respectively in the Okie 3's.

Muscling Score within Cattle Type

Muscling score was compared within the different cattle types (Table 13). As might be expected, the heavily muscled Okie 1 cattle had significantly ($P<.05$) heavier hot carcass weights than did the

Table 12. Carcass Characteristic Means Compared by Frame Size within Cattle Types.

	Okie 1's			Okie 3's		
Frame Size	Small	Medium	Large	Small	Medium	Large
Number of Animals	22	84	22	24	80	25
Hot Carcass Wt. (Kg)	283[d]	306[c]	304[c]	277	300	324
Marbling	13	12	11	14[d]	12[c]	11[c]
Quality Grade	11	11	10	12[d]	10[c]	10[c]
Fat Thickness (cm)	1.48[d]	1.44[d]	1.14[c]	1.03	1.08	1.20
Ribeye Area (cm^2)	69.1	71.5	74.1	71.8	71.7	75.6
KPH %	3.1	3.0	2.8	2.9	3.0	3.0
Yield Grade	3.5[d]	3.5[d]	3.0[c]	2.9	3.1	3.2

[a]Score of 11 = Slight, 12 = Slight plus, 13 = Small minus.

[b]Score of 10 = Good, 11 = Good plus, 12 = Choice.

[c,d] Values within same line and type having unlike superscripts differ significantly ($P<.05$).

medium muscled cattle. Ribeye area was the only other carcass trait within the Okie 1's that was significantly ($P<.05$) affected by muscle score. As with hot carcass weight, heavier muscled cattle were expected to have larger ribeye areas and they did.

Table 13. Carcass Characteristic Means Compared by Muscle Score within Cattle Type.

	Okie 1's		Okie 3's	
	Medium Muscled	Heavily Muscled	Medium Muscled	Heavily Muscled
Number of Animals	11	117	130	3
Hot Carcass Wt. (Kg)	279[c]	304[d]	300	322
Marbling[a]	12	12	12	11
Quality Grade[b]	11	11	11	10
Fat Thickness (cm)	1.37	1.40	1.08	1.39
Ribeye Area (cm^2)	66.1[c]	72.1[d]	72.3	76.8
KPH %	2.8	3.0	3.0	2.7
Yield Grade	3.4	3.4	3.1	3.2

[a]Score of 11 = Slight, 12 = Slight plus, 13 = Small minus.

[b]Score of 10 = Good, 11 = Good plus, 12 = Choice.

[c,d]Values within same line and type having unlike superscripts differ significantly ($P<.05$).

Cattle Type within Frame Size

Cattle type, when compared within frame size had a significant ($P<.05$) effect on hot carcass weight, fat thickness and yield grade (Table 14). The large framed cattle showed the only significant ($P<.05$) difference in hot carcass weight with the Okie 3 cattle being heavier than the Okie 1 cattle (324 Kg. and 304 Kg.,

Table 14. Carcass Characteristic Means Compared by Cattle Type within Frame Size.

Type	Frame Size					
	Small		Medium		Large	
	Okie 1	Okie 3	Okie 1	Okie 3	Okie 1	Okie 3
Number of Animals	22	24	84	83	22	25
Hot Carcass Wt. (Kg)	283	277	306	300	304[c]	324[d]
Marbling[a]	13	14	12	12	11	11
Quality Grade[b]	11	11	11	10	10	10
Fat Thickness (cm)	1.48[c]	1.03[d]	1.45[c]	1.08[d]	1.14	1.20
Ribeye Area (cm^2)	69.1	71.8	71.5	71.7	74.1	75.6
KPH %	3.1	2.9	3.0	3.0	2.8	3.0
Yield Grade	3.5[c]	2.9[d]	3.5[c]	3.1[d]	3.0	3.2

[a] Score of 11 = Slight, 12 = Slight plus, 13 = Small minus, 14 = Small.

[b] Score of 10 = Good, 11 = Good plus, 12 = Choice.

