To the Graduate Council:

I am submitting herewith a thesis written by Danny Ray Wright entitled "Mixtures of Whole Shelled Corn and Whole Wheat as Rations for Finishing Beef Cattle." I recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Animal Science.

W. R. Backus, Major Professor

We have read this thesis
and recommend its acceptance:

Accepted for the Council:

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Graduate Studies and Research

MIXTURES OF WHOLE SHELLED CORN AND WHOLE WHEAT AS RATIONS FOR FINISHING BEEF CATTLE

A Thesis

Presented for the

Master of Science

Degree

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Danny Ray Wright

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ABSTRACT

The data collected in this study were from 64 Hereford yearling steers (Trial I) and 60 yearling Angus heifers (Trial II). These animals were fed all-grain finishing rations consisting of varying levels of corn and wheat. The rations consisted of (1) 100% whole shelled corn, (2) 80% whole shelled corn and 20% whole wheat, (3) 60% whole shelled corn and 40% whole wheat, (4) 40% whole shelled corn and 60% whole wheat. All rations were top-dressed with Tend-R-Leen in varying amounts in order to maintain a constant crude protein level in each treatment (ration).

Live animal and carcass variables were collected for these two trials. The live animal variables were final weight, average daily gain, feed efficiency and daily feed comsumption. The carcass variables were hot carcass weight, adjusted fat thickness, longissimus muscle area, percentage kidney, heart and pelvic fat, USDA quality and USDA yield grade.

Results from Trial I indicated that wheat may be substituted in rations of finishing beef animals at levels as high as 60% without a detrimental effect upon live animal or carcass variables. No significant differences were shown among the four treatments in this trial.

Carcass data from Trial I also indicated no significant differences among treatments. Levels up to 60% whole wheat substituted for corn did not significantly affect any of the carcass variables.

Results from Trial II indicated that Angus heifers fed 20% whole wheat or 60% whole wheat were significantly higher in average

daily gains and feed efficiency than the 100% whole shelled corn rations. The 40% whole wheat rations were not significantly different from the 100% whole corn rations.

Although the data from these two trials did not totally agree, it does indicate that wheat may be fed whole and substituted for a portion of the whole shelled corn in an all-concentrate-all whole grain ration. Additionally, the higher protein content of wheat in comparison to corn can be an advantage as less supplemental protein was fed with the higher wheat rations and the performance was not significantly less than the 100% corn rations in any case.

The reasons the Angus heifers had superior gains to Hereford steers which include breed, season of year cattle were fed, or a variation in the length of feeding period, cannot be explained from these data.

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CHAPTER I

INTRODUCTION

Wheat, which is primarily grown for direct human consumption, is one of the major grains traded in world commerce. In Tennessee, wheat ranks fifth in importance as a cash crop (Cobble, 1979). About one-third of the annual United States wheat crop is used domestically for human food and planting seed purposes. The remaining two-thirds (Cobble, 1979) are usually exported and/or used as livestock feed. In years when export sales are low, large quantities of wheat are consumed by livestock. Contaminating seeds (i.e. garlic) can lower the cost of wheat making it more appealing to livestock feeders. In recent years, wheat has often been competitive in price with other feed grains and so has been used as an alternative energy source for finishing cattle.

There is increasing interest in the use of wheat grain for finishing cattle when its price becomes low enough to make it attractive as a livestock feed. With feedlot rations often consisting of 80% grain, cattle feeders are concerned with methods of getting the maximum utilization and efficiency of the grain being fed. Wheat fits well into this program because of its excellent nutritive value. In a comparison of wheat with corn, wheat is equal to corn in total digestible nutrients and higher than corn in digestible protein. Thus, rations containing a relatively high percentage of wheat could contain protein in excess of the required daily allowance for finishing cattle. It follows that less protein supplement would be required when wheat is fed in higher percentages than is corn.

Using wheat as a substitute for part of the corn in finishing rations has been popular when its price is competitive with corn. However, it is generally accepted that wheat must be processed (coarsely ground, micronized or rolled) before being fed to beef cattle. Tennessee at this time does not have easily accessible or widely distributed facilities for the processing of wheat. Therefore, if rations could be formulated using whole wheat, it would make its inclusion in beef finishing rations a more viable alternative.

