HARD RED SPRING AND DURUM WHEAT IN RATIONS FOR GROWING-FINISHING BEEF CATTLE

W. E. Dinusson, D. O. Erickson, C. N. Haugse and M. L. Buchanan

North Dakota ranks first of all states in the production of durum and hard red spring wheat and second in the production of all wheat. If price becomes competitive with feed grains or if weather or harvest conditions cause some damage and drop in quality for milling, wheat produced in North Dakota could become available for feeding.

Interest in feeding wheat has stimulated research at many stations, most of it with wheats other than the classes grown in North Dakota. The six main market classes of wheat include Durum, Hard Red Spring, Hard Red Winter, Soft Red Winter, White and Mixed Wheat. Several of the reports in the literature on the feeding value of wheat neglected to give the class and quality of the wheat used. Information on the feeding value of durum wheat is especially lacking.

The Proceedings of the Symposium, **Wheat in Livestock and Poultry Feeds,** held at Oklahoma State University in June, 1970, has excellent reviews on feeding wheat to beef cattle. J. R. Brethour reporting at the conference on wheat for beef commented on the basis of some 87 comparisons, "The most consistent observation in comparisons of wheat with other grains is the reduced intake with wheat," and "When wheat alone was fed, the 16 percent average reduction in intake was enough to depress rate of gain 10 per cent, although wheat rations were more efficient. However, by limiting wheat to 50 per cent of the grain in the ration, feed intake was maintained at more satisfactory levels and rate of gain was not depressed." Brethour also concluded that adding four per cent fat to wheat rations improved performance, and added that "Palatability does not seem to be as much a problem with softer wheats used in California and the Pacific Northwest."

Other problems mentioned which appear to be associated with feeding wheat were increased incidence of liver abscesses and rumen acidosis from lactic acid production. This lactic acid production may be higher with hard than soft wheats. This also was discussed by R. R. Oltjen in his review on the metabolic aspects of feeding wheat. Cattle fed wheat rations had increased lactic acid production in the rumen which may have been associated with the cattle going "off feed".

In the Proceedings, G. P. Lofgren reviewed the comparative Net Energy values of wheats with other grains. He reported that the Net Energy values for wheat were two percent higher than barley, but two per cent lower than corn. Presumably these values were for soft wheats.

With only very limited recent information on the feed values of hard red spring wheat or durum wheat for cattle, experiments were designed to evaluate wheats at several levels in the rations and to obtain some information on how best to use wheats for cattle feeding. Two hard red spring

Dr. Dinusson is professor, Dr. Erickson is associate professor, Haugse is associate professor, and Buchanan is professor and head, Department of Animal Science.

Table 1. Description of feed used.

Feed	Abbreviation	Grade	Wt. Lbs. Bu.	Moisture %	Protein % Crude
Hard Red Spring wheat	HSWH	No. 1 Hyy. Dark Nor. Sp.	60.2	10.5	15.2
Hard Red Spring wheat	HSWL	No. 3 Dark Nor. Sp.	56.2	14.8	15.4
Durum wheat[1]	Dur	Sample grade AD	53.5	12.5	14.6
Barley	Bly	No. 4 Barley	41.9	11.5	11.2
Oats	Oat	No. 1 Extra Heavy White Oats	38.1	11.2	10.5
Mol. beet pulp	B.P.			11.9	8.9
Corn silage	C.S.			69.5	7.2
Alfalfa pellets	Alf			11.7	14.4

[1]Durum wheat had 35 per cent sprout damage.

wheats and a sprout damaged durum wheat were obtained and used in comparisons with other common feed grains. The description of the grains and the feeds used are given in Table 1.

Procedures

Eighty-four steer calves of Hereford breeding, all from the same herd and similar in type, quality and uniformity, were allotted by a "pairing" technique and assigning at random to 14 lots of six steers each. The "pairing" was done to permit re-alloting at the end of the growing phase (Phase 1) and allow measurement of any "carry-over" effect the growing rations might have on gains in the second, or finishing phase.

The steers were fed the respective rations twice a day in indoor pens. Water was available at all times in paved outdoor pens. The steers were individually weighed every 21 days. Feed was withheld the evening and morning previous to the weighing and the "shrunk" weights were taken in early afternoon. After conclusion of the finishing phase the steers were slaughtered at a local packing plant and carcass data obtained. Liver samples were taken for vitamin A analysis. The rumens were checked for rumenitis.