[c,d] Values within same line and within each frame size with unlike superscripts differ significantly ($P<.05$).

respectively). Fat thickness and yield grade were both similarly affected by cattle type within the small and medium framed cattle but not within the large framed cattle. Okie 3's had less ($P<.05$) fat thickness than the Okie 1's (1.03 cm vs. 1.48 cm small framed and 1.80 cm vs. 1.45 medium framed) and the Okie 3's had a lower yield grade than the Okie 1's (2.9 vs. 3.5 small and 3.1 vs. 3.5 medium). The large framed cattle showed no difference ($P>.05$) between cattle types when fat thickness or yield grades were compared. Marbling, quality grade and KPH % were not significantly affected by cattle type within frame size.

Muscling Score within Frame Size

When comparing the carcass traits by muscling score within frame sizes (Table 15), fat thickness and USDA yield grade were the only two traits that differed ($P<.05$) between the medium and heavily muscled cattle. This difference was noted in the small and medium framed cattle but not in the larger framed cattle. The fat thickness and subsequently the yield grade were both greater in the heavily muscled cattle than in the medium muscled cattle.

Carcass Composition

Cattle Type

Table 16 shows that predicted percentage of protein and lipid were significantly ($P<.05$) different by cattle type. Okie 3 cattle had higher protein levels and lower percent lipid levels than Okie 1 cattle on a boneless carcass basis. Okie 3's possessed 15.05% protein,

Table 15. Carcass Characteristics Means Compared by Muscling Score within Frame size.

	Frame Size					
	Small		Medium		Large	
Muscling	Medium	Heavily	Medium	Heavily	Medium	Heavily
Number of Animals	22	22	86	81	30	17
Hot Carcass Wt. (Kg)	277	283	299	307	313	318
Marbling[a]	14	13	12	12	11	11
Quality Grade[b]	12	11	11	11	10	10
Fat Thickness (cm)	1.03[c]	1.48[d]	1.09[c]	1.44[d]	1.11	1.20
Ribeye ARea (cm^2)	71.8	69.1	71.4	71.8	73.0	78.3
KPH%	2.9	3.1	3.0	3.0	2.9	2.8
Yield Grade	2.9[c]	3.5[d]	3.1[c]	3.5[d]	3.2	2.9

[a]Score of 11 = Slight, 12 = Slight plus, 13 = Small minus, 14 = Small.

[b]Score of 10 = Good, 11 = Good plus, 12 = Choice.

[c,d]Values within same line and within same frame size with unlike superscripts differ significantly ($P<.05$).

Table 16. Predicted Carcass Composition Means Compared by Cattle Type.

Component[a]	Okie 1	Okie 3
Number of Animals	126	130
Percent Protein	14.50[b]	15.05[c]
Percent Lipid	44.97[b]	43.28[c]
Percent Moisture	36.53	37.74

[a]Values for % Protein, Lipid and Moisture are predicted whole carcass percentages.

[b,c]Values on same line having unlike superscripts differ significantly ($P<.05$).

43.28% lipid and 37.74% moisture whereas the Okie 1's had 14.50% protein, 44.97% lipid and 36.53% moisture. Moisture was not significantly different ($P>.05$).

Protein Level and Source

Protein level of the diet and protein source had no significant effect upon any component of the predicted carcass composition (Table 17). Although nonsignificant, the percent lipid increased slightly with the higher level of dietary protein in both the cottonseed meal and the dehydrated alfalfa fed cattle. The carcass protein percentage decreased (Table 18). The values dropped from 14.65% to 14.21% protein. No significant differences ($P>.05$) in carcass

Table 17. Predicted Carcass Composition Means Compared by Protein Level and Protein Source.

Component[a]	CSM 10	CSM 11.2	DEHY 10	DEHY 11.2
Number of Animals	63	66	64	63
Percent Protein	14.81	14.77	14.78	14.77
Percent Lipid	43.73	44.00	43.82	44.90
Percent Moisture	37.53	37.22	37.35	36.47

[a]CSM 10 = Cottonseed Meal 10%, CSM 11.2 = Cottonseed Meal 11.2%, DEHY 10 = Dehydrated Alfalfa 10%, DEHY 11.2 = Dehydrated Alfalfa 11.2%.

[b]Values for % Protein, Lipid and Mositure are predicted whole carcass percentages.

Table 18. Predicted Carcass Composition Compared by Protein Level of the Diet.