Previous studies conducted at the Tennessee stations Fain (1979) indicated that rations consisting of varying percentages of whole wheat and whole corn are satisfactory for finishing yearling cattle. However, the supplemental protein in these initial trials was not adjusted for the increased crude protein supplied by wheat as its percentage in the grain mixture increased. The need exists to investigate the possibility of feeding mixtures of whole shelled corn and whole wheat rations with the crude protein level held constant. A reduction in the supplemental protein requirement could possibly make wheat a more competitive ration component.

The objective of this study was to determine if supplemental protein could be reduced in the rations containing levels of wheat without having a detrimental effect on gain, feed efficiency or carcass merit.

CHAPTER II

REVIEW OF LITERATURE

Concentrates and roughages are both used in the growth and finishing of cattle. Cattle nutrition research has addressed the problem of how these feedstuffs might be most efficiently utilized in the production of high quality beef. New alternatives have been widely investigated by animal scientists. Among the alternatives is a 100% grain ration for finishing yearling cattle. Various grains have been compared as well as methods of grain processing prior to ration formulation.

The possibility of feeding rations that contain no roughage to ruminants has concerned animal scientists for many years. Research by Davenport (1897), McCandlish (1923) and Huffman (1928), showed that early attempts to rear calves on roughage free diets were unsuccessful. In contrast, Meade and Regan (1931) were the first to conclude that roughage or bulk was not necessary in the diets of calves. Other research has compared all-concentrate rations to roughage-containing rations. Ellis (1956) concluded that concentrate rations with small amounts of roughage showed a more constant rate of gain with less feed required per pound of gain than all-concentrate rations. Tietz (1969) indicated that in all cases, steers finished more quickly and efficiently on all-concentrate rations. Wise et al. (1968) observed that an all-concentrate ration lends itself to mechanization; since the quantity of ration consumed per pound of gain is reduced, so is the amount of mixing and handling. Bowling et al. (1977) concluded that

grain-finished beef carcasses were of higher quality than were forage-finished carcasses. Also, cooked steaks from grain-finished beef are generally more tender and more acceptable in flavor than forage-fed beef.

Various kinds and forms of grains have been compared in the all-concentrate finishing rations. Corn is unsurpassed as a finishing ration Fowler (1969). He recommended rolled or coarsely ground corn except in cases where hogs are available afterward to utilize the cattle wastes. Methods of processing corn were compared by Burkhardt et al. (1969): (1) dry and unprocessed, (2) dry and rolled, (3) reconstituted high moisture, (4) reconstituted high moisture and rolled, and (5) steam processed and flaked. Results indicated no apparent advantage to the processing of corn.

Hixon et al. (1969) reported that the quantity of the cracked corn ration needed to produce a pound of gain was numerically (not significantly different) greater than that of whole shelled corn rations. The average daily gain for steers fed whole shelled corn was 3.98 lbs. and 3.43 lbs. for steers fed cracked corn. Also, Backus et al. (1978) reported excellent results with whole shelled corn as a finishing ration for yearling cattle. Studies by Martin et al. (1971) indicated that feeding whole corn was cheaper than feeding ground or rolled corn due to processing.

When the price of wheat becomes competitive with other grains, alternatives are considered. Wheat may be incorporated with corn as an alternative energy source. Wheat has long been used as a livestock feed. Haney and Elling (1906) reported the feeding of ground wheat

to cattle. Data by Baker and Baker (1960) suggest that wheat may also be fed to other classes of livestock. Early data dealing with the incorporation of wheat into beef rations suggests that the wheat must be processed. Feeding studies by Brethour (1966) showed little improvement in performance of finishing cattle fed processed wheat versus coarsely ground or dry rolled wheat. In contrast, Walker (1970) found that in vitro enzymatic degradation of both a red and white wheat was improved by processing with dry heat expansion. Eng (1970) found that wheat did not absorb moisture as readily as other grains and proposed that this may account for the less ridged flakes and higher percentage of fines. He found that unprocessed wheat starch was partially gelatinized with little further gelatinization during processing than observed with other grains. Bris, Dyer and Howes (1966) reported somewhat higher performance with steam flaked than with dry rolled soft wheat. However, results by Cornett (1971) indicated that dry rolled wheat was as digestible as steam flaked or micronized flaked wheat for steers and wethers. Aimone and Wagner (1971) reported that processing wheat by micronization improves intake and gain in feedlot cattle but not feed/gain ratio as compared to dry rolled wheat. Moreover, both feedlot and metabolism studies suggest wheat is very digestible and is not improved by processing to the extent of other grains.