Table 2. Formulas for Supplements, Exp. C-21, C-22.

Ingredient	C-21(22) pounds	C-21-x pounds
Alfalfa Pellets (sun-cured)	50	37.5
Molasses Beet Pulp	30	22.5
Wheat Bran	10	7.5
Limestone	3	2.25
Dicalcium Phosphate	3	2.25
Trace Mineral Salt	4	3.0
Soybean Oil Meal	-	25.0
Fat[1]	2	2.0
Vitamin A, I.U.[2]	800,000	600,000
Vitamin D, I.U.[2]	80,000	60,000
Zinc Bacitracin[2]	2,500	1,875
To be fed at per day	3	4

[1]Fat was tallow used to reduce dustiness and help pelleting.
[2]The vitamins and antibiotic were premixed in a wheat bran.

Experiment C-21

The design of this experiment, C-21, was a 2 x 4 factorial, two levels of grain and four grains. This was for the growing phase of the experiment. It was planned to feed two or six pounds of the respective grains, supplement, and all the corn silage they would consume. The formulas for the supplements are given in Table 2. The supplement, C-21, was fed to the lots receiving the higher level of grain. This, fed at three pounds per head daily, provided 1.5 pounds of alfalfa (sun-cured, ground and pelleted), 0.9 pounds of molasses beet pulp and the necessary minerals and vitamins. Supplement C-21-x was fed at a level of four pounds per head daily to the calves receiving two pounds per head daily of the grains. This provided the same amount of alfalfa, beet pulp, minerals, etc., as the steers on the higher level of grain feeding plus one pound of soybean oil meal to provide the protein needed with limited grain and corn silage. In addition to the grain and supplement, all the calves were fed corn silage in amounts they would clean up. The grains were dry-rolled prior to feeding. The description of the grains and other feeds used is given in Table 1.

In Phase 2, or finishing phase, the steers were re-allotted, as previously planned by pairing, and the wheats were fed with barley or oats as 40 per cent of the grain (wheats, 60 per cent) and barley or oats as controls. The supplement was C-21 (Table 2) fed at three pounds per head daily. No roughage other than that in the supplement was offered. The pens were bedded with straw and it was observed that the cattle did nibble on the straw at the time the pens were bedded. By estimates of pounds of bedding provided per lot, this straw consumption was less than four pounds per head per week.

Experiment C-22

The steers used in Phase 1, growing phase, were handled in identical manner to those in C-21. In fact, the same lots served as controls for both

Table 3. Experiment C-21, Summary of Results, Phase 1. (Growing phase, 126 days) 6 steers per lot

Treatment	HSWH	HSWL	Durum	Barley
Lot No.	1	2	3	4
Initial wt., lb.	325	326	320	325
Final wt., lb.	466	481	478	509
Avg. daily gain, lb.	1.12	1.23	1.25	1.35
Supp. C-21 per day, lb.	3.7	3.7	3.7	3.8
Grain/day, lb.	2.0	2.0	2.1	2.0
Silage/day, lb.	13.4	13.3	13.3	14.2
Feed/day (air dry), lb.	10.8	10.8	10.8	10.7
Treatment	**HSWH**	**HSWL**	**Durum**	**Barley**
Lot No.	**5**	**6**	**7**	**13**
Initial wt., lb.	331	330	323	332
Final wt., lb.	521	532	527	523
Avg. daily gain, lb.	1.51	1.61	1.62	1.52
Supp C-21 per day, lb.	2.9	2.9	2.9	2.9
Grain/day, lb.	5.2	5.2	5.2	5.1
Silage/day, lb.	10.1	10.8	6.6	9.1
Feed/day (air dry) lb.	11.5	11.8	10.3	11.2

experiments. The design of this trial was a 2 x 3 factorial, two levels of grain feeding and three grains, barley, oats and the hard red spring wheat (56 pounds per bushel or "light"). The same supplements were used as in experiment C-21.

In the finishing phase the experimental design was again a 2 x 3 factorial, three grains with or without 30 percent beet pulp substituted for a like amount of grain. The management was the same as for Phase 2 in Experiment 21. Carcass data and liver samples were obtained at slaughter.