Component[a]	Protein Level	
	10%	11.2%
Number of Animals	127	129
Percent Protein	14.80	14.77
Percent Lipid	42.57	43.24
Percent Moisture	37.44	36.85

[a]Values for % Protein, Lipid and Moisture are predicted whole carcass percentages.

composition between the two sources of protein used, cottonseed meal vs. dehydrated alfalfa, were noted (Table 19).

Frame Size

Frame size had no significant ($P > .05$) influence on the carcass composition (Table 20). The percent protein did show a slight increase as frame size increased but this was nonsignificant ($P > .05$).

Muscle Score

When the components of the carcass composition were compared by muscling scores (Table 21), there was a significant ($P < .05$) effect. The heavily muscled cattle had less protein (14.51% vs. 15.01%), more fat (45.11% vs. 43.27%) and less moisture (36.37% vs. 37.79%) than did the medium muscled cattle. The heavily muscled cattle had .5% less protein, almost 2% more fat and 1.4% less moisture than the medium muscled cattle. Again, this might be the result of fatter cattle being scored as more heavily muscled cattle.

Table 19. Predicted Carcass Composition Means Compared by Protein Source.

Component[a]	Cottonseed Meal	Dehydrated Alfalfa
Number of Animals	129	127
Percent Protein	14.79	14.77
Percent Lipid	42.63	43.19
Percent Moisture	37.37	36.91

[a]Values for % Protein, Lipid and Moisture are predicted whole carcass percentages.

Table 20. Predicted Carcass Composition Means Compared by Frame Size.

	Frame Size		
Component[a]	Small	Medium	Large
Number of Animals	45	166	44
Percent Protein	14.73	14.76	14.93
Percent Lipid	43.35	41.49	43.31
Percent Moisture	38.33	36.74	37.55

[a]Values for % Protein, Lipid and Moisture are predicted whole carcass percentages.

Table 21. Predicted Carcass Composition Means Compared by Muscling Score.

Component[a]	Muscling Score	
	Medium	Heavily
Number of Animals	139	117
Percent Protein	15.01[b]	14.51[c]
Percent Lipid	43.27[b]	45.11[c]
Percent Moisture	37.79[b]	36.37[c]

[a]Values for % Protein, Lipid and Moisture are predicted whole carcass percentages.

[b,c]Values on the same lines having unlike superscripts differ significantly ($P<.05$).

GENERAL DISCUSSION

Cattle type had a significant ($P<.05$) effect upon some carcass traits. Okie 1 cattle were fatter than Okie 3 cattle. This was evident in the fat thickness values with the Okie 1's having an average of .3 cm more backfat. The yield grade was .3 higher and the mean predicted lipid content of the carcass was on the average 1.69% higher in Okie 1's. Overall carcass composition also showed Okie 1 cattle to have less protein and more fat than Okie 3 cattle. Okie 3 cattle had similar marbling scores, quality grades, ribeye areas and KPH% to the Okie 1 cattle. The Okie 3's were equal to, or better than the Okie 1's when the carcass characteristics were compared between the two types of cattle.

Comparison of protein levels and protein sources in this study points out similar results that were observed by other researchers (Haskins et al. 1967, Braman et al. 1973, Burris et al. 1974, Thompson and Riley 1979 and Utelly and McCormick 1980). There was no appreciable main treatment effects due to either the level or the source of protein. Only when compared within cattle type did a significant effect result. Hot carcass weight was significantly ($P<.05$) increased with the use of dehydrated alfalfa for Okie 1 cattle but not for Okie 3 cattle.

It did not matter whether the industry standard of 11.25% protein level or the 10% protein level was used in this study. The lower 10% protein level gave equal results to the 11.2% protein level. These results indicate that the continued use of the higher supplemental level is not justified in cattle of this type. Feedlot data (Marchello, Gorman and Bennett 1980b) from this experiment revealed that the average daily gain, feed required/unit of gain and cost/unit of gain were similar regardless of cattle type, protein supplement or protein level. This, coupled with the fact that the Okie 3's had 2% less total fat, .5% more carcass protein, less fat covering over the 12th rib (1.09 cm vs. 1.39 cm) similar marbling scores and quality grades to the Okie 1's, shows that some economical benefit could be gained as a result of feeding Okie 3's a lower level of protein than the current industry standard. The Okie 3 cattle generally are 3 to 5 cents cheaper per pound when bought as feeder cattle than are Okie 1's.