Brethour and Duitsman (1972) reported high average daily gains for cattle fed roasted wheat. Hale et al. (1970) found some improvement in performance with poorly flaked wheat compared to flat flaked wheat primarily because of the reduction in the percentage of fines in poorly

flaked wheat. However, Lofgreen (1970) reported no difference in gain and feed requirements when wheat was coarsely ground or steam flaked. This is in contrast to work by Martin (1973) in which steam flaked wheat produced improved intake, gain and efficiency compared to dry rolled wheat.

Both feedlot and metabolism studies suggest wheat is very digestible and is not improved by processing to the extent noted in other grains, particularly sorghums.

Australian researcher J. P. Langlands (1973) investigated formaldehyde treated wheat. Formaldehyde treatment of wheat protein decreased the degradation in the rumen and may have increased the quantity of protein absorbed in the lower stomachs. However, formaldehyde treatment of wheat did not significantly change the proportions of the individual volatile fatty acids.

Results from Pryor and Laws (1972) suggest that wheat may not need to be processed under practical feeding conditions. This agrees with the findings of Arnett (1971) whose results showed that steers fed a diet containing 42% wheat had greater intake (11.5 vs 9.7 kg) and better feed conversion (8.50 vs 7.34) when wheat was fed whole rather than dry rolled.

Controversy exists pertaining to amounts of wheat that can be incorporated into the diets of beef cattle. Early work by Dyer and Weaver (1955) reported that ground wheat, when fed as the only grain in a ration containing from 30 to 35% roughage, caused frequent digestive disturbances, slow gains and resulted in lower grading carcasses. However, Morrison (1956) summarized data from nine trials and reported

that in roughage containing rations, wheat-fed cattle made nearly as rapid gains as did corn-fed cattle. Praylor and Laws (1972) fed 15, 50 and 85% wheat plus barley straw. Steers fed the high wheat rations grew faster, had higher feed conversions and dressing percentages than the cattle fed the low wheat and barley straw rations. In contrast, research by Oltjen et al. (1965) indicated that cracked wheat may make up approximately 50% of the concentrate source in all-concentrate rations without adversely affecting rate of gain. Their data also indicated lower feed efficiency and significant decreased gains when rations contained 60 or 90% wheat. These findings agree with Baker and Baker (1960) who concluded wheat was satisfactory for fattening cattle when used to replace one-half of the corn. Wheat was not equal to corn when used as a total replacement in conventional fattening rations. Oltjen et al. (1966) found that steers fed a 60 and 90% corn ration gained significantly faster (1.4 kg. daily) than did steers fed a 60 and 90% wheat ration (1.1 kg. daily). Performance was similar for all groups during the first 70 days but steers comsumed less of the high-wheat ration the last 28 days of the trial. Fowler (1969), Nichols (1970) and Wagner et al. (1971) agree that wheat should make up no more than 30 to 50% of the grain in the diet. Fain (1979) reported significantly lower average daily gains resulting from a 60% whole wheat ration when compared with 100% whole shelled corn, 60% whole shelled corn and 40% whole wheat and 80% whole shelled corn and 20% whole wheat rations.

Wheat has been shown to have excellent nutritional value. Wheat is higher in digestible protein than corn but is equal to corn in total digestible nutrients. Varner and Woods (1975) reported that

wheat, regardless of variety, seems to be digested more rapidly and to a greater extent *in vitro* than corn. They theorized that the increased digestibility of wheat starch and subsequent high levels of rumen lactate could partially explain the reduced feed intake by animals fed wheat. Data by Nichols (1970) concluded that wheat is 2.5 to 3.0% higher in protein content than corn. Different varieties of wheat have varying levels of protein.