Results and Discussion

Results from part of this experiment, that on high-moisture oats, have been published elsewhere (**High Moisture Oats in Rations for Beef Cattle.** No. Dak. Farm Research 27:5-10). The results of Phase 1, C-21, are presented in Table 3. The gains of the calves during this 126-day period were somewhat less than was anticipated. Cattle fed two pounds of grain varied in gains from 1.12 to 1.35 pounds per day. The total consumption of feed per day (silage expressed on a 90 per cent dry matter basis) was about 10.4 pounds or 2.6 per cent of body weight. The calves on the higher level of grain gained about 1/3 pound a day faster than those on the two pounds of grain.

Although the intention was to feed six pounds of the respective grains per head per day, it was not possible to increase the grain intake of these small calves (325 pounds initial weight) rapidly enough, and the average grain intake for the period was only about 5.2 pounds per day. If one assumes one pound of soybean oil meal to contain the same usable energy as the grain, then the extra grain consumption was only 2.2 pounds per day. In addition, the calves on the higher grain level consumed less silage, about 4.2 pounds (on an as-is basis) per day. This was more variable, especially for the durum wheat (Lot 7). In any event the steers were more efficient in pounds of feed needed per pound of gain by about 17 per cent. Because of variation within lots, the difference between grains was not significant, but the difference between levels of grain fed was highly significant (less than one in a 100 chances that the differences were due to chance and not to treatment; see Table 7).

In the growing phase of C-22, the calves performed similarly to those in C-21. The results are summarized in Table 4. Note that Lots 4 and 13, the barley-fed lots, are the same in both experiments. The experiments were conducted simultaneously, with similar calves and with the same lots. Combining the treatments in both experiments shows that the calves on the two pounds of grain gained an average of 1.24 pounds per day, while those on the higher level gained 1.54 pounds or about the same difference as with experiment C-21 alone.

In Phase 2 of Experiment C-21, the finishing phase, with but one exception, barley as 40 per cent

Table 4. Experiment C-21, Summary of Results, Phase 2, (Finishing phase - 210 days - 6 steers per lot).

Treatments	Barley as 40% of grain			
	HSWH	HSWL	Durum	Barley
Lot no.	1	2	3	4
Initial wt., lb.	509	502	497	532
Final wt., lb.	1041	1030	1000	1082
Avg. daily gain, lb.	2.53	2.51	2.40	2.62
Supp/day, lb.	2.90	2.90	2.90	2.90
Barley/day, lb.	5.80	5.80	5.80	14.40
Other grain, lb.	8.20	8.30	8.30	-
Feed/lb. gain, lb.	6.60	6.80	7.10	6.60
U.S. Grade[1]	9.00	9.00	9.00	10.00
Dressing %[2]	59.20	58.70	58.10	58.70
Vit. A (ug/gm)	14.00	15.00	13.00	18.00
Treatments	**Oats as 40% of grain**			
	HSWH	HSWL	Durum	Barley
Lot no.	5	6	7	8
Initial wt., lb.	478	501	508	501
Final wt., lb.	979	1032	978	983
Avg. daily gain, lb.	2.38	2.59	2.24	2.30
Supp/day, lb.	2.90	2.90	2.90	2.90
Oats/day, lb.	5.80	5.60	5.60	14.80
Other grain, lb.	8.20	8.50	7.60	-
Feed/lb. gain, lb.	7.10	6.80	7.20	7.70
U.S. Grade[1]	9.00	9.00	8.00	8.00
Dressing %[2]	59.20	58.90	56.90	57.70
Vit. A (ug/gm)[3]	16.00	14.00	23.00	24.00

[1]8 equals avg. good, 9 equals high good, 10 equals low choice etc.
[2]Calculated on hot carcass wts.
[3]Vitamin A in liver - micrograms per gram of wet liver.

Table 5. Experiment 22, Summary of Results, Phase 1 (growing phase, 126 days).