Other researchers (Carroll et al. 1964, Walker et al. 1977, Gill et al. 1977, Martin et al. 1978 and Thompson and Riley 1979) point out that most carcass traits are not significantly affected by the level of protein in the diet as long as the minimum protein requirements are met. Crickenberger et al. (1978) indicated that when cattle reach about 410 Kg, supplemental protein could be withdrawn if the basal ration contained above 8.5% crude protein. Gill et al. (1977) and Walker et al. (1977) used a low level of 9.5% crude protein and observed no significant differences in carcass characteristics when compared to levels of 10.3% or 11.2% crude protein.

When protein source and level were compared within Okie type (Table 8) differences in hot carcass weight were noted. The other carcass traits were similar between the two types of protein regardless of cattle type. The use of dehydrated alfalfa produced significantly ($P<.05$) heavier carcasses than the use of cottonseed meal 307 Kg vs. 296 Kg for Okie 1's. This significant difference did not show up in the Okie 3 cattle. Dehydrated alfalfa may be slightly more digestible than cottonseed meal. Utely and McCormick (1980) found that there were differences in protein degradation and in protein solubility but they were not large enough to cause significant differences in carcass characteristics. Other researchers have found no significant differences in carcass characteristics due to the source of protein (Haskins et al. 1967, Epley et al. 1971, Burris et al. 1974 and Burris et al. 1977).

No significant differences were observed in carcass composition when compared between the two levels or two sources of protein. In an earlier W-145 regional project (Marchello et al. 1980b) in 1979, large framed cattle were found to possess more ($P<.05$) protein on a boneless basis and less fat ($P<.05$) than the medium or small framed cattle. This was the case in the present study. There were no significant differences in composition between frame sizes. If the small framed cattle were fed longer this difference in composition might have shown up.

Frame size is an important factor to consider when feeding cattle. Cattlemen are willing to feed cattle of different frame sizes depending upon availability and cost, how much the gain will cost and the value per pound of the carcass. In the present study, frame size had a significant effect on the hot carcass weight, marbling, quality grade and ribeye area (Table 6). In other studies (Adams and Smith, 1979 and Marchello et al. 1980a) similar results were observed. The large framed cattle had heavier carcasses, higher percent protein, were more heavily muscled and were slightly lower in quality than the smaller framed cattle.

Fat thickness and yield grade were the only carcass characteristics that were significantly ($P<.05$) affected by muscling score. The more heavily muscled cattle had higher values for both fat thickness and yield grade. The apparent cause for this is not due to the muscling itself but rather the fact that the majority of Okie 1 cattle were consistently scored higher for degree of muscling than the Okie 3's. As stated previously, the Okie 1 cattle appeared to have more condition than the Okie 3 cattle. Therefore, this trend shows up as an effect of the muscling score placed on these cattle as the beginning of the finishing period. The same reasoning is applied to the predicted lipid content (Table 21) which was significantly ($P<.05$) higher for the heavily muscled cattle. The significantly ($P<.05$) lower level of protein for the heavily muscled cattle does not seem to follow logically. But again, the heavily muscled cattle consisted primarily of Okie 1 cattle which were significantly higher in fat thickness, yield grade, and predicted percent lipid.

This trend for the fatter cattle (Okie 1) to have a higher ($P<.05$) muscling score is also shown in the small and medium framed cattle. This was noted in the large framed cattle but was nonsignificant (Table 15).

Based on the data presented in this study, it would seem to be economically feasible to feed Okie 3's rather than Okie 1's due to the fact that they can be purchased at 3 to 5 cent cheaper per pound. They perform in the feedlot equal to the Okie 1's and provide comparable carcasses. However, one disadvantage of the Okie 3's may be a higher incidence of health related problems in the feedlot.

The data shows that the use of 11.2% dietary protein can not be justified when finishing cattle perform equally as well on a lower 10% level of dietary protein. Feedlot performance, carcass characteristics, and carcass composition were all similar when the two different levels of dietary protein were compared.