The variety of wheat used in high concentrate feedlot rations can cause differences in beef cattle performance Fulton *et al*. (1974). Trails indicated that there were distinct feeding differences among Centurk, Scoutland and Trader varieties of wheat. Centurk wheat was found to be superior to the other varieties and could be fed at a rate of 50% of the grain mixture while Scoutland and Trader could only be fed if limited to one-third of the grain portion in the ration. These authors concluded that the level of wheat that could be safely imcorporated into a high concentrate ration appeared to be highly dependent on the variety of wheat used. Fulton *et al*. (1973) reported that the results of five trails clearly indicated that wheat varieties varied in their feeding characteristics. Varieties differed in the production of lactic acid and the lowering of pH values during rumen fermentation; this variation produced marked differences in steer performance. Brethour and Duitsman (1979) compared two hard red winter wheats to a soft red winter wheat and a white wheat. Both hard red winter wheats were superior in feeding value for rate of gain over soft red winter and white wheats. White wheat appeared to be slightly better than soft red winter wheat for gain and feed effieiency.

Brethour and Duitsman (1972) reported that steers fed weak gluten hard red winter wheat gained and graded slightly less than those fed a strong gluten wheat. Efficiency, economy of gain and net energy values were also higher for the strong gluten wheat variety.

Data from Williams (1967) showed that harder kernel wheats have higher levels of starch degradation due to processing than do the soft wheat varieties. This suggests that harder wheat is more digestible in a ration for beef animals. Williams (1967) also indicated that hard wheat may cause problems with high rumen lactate production and results in reduced intake when included at high levels in ruminant rations. Dyer (1965) made a comparison of rations consisting of hard red winter wheats and soft white winter wheats. His work showed a reduction in intake for the animals fed the hard red winter wheat. Hale et al. (1971) maintained hard red winter wheat offers an opportunity for use as a feed grain when fed in limited amounts.

Varner and Woods (1975) indicated that climatic factors and cultural practices at various locations may help to explain differences in percent protein, starch and moisture in the grain which in turn influences rate and/or extent of digestion in the rumen.

Although wheat may be incorporated into beef cattle rations without detramental effects on gain, it is not fed without risk. Conditions may occur with high percent wheat rations such as lactic-acidosis, laminitis and hepatic abcesses. These diseases are presumably the result of change in rumen pH to increased concentrations of lactic acid and possibly other toxic substances. Oltjen et al. (1966) gave evidence that levels of acidosis was greater with high

level wheat diets.

It is generally agreed that a long adaptation period will reduce the incidence of these conditions. Shaw et al. (1972) reported that animals fed a ration consisting of 85% wheat have normal rumen pH of 6.9 to 7.0 following an adaptation period when approximately 1% sodium bicarbonate was incorporated into the ration.

Based on the literature review outlined herein, general conclusions are as follows: (1) mixtures of corn and wheat may be used in rations for finishing beef animals without a detrimental effect upon average daily gain and feed efficiency, (2) the variety of wheat used in high concentrate rations can cause differences in beef performance, (3) wheat used in these rations may be fed whole without any type of processing and (4) wheat may be incorporated into an all-concentrate finishing ration in levels up to 50% without a decrease in average daily gain or feed efficiency.

CHAPTER III

EXPERIMENTAL PROCEDURE

Data were collected from two feeding trails at two locations. The first trial, conducted at the University of Tennessee-Martin involved 64 Hereford steers fed from January 1979 to April 1979. The second trial, conducted at the Middle Tennessee Experiment Station, consisted of 60 Angus heifers fed from July 1979 to September 1979.

The Hereford steers used in the Martin trial were purchased through order buyers in the northwest Tennessee area. They ranged in weight from approximately 700 to 800 lbs. at the time of purchase. The Angus heifers used in the second trial were purchased as feeder calves in October 1978. They were wintered on roughage at the Middle Tennessee Experiment Station and grazed on permanent grass-legume pasture prior to being used in the feeding trial. They weighed approximately 700 to 800 lbs. at the initiation of the trial.