Treatment Lot No.	Bly 4	Oats 8	HSWL 10	Bly 13	Oats 12	HSWL 14
Initial wt., lb.	325	322	321	332	326	327
Final wt., lb.	509	484	482	523	507	522
Avg. daily gain, lb.	1.35	1.29	1.28	1.52	1.44	1.55
Supp C-21/day, lb.	3.80	3.70	3.70	2.90	2.90	2.90
Grain/day, lb.	2.10	2.00	2.00	5.10	5.10	5.10
Silage/day, lb.	14.2	12.0	12.9	9.00	8.10	8.70
Feed/day (air dry), lb.	10.7	9.80	10.1	11.1	10.7	10.9

of the grain mix with the wheats gave more rapid gains and greater feed efficiency than when oats formed 40 per cent of the grain (Table 4). These differences were significant at the 5 per cent level. Apparently the extra hull content from the oats on this low roughage ration was not a benefit. The gains on the barley-wheats replicate were 2.51 pounds per day, about 5.5 per cent faster than the gain of 2.38 on the oats replicate. In addition, it took about six per cent less feed per pound of gain on the barley replicate than where oats was used. Of the wheats, the durum wheats combinations resulted in the poorest gains. Although the difference was not large enough to be significant (too much variation in gain within lots), the lower gains and poorer feed efficiency reflect the lower energy in this sample grade, sprouted, 53-pound per bushel durum wheat. Only the oats rations (Lot 8) had poorer feed efficiency than the durum. Therefore the Total Digestible Nutrient (TDN) content of this lot of durum wheat was somewhere between that of oats and the barley used. The hard red spring wheat had TDN values similar to that of the barley because the feed efficiencies and gains were similar to those of the barley-fed steers. From these results it can be seen that either barley or oats can be fed with the wheats, because the rates of gain in all lots were good for cattle of this type and the feed efficiencies of all lots were good.

In the finishing phase of Experiment C-22 (Table 6), one of the objectives was to evaluate molasses-beet pulp as 30 per cent of the grain mix in these low roughage, high energy type rations. Averaging the gains of the three lots without beet pulp and comparing to the average from the three lots where beet pulp replaced 30 per cent of the grain show about 5 per cent benefit from beet pulp (2.34 to 2.46 pounds per day). However, this difference was not large enough to be significant (approached significance at the 7 per cent level), the oats ration showed no response, the barley ration was negatively affected, and the hard red spring wheat showed improvement with the beet pulp additions. In looking at the two comparisons, wheat without (Lot 10) and wheat with beet pulp, it becomes evident that substituting beet pulp for wheat increased gains over 10 per cent. The same substitution for barley resulted in a drop in gain of three per cent. So, it is evident that beet pulp doesn't have the same value in all rations. It is possible that if the wheat ration had contained more roughage the results would have been different. In the case of feed intake, total daily feed was the same for the barley lots, increased in the oats lots by about 0.8 pounds, and in the wheat lots by 2.3 pounds per day. With the increased gain, same feed efficiency and greater feed intake, the wheat ration was definitely improved by the beet pulp.

Table 6. Experiment 22, Summary of Results, Phase 2 (finishing phase - 210 days).

	No Beet Pulp			Beet Pulp (30% of grain)		
Treatment Lot No.	Bly 4	Oats 8	HSWL 10	Bly 13	Oats 12	HSWL 14
Initial wt., lb.	532	501	508	504	490	495
Final wt., lb.	1082	983	1006	1020	971	1043
Avg. daily gain, lb.	2.62	2.30	2.37	2.54	2.29	2.61
Supp/day, lb.	2.90	2.90	2.90	3.00	2.90	2.90
Beet pulp, lb.	-	-	-	4.00	4.20	4.00
Grain/day, lb.	14.40	14.80	12.60	10.40	11.40	10.30
Feed/lb. grain, lb.	6.60	7.70	6.60	7.00	8.10	6.60
U.S. Grade[1]	10.00	8.00	8.00	9.00	9.00	9.00
Dressing %[2]	58.70	54.50	57.90	58.60	57.90	57.50
Vit. A (ug-gm)[3]	18.00	24.00	12.00	13.00	28.00	18.00

[1]8 equals avg. good, 9 equals high good, 10 equals low choice, etc.
[2]Based on hot carcass weights.
[3]Vitamin A in micrograms per gram of wet liver.