Frame size had the greatest effect on carcass characteristics with the larger framed cattle being ($P<.05$) heavier, more muscled and lower in quality than the small framed cattle. Frame size had no effect on carcass composition. If the time on feed were different for the different frame sizes, differences in carcass composition might have shown up. This would be due to the smaller framed cattle being physiologically earlier maturing than the larger framed cattle.

Muscling scores did not affect the carcass characteristics to any degree, however, they did affect carcass composition.

SUMMARY

Two hundred seventy two steers were selected to represent Okie 1 and Okie 3 type cattle. Okies are crossbred cattle with no Brahma breeding. These cattle were fed diets that contained cottonseed meal or dehydrated alfalfa as the protein supplements and the diets were formulated to have either 10% or 11.2% protein. The steers were scored for frame size and muscling at the beginning of the trial.

Carcass data were obtained and the wholesale rib cut composition was used to predict whole carcass composition.

Okie 3 cattle were similar in carcass characteristics to Okie 1 cattle. The Okie 3's had less ($P<.05$) fat thickness (1.09 cm vs. 1.39 cm) and lower ($P<.05$) yield grades (3.1 vs. 3.4) than did the Okie 1 cattle. Hot carcass weight, marbling, quality grade and KPH% were all similar ($P<.05$) between the two types of cattle. Although percent moisture was not different ($P>.05$), percent lipid was almost 2% lower ($P<.05$) and percent protein was .5% higher ($P<.05$) in Okie 3's than in Okie 1's.

The level of protein in the diet did not have any significant ($P>.05$) effect upon carcass characteristics or upon carcass composition. The lower 10% level performed equally as well as the higher 11.2% level.

Hot carcass weight was increased ($P<.05$) by supplementing the diet with dehydrated alfalfa as compared to cottonseed meal. Okie 1 cattle fed dehydrated alfalfa had carcasses averaging 9 Kg. heavier than those fed cottonseed meal. Okie 3 cattle showed no difference in carcass characteristics between the two sources. The source of protein had no effect ($P>.05$) upon carcass composition.

Frame size had an effect on carcass characteristics. The larger framed cattle were heavier ($P<.05$), more muscular ($P<.05$) and lower in quality ($P<.05$) than were the smaller framed cattle. Carcass composition was not influenced ($P>.05$) by frame size.

Muscling score did not significantly ($P>.05$) affect carcass characteristics except in fat thickness and yield grade. The heavily muscled cattle had 1.40 cm of backfat while the medium muscled cattle had .28 cm less ($P<.05$) backfat. The heavily muscled cattle had a .3 higher ($P<.05$) value for the yield grade.

Carcass composition was significantly ($P<.05$) affected by muscle score. Heavily muscled cattle had .5% less protein, almost 2% more lipid and 1.4% less moisture than did the medium muscled cattle.

APPENDIX A

Table A1. Diet Composition.

Diet	DEHY 10%	DEHY 11.2%	CSM 10%	CSM 11.2%
Corn	62	62	62	62
H M. Corn	15	15	15	15
Alfalfa	12	12	12	12
Cane Molasses	6	6	6	6
Protein Supplement[a]	5	5	5	5

[a]Protein supplement was formulated to provide proper protein source and level as required.

Table A2. Feedlot Performance of Okie #1 and #3's on Different Protein Sources and Levels.

	Protein Source			
	Cottonseed Meal		Dehydrated Alfalfa	
	Level		Level	
	10%	11.25%	10%	11.25%
Okie #1				
Avg. Daily Gain, lb	2.6	2.7	2.7	2.7
Feed/lb Gain, lb	7.9	7.3	7.6	7.4
Cost/lb Gain, $	.57	.53	.57	.56
Okie #3				
Avg. Daily Gain, lb	2.7	2.6	2.6	2.6
Feed/lb Gain, lb	7.6	7.5	7.5	7.5
Cost/lb Gain, $	.56	.56	.56	.56
Average of #1 and #3				
Avg. Daily Gain, lb	2.6	2.7	2.6	2.6
Feed/lb Gain, lb	7.8	7.4	7.6	7.5
Cost/lb Gain, $	.55	.55	.56	.56

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