All cattle were treated for internal and external parasites and were implanted with 36 mg. of Ralgro (IMC Corporation) and injected with 1,000,000 I. U. of Vitamin A prior to the initiation of the trial. The cattle were adapted to the experimental rations over a 14-day period. During this period, the cattle were fed their respective grain mixture (one percent of body weight) of protein supplement (recommended daily allowance) and grass hay ad libitum. The grain mixture was increased at the rate of one pound per head per day, the protein supplement remained constant and the hay was gradually reduced. After the 14-day adaptation period, the cattle were grain

fed ad libitum their recommended supplemental protein. No roughage was fed after the adaptation period (Table 1).

Following the 14-day adaptation period, starting weight was based on the average of two weights determined 24 hours apart. Intermediate weights were subsequently recorded at twenty-eight day intervals. Feed weigh backs were also taken at this time. The final animal weight was based on the average of two weights (no withdrawal of feed or water) recorded 24 hrs. apart.

The 64 Hereford steers were divided into two equal groups (heavy and light). The 32 heavier steers were randomly assigned to four pens of eight steers each. Each pen was randomly assigned to each of the four experimental rations (Table 1). The 32 lighter steers were randomly assigned to four pens of eight steers each. Each pen of lighter steers was likewise assigned to each of the experimental rations. Thus each treatment (ration) contained two replications of eight steers each.

The Angus heifers at the Middle Tennessee Experiment Station were randomly alloted to twelve pens of five animals each. Four treatments with three replications each comprised the trial.

The experimental rations (Table 1) were the same for both trials. Soft red winter wheat was purchased from growers in the Martin area. Wheat grown at the Middle Tennessee Experiment Station was used for Trial II. Rations were balanced with the supplement (Tend-R-Leen) so that when the percentage of wheat increased in the ration the crude protein supplied by the supplement decreased and the crude protein content of the rations remained constant.

TABLE 1

EXPERIMENTAL PROCEDURES

Treatment No.	Trial[a] No.	Ingredient			
		Whole shelled corn(%)	Whole wheat (%)	21% protein Tend-R-Leen supplement	36% protein Tend-R-Leen supplement
1	I	100	0	no	yes
1	II	100	0	no	yes
2	I	80	20	no	yes
2	II	80	20	no	yes
3	I	60	40	yes	no
3	II	60	40	yes	no
4	I	40	60	yes	no
4	II	40	60	yes	no

[a]Trial I was conducted at the University of Tennessee at the Martin Experiment Station. The crude protein contents were 11.73% (wheat) and 8.33% (corn). Trial II was conducted at the University of Tennessee Middle Tennessee Experiment Station. The crude protein contents were 13.65% (wheat) and 8.27% (corn).

Tend-R-Leen manufactured by Doughboy Industries, New Richmond, Wisconsin is a 36% protein fed as a supplement with whole shelled corn. However, a 21% Tend-R-Leen was formulated to reduce the supplemental protein in the high wheat rations and also maintain a relatively constant level of non-protein Tend-R-Leen ingredients. Mixtures of the 36 and 21% protein product were made to adjust the supplemental protein level depending on the wheat content of the ration. The level of protein supplied by each ration was in accordance with the recommendations of the National Research Council (1976).

Following the feeding trial, animals were transported, fasted 24 hours and slaughtered in a commercial firm. After a 48 hour chill period in a $2^{o}C$ cooler each carcass was evaluated by University of Tennessee personnel and a USDA grader for carcass grade factors according to USDA (1976).

The response variables measured were final weight, average daily gain, lbs. of feed/lb. of gain and daily feed consumption. The response variables for the carcass data were as follows: carcass weight, USDA quality grade, USDA yield grade, longissimus muscle area, adjusted fat thickness, and percentage kidney, heart and pelvic fat.

Data were analyzed by Least Squares Procedure.

CHAPTER IV

RESULTS AND DISCUSSION

The dependent variables used in this study were final weight, average daily gain, feed efficiency (lbs. of feed/lb. of gain) and daily feed consumption. The dependent variables for the carcass data were hot carcass weight, adjusted fat thickness, Longissimus muscle area, percentage kidney, heart, and pelvic fat, USDA quality grade and USDA yield grade. Since all these variables were measurements or calculations, variation due to errors in measurement probably exist. However, these errors were considered random and were therefore included in the error terms.

In order to simplify the discussion, data for the 64 Hereford steers will be referred to as Trial I and data for the 60 Angus heifers will be referred to as Trial II.