Differences between the gains due to the grains was significant. When fed as the only grain, with only three pounds of supplement C-21 supplying a limited amount of roughage, the 56-pound spring wheat was not altogether satisfactory as a feed grain. The steers were harder to keep on feed and did not seem to be as eager at the feed bunk as were the steers on the other grains or where beet pulp was added to the wheat. It does show that with care in feeding and management wheat can be used as the only grain with reasonably good results.

Another objective of these experiments was to measure "carry-over" effect of two levels of grain feeding during the growing period on subsequent gains in the finishing period. Both experiments were combined in the interpretation of these results. As mentioned earlier, the calves on two pounds of grain gained 1.24 pounds per day as compared to 1.54 on the higher grain level, a 24 per cent increase in rate of gain. In the finishing phase of C-21, the steers on the low level of grain feeding in the growing phase gained 2.49 pounds per day compared to 2.41 for those on the higher level, a difference of about three per cent. This effect was consistent with all steers and was statistically significant (Table 7). In Phase 2 of C-22, the gains were 2.44 pounds for the original two-pound grain level and 2.36 pounds for the higher grain level, or a difference of about three per cent. In this case the variation was greater within treatment and the three per cent difference only approached significance (10 per cent level). In any event, the steers that gained more slowly during the growing phase did compensate by increased gains and narrowed the differences in gains from 24 per cent to three per cent.

The vitamin A values reported in the Tables 4 and 6 are those for the liver samples collected at slaughter and are reported in micrograms per gram of wet liver. There was considerable variation between steers and between treatments, but the values indicate that vitamin A was not limiting in these high energy rations.

The incidence of abscessed livers in these experiments was rather high. In C-21, 21 out of 48 livers were abscessed and of these 19 were in the wheat lots and one each in the barley or oats lots. This is a biased comparison because six of the eight lots were fed wheat or durum. But there were 10 abscessed (five per lot) livers where durum wheat was fed, six in the heavy spring wheat (average of three out of six per lot) and three out of 12 for the lighter spring wheat. In Experiment C-22, there were 12 abscessed livers out of 36. However, nine of the 12 came from the two lots on the wheat and only three from the four lots on barley or oats rations. In the two experiments, the greater incidence of abscessed livers in the wheat treatments was too great to be due to chance.

The carcass grades are reported in Tables 4 and 6. In only one lot fed a barley ration did the grades average low choice. For some of the treatments the grades were only average good. The carcasses had ample amounts of backfat but tended to lack marbling. Whether this is due to treatment or to inheritance is not known.

Table 7. Statistical Interpretation of Gains - Exp. C-21 & C-22 (Phase 1), (Analysis of Covariance).

Source	DF[1]	MS	F
Regression	1	0.218	4.902*
Within	65	0.044	——
2 to 6 lbs. gain	1	1.835	41.104**
Between grains	5	0.039	0.886
Interaction	10	0.021	0.480
	Phase 2 - C-21		
Regression	1	0.280	6.895*
Within	36	0.041	——
Bly vs oats	1	0.172	4.226*
Between grains	3	0.110	2.723
"Carryover" effect	1	0.124	3.049*
Interaction	3	0.057	1.047
	Phase 2[1] - C-22		
Regression	1[1]	0.365	5.727*
Within	36	0.064	——
Beet pulp vs none	1	0.235	3.686(7% level)
Between grains	3	0.193	0.031*
"Carryover" effect	1	0.181	2.833(10% level)
Interaction	3	0.082	1.284

[1]Part of C-22 relating to high moisture oats previously published in N. D. Farm Research 27: 5-10, 1969.

Summary

1. Either hard red spring wheat or durum wheat can be used successfully for finishing cattle on high energy rations.
2. The wheats were about equal to barley as feeds for cattle.
3. Barley as 40 per cent of the grain fed was superior to oats used in the same proportion of the ration.
4. Calves fed to gain more slowly on growing rations did tend to compensate when put on full feed.
5. Steers on wheat rations had more abscessed livers than did those on barley or oats rations.
6. Molasses beet pulp as 30 per cent of the grain was more useful with wheat rations than with barley or oat rations.

Appreciation is expressed to Elanco Co. for the stilbestrol used in this experiment. Appreciation also is expressed to Dr. V. K. Johnson and R. D. Knutson for carcass grading and evaluation.