Production Variables Trial I

The results of Trial I are presented in Table 2. There were no significant differences between treatments for final weights of cattle fed various levels of wheat and corn. The data indicate that average daily gain was the greatest for the 100% whole corn ration and the 60% and 40% whole wheat ration (2.9, 2.6, and 2.6 lb/day respectively). This is in agreement with Fowler (1969) who indicated whole shelled rations to be unsurpassed as a finishing ration. These data are in agreement with Hixon et al. (1969) who reported that average daily gains were not improved by adding wheat to the whole shelled corn

TABLE 2

MEAN VALUES OF LIVE ANIMAL VARIABLES FOR TRIAL I.[a,b]

Traits	% wheat in corn-wheat mixture			
	0	20	40	60
Initial weight (lb.)	775.3	729.7	768.1	739.1
Final weight (lb.)	1086.3	1014.4	1062.5	1027.2
Average daily gain (lb.)	2.9	2.5	2.6	2.6
Feed efficiency (lbs. feed/lb. gain)	7.2	7.5	8.3	8.2
Daily feed consumption (lb.)	21.3	19.0	21.7	21.3

[a]These data were collected from the 64 Hereford steers fed at the Martin Experiment Station.

[b]N=16 Hereford steers for each treatment.

ration. Also significant differences between treatments for average daily gain were noted in the present study.

The regression analyses (Table 3) indicate a significant positive linear relationship ($P < .05$) between level of wheat in the ration and feed efficiency. This indicates that feed efficiency decreased as level of wheat was increased. The feed efficiency was slightly higher for the 100% whole corn rations, but the differences among treatments were not statistically significant. Regression analyses were calculated on all other variables; no significant relationships were found among these variables. These data disagree with work by Arnett (1971) who showed results of greater intake and feed conversion with a whole wheat ration than with a dry rolled wheat ration. Reports by Praylor and Laws (1972) indicated that a ration (high wheat) resulted in faster growth and higher feed conversion. In the present study, there were no significant differences among the treatments. This closely follows the findings of Oltjen et al. (1965) whose data indicated lower feed efficiency and significantly decreased gains when rations contianed 60 or 90% wheat. Baker and Baker (1960) and Fowler (1969), Nichols (1970) and Wagner et al. (1971) reported that when wheat is added to a ration at a greater than 50% ratio, feed efficiency is inhibited. This is also in general agreement with Fain (1979) who reported lower average daily gains resulting from a 60% whole wheat ration when compared with 100% whole shelled corn, 60% whole shelled corn and 40% whole shelled corn.

Differences in daily feed comsumption for the four treatments were likewise not significant. These analyses indicate there were no

TABLE 3

REGRESSION ANALYSES FOR FEED EFFICIENCY

Source	df	M.S.	
Weight class	1	.51	
Treatment	3	.62**	
Linear	1		1.56*
Quadratic	1		.08
Cubic	1		.21
Residual	3	.09	
R^2		.90	

* Statistically significant ($P < .05$).

** Statistically significant ($P < .10$).

significant differences between treatments for the live animal variables.

Carcass Variables

The treatment means of the carcass variables are presented in Table 4. The differences between the treatments for carcass weight were significant ($P < .05$). This difference most likely occurred because of a combination of slightly heavier initial weights, slightly faster average daily gains and the most subcutaneous fat thickness which logically produced a higher dressing percentage. When final weight was (statistically) held constant, it was again a significant source of variation in all analyses. However, treatment differences remained nonsignificant.

Adjusted fat thickness and longissimus muscle area were not different due to treatment. USDA quality grades and yield grades were higher for the 100% whole corn ration but were not significant.

These data indicate that rations consisting of up to 60% whole wheat may be fed to yearling cattle without detrimental effects upon the live animal and carcass variables studied. The data indicate that the 64 Hereford steers fed either the 20, 40 or 60% whole wheat rations performed as well as the steers fed the 100% whole shelled corn ration. Thus, supplemental protein may be reduced in the rations containing higher levels of wheat without having a detrimental effect upon gain, feed efficiency or carcass merit.

Production Variables Trial II

The results for Trial II are presented in (Table 5). The cattle in this study had no significant ($P < .05$) differences in initial weight.

TABLE 4

MEAN VALUES OF CARCASS VARIABLES FOR TRIAL I.

Carcass variables	% wheat in corn-wheat mixture 0	20	40	60
Hot carcass weight (lb.)	662.2[a]	612.4[b]	645.4[ab]	620.1[b]
Adjusted fat thickness, 12th rib (mm)	15.3[a]	11.6[a]	12.8[a]	12.5[a]
Longissimus muscle area (in^2)	11.0[a]	10.5[a]	11.2[a]	10.6[a]
Kidney, pelvic and heart fat (%)	2.5[a]	2.4[a]	2.3[a]	2.3[a]
USDA-quality grade[c]	12.5[a]	11.2[a]	11.1[a]	11.6[a]
USDA-yield grade	3.0[a]	2.6[a]	2.6[a]	2.7[a]

[a,b]Mean values in the same row with different superscripts are significantly different ($P < .05$).

[c]Quality grade: 11.0 = Good-plus, 12.0 = Choice-low.

TABLE 5

MEAN VALUES FOR LIVE ANIMAL PRODUCTION TRAITS FOR TRIAL II.[c,d]

Traits	% wheat in corn-wheat mixture			
	0	20	40	60
Initial weight (lb.)	786.6	799.3	794.7	777.9
Final weight (lb.)	937.5[a]	985.1[b]	958.3[ab]	952.8[a]
Average daily gain (lb.)	2.7[a]	3.3[b]	2.9[a]	3.1[ab]
Feed efficiency (lbs. feed/lb. gain)	7.2[b]	6.0[a]	7.0[b]	6.0[a]
Daily feed consumption (lb.)	19.3[a]	19.6[a]	20.0[a]	18.8[a]

[a,b]Mean values in the same row with different superscripts are significantly different ($P < .05$).

[c,d]These data were collected from the 60 Angus heifers fed at the Middle Tennessee Experiment Station. N = 15 Angus heifers for each treatment.

There was a significant difference in the final weight ($P < .05$). However, final weights were not different when initial weights were statistically held constant.

The 20% whole wheat ration had a significantly higher ($P < .05$) average daily gain then the 0 or 40% ration and also tended to be superior to the 60% ration; however, the difference was not significant. This study indicates that the average daily gain of cattle fed the 20% whole wheat ration and the 60% whole wheat ration were different ($P < .05$). The average daily gains were 3.3, 3.1, 2.9, 2.7, for the 0, 20, and 60% wheat rations respectively (Table 5). These data also indicate that the cattle fed the 20% whole wheat rations and the 60% whole wheat rations had higher feed conversions ($P < .05$). This is in agreement with Praylor and Laws (1972) who reported that a higher wheat ration resulted in faster growth and feed conversions. Oltjen et al. (1965) indicated lower feed efficiencies and significantly decreased gains when rations contained 60% and 90% wheat fed for 98 days. Treatment 3 (40% whole wheat) had the greatest daily feed consumption, followed by treatment 2 (20% whole wheat). The live animal variables for this trial show that rations consisting of 20, 40 and 60% whole wheat tended to enduce superior performance when compared to 100% whole corn rations. It is important to note that these heifers were fed for only 56 days on full-feed following growth on pasture. However, they attained their logical slaughter weight and grade for heifers of their frame size.

Carcass Variables

Treatment means for the carcass variables for Trial II are given in (Table 6). There were no significant differences for any carcass variables except carcass weight ($P < .05$). This is reflective of the higher final weights. The cattle fed the 20 and 60% whole wheat rations had a higher longissimus muscle area partially due to weight. USDA quality and yield grade differences were not significant ($P < .05$), as shown in (Table 6).

Data from Trial I indicated that there were no significant differences between the live animal variables or carcass traits of cattle fed rations consisting of 20, 40, or 60% whole wheat in comparison to a 100% whole shelled corn ration. In every case except daily feed consumption, both the live animal and carcass variables for the 100% corn rations were slightly superior to the other rations, but differences were not statistically significant. Results of Trial II did not agree with those of Trial I. The animals fed wheat rations had significantly higher final weights, average daily gains and lower feed to gain ratios, than the animals fed the 100% whole corn ration. The results were more favorable for the 20 and 60% whole wheat rations with the 40% whole wheat rations comparable to the 100% whole corn rations.

Trial II data indicate that if the market prices of wheat should become competitive with corn, wheat could be fed in combination with corn in beef finishing rations. Substitutions up to 60% whole wheat for corn could be made without a detrimental effect upon gain or feed conversion. The data in this trial indicate that rations consisting

TABLE 6

MEAN VALUES OF CARCASS VARIABLES FOR TRIAL II.

Carcass variables	% wheat in corn-wheat mixture			
	0	20	40	60
Hot carcass weight (lb.)	545.8[a]	573.5[b]	557.7[ab]	533.9[a]
Adjusted fat thickness, 12th rib (mm)	8.8[a]	8.7[a]	9.0[a]	8.3[a]
Longissimus muscle area (in^2)	10.7[a]	11.6[a]	10.7[a]	11.4[a]
Kidney, pelvic and heart fat (%)	2.7[a]	2.8[a]	2.9[a]	2.7[a]
USDA-quality grade[c]	13.6[a]	12.1[a]	13.8[a]	12.0[a]
USDA-yield grade	2.0[a]	1.9[a]	2.1[a]	1.8[a]

[a,b]Mean values in the same row with different superscripts are significantly different ($P < .05$).

[c]Quality grade: 11.0 = Good-plus, 12.0 = Choice-low.

of 20, 40 and 60% whole wheat, top dressed with Tend-R-Leen, with the protein level for each ration held constant, in general had better conversions and average daily gain than the 100% whole corn rations.

CHAPTER V

SUMMARY

The data collected in this study were from 64 Hereford yearling steers (Trial I) and 60 yearling Angus heifers (Trial II). These animals were fed all-grain finishing rations consisting of varying levels of corn and wheat. The rations consisted of (1) 100% whole shelled corn, (2) 80% whole shelled corn and 20% whole wheat, (3) 60% whole shelled corn and 40% whole wheat, (4) 40% whole shelled corn and 60% whole wheat. All rations were top-dressed with Tend-R-Leen in varying amounts in order to maintain a constant crude protein level in each treatment (ration).

Live animal and carcass variables were collected for these two trials. The live animal variables were final weight, average daily gain, feed efficiency and daily feed comsumption. The carcass variables were hot carcass weight, adjusted fat thickness, longissimus muscle areas, percentage kidney, heart and pelvic fat, USDA quality and USDA yield grade.

Results from Trial I indicated that wheat may be substituted in rations of finishing beef animals at levels as high as 60% without a detrimental effect upon live animal or carcass variables. No significant differences were shown among the four treatments in this trial.

Carcass data from Trial I also indicated no significant differences among treatments. Levels up to 60% whole wheat substituted for corn did not significantly affect any of the carcass variables.

Results from Trial II indicated that Angus heifers fed 20% whole wheat or 60% whole wheat were significantly higher in average daily gains and feed efficiency than the 100% whole shelled corn rations. The 40% whole wheat rations were not significantly different from the 100% whole corn rations.

Although the data from these two trials did not totally agree, it does indicate that wheat may be fed whole and substituted for a portion of the whole shelled corn in an all-concentrate-all whole grain ration. Additionally, the higher protein content of wheat in comparison to corn can be an advantage as less supplemental protein was fed with the higher wheat rations and the performance was not significantly less than the 100% corn rations in any case.

The reasons the Angus heifers had superior gains to Hereford steers, which include breed, season of year cattle were fed, or a variation in the length of feeding period, cannot be explained from these data.

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VITA

Danny Ray Wright was born September 27, 1956, in the small town of Lexington, Tennessee. His education began at Reagan Elementary School. He then attended Sardis High School graduating with honors in June of 1974.

In September of 1974, he entered Jackson State Community College. He graduated Cum Laude in June of 1976, with an Associate of Science degree. After graduation, he attended the University of Tennessee, Martin, in September of 1976. Majoring in Animal Science, he graduated in June of 1978 with a Bachelor of Science degree.

In September of 1978, he entered the University of Tennessee, Knoxville to pursue a Master of Science degree. While completing his graduate program, he was under the guidance and direction of Dr. William R. Backus.

He received the Master of Science degree in Animal Science in August of 1980.