HIGH MOISTURE OATS IN RATIONS FOR BEEF CATTLE

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Introduction

Oats (**Avena sativa**) has long been a popular grain for use in rations for breeding herds and growing cattle. Oats also are used successfully as part of rations for fattening cattle. A recent report from this station (N. Dak. Research Report, Number 24:1969) suggests that oats are equal to barley when used at a level of not over 30 per cent of the ration, but are worth about 12 per cent less than barley if used as the only grain in rations for fattening cattle.

A previous publication (N. Dak. Farm Research Report, 25: 9-13, 1965) reported that high-moisture barley (harvested and stored at about 30 per cent moisture in oxygen free storage) was about equal, on a dry matter basis, to dry barley, with some slight advantage in harvesting and feeding.

Harvesting oats at 25 to 30 per cent moisture would have certain advantages. It would extend the combining period, reduce shattering and reduce risk from hail and other climatic factors. It might also have advantages in feeding. Disadvantages would include more expensive storage facilities and modification of roller mills and other handling equipment.

Two experiments were carried out with high moisture oats to evaluate the feasibility of this system of handling and feeding oats.

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EXPERIMENT C-22

Methods

Thirty-six Hereford steer calves, all from the same herd, of similar breeding and weighing about 325 pounds, were purchased for this experiment. These calves were allotted by "pairing" steers and assigning the pairs at random, to six lots of six steers each. At the end of phase 1 (growing-wintering phase), the "paired" steers were exchanged between lots in order to measure any carry-over effect of the energy level, two or six pounds of grain, during the wintering phase on subsequent gains during the fattening phase (phase 2).

The steers were individually weighed every 21 days. Data on feed intake were recorded. During phase 2, feed, but not water, was withheld for at least 12 hours before weighing. The steers were fed in concrete bunks in an experimental barn (pen size 12 by 18 feet) with access to outside paved lots (12 by 40 feet) provided with automatic waterers.

The design for phase 1 was a 2 x 3 factorial. Three grains were fed at two levels. The grain was fed at either two or six pound levels per head daily. Where only two pounds of the respective grains were fed, four pounds of supplement C-22-X were fed. Where six pounds of grain were fed, supplement C-22 was fed at a level of three

pounds daily. In addition, the steers were given all the silage they would clean up when fed twice a day. Initially, the silage was from corn with a dry matter content of about 34 per cent and protein 7.3 per cent (on dry matter basis). Towards the end of the wintering phase, sorghum silage was substituted with a dry matter content of 31 per cent and protein (dry matter basis) of 6.8 per cent. The barley was only fair, with an average bushel weight of about 42 pounds and protein of 11.5 per cent. The oats averaged 37.9 pounds per bushel with protein level of 10.6 per cent. The bushel weights for the high moisture oats was not determined, but all oats were harvested from the same field. The moisture content of the high-moisture oats averaged 27.6 per cent. All grains were rolled prior to feeding. The high-moisture oats were rolled as taken from the oxygen-free storage, and required a scraper on the roller to prevent buildup of grain.

The supplement formulas are presented in Table 1. Wheat bran was used as a carrier for the vitamin and antibiotic premix, and the supplements were formulated to provide 1.5 pounds of alfalfa and 0.9 pounds of molasses beet pulp per head per day.

Table 1. Supplement Formulas, Experiment C-22.

Supplement No.	C-22 %	C-22-X %
Alfalfa (sun cured)	50	37.5
Molasses Beet Pulp	30	22.5
Soybean Oil Meal	—	25.0
Wheat Bran[1]	10	7.5
DiCalcium Phosphate	3	2.25
Limestone	3	2.25
Trace Mineral Salt	4	3.0
Fed per day, lbs.	3	4

[1]Wheat bran was carrier for vitamins, stilbestrol and antibiotic. Added to provide: A - 24,000 IU; D - 2,400 IU; zinc bacitracin 75 mgm per head per day and 10 mgm stilbestrol per day.

In the growing-wintering phase (phase 1) the response of the steers was similar. The differences in gain for the steers receiving two pounds of grain were significantly less than for those receiving six pounds (1.26 vs. 1.50 lbs. per day). This difference was significant at the one per cent level. The steers fed on high moisture oats at the two-pound grain level (lot 9) did not gain as expected even if through error they were fed 50 per cent more grain for several days than the design and plan of experiment called for. Lot 11, which received the six pounds of high moisture oats, gained as well as the barley lots. Actually, the differences in gains between lots receiving the different grains were not significant except for level of grain fed. The variation within lot was almost as great as between treatments.

Table 2. Summary of Phase 1 (Wintering) C-22. 126 Days.

Treatment Lots	HM Oats 9	Oats 8	Barley 4
Initial weight lb.	329	322	325
Final weight lb.	471	484	509
Average daily gain, lb.	1.13	1.29	1.35
Supp. per day, lb.	3.74	3.74	3.84
Grain per day, lb.	2.64[3]	2.00	2.07
Silage per day, lb.[1]	13.0	12.0	14.2
TDN/lb. gain, lb.	5.0	4.2	4.2
TDN c/m/lb., lb.[2]	2.1	1.7	1.8
Lots	**11**	**12**	**13**
Initial weight lb.	325	326	332
Final weight lb.	518	507	523
Average daily gain, lb.	1.53	1.44	1.52
Supp. per day, lb.	2.9	2.9	2.9
Grain per day, lb.	4.75[3]	5.12	5.12
Silage per day, lb.[1]	8.7	8.1	9.1
TDN/lb. gain lb.	4.4	4.4	4.4
TDN c/m/lb., lb.[1]	2.2	2.1	2.1

[1]Silage averaged 33% dry matter.
[2]TDN c/m means corrected for maintenance requirements.
[3]Corrected to 90 % dry matter basis.

More interesting in this phase of the experiment was the efficiency of the steers. Subtracting the energy requirement for maintenance from the total digestible nutrients required for gain gives a TDN value for gain only (TDN c/m). This value showed that the steers receiving only two pounds of grain were slightly more efficient in energy use than the steers receiving the six-pound level, and that for some unexplained reason, the steers in lot 9 were slightly less efficient than lots 8 and 4. When treatments were averaged together, the efficiencies of the grains were similar (Table 3). When the data are combined by treatments as in Table 3, the gains show a slight advantage for

Table 3. Treatment summary, Phase 1, C-22, 126 days.

Treatment	HM Oats	Oats	Barley	2 lb. Grain	6 lb. Grain
Lots	**9,11**	**8,12**	**4,13**	**4,8,9**	**11,12,13**
Initial weight, lb.	327	324	328	325	328
Average daily gain, lb.[1]	1.33	1.36	1.43	1.26	1.50**
TDN/lb. gain, lb.	4.7	4.2	4.3	4.5	4.4
TDN c/m/lb., lb.[2]	2.1	1.9	2.0	1.9	2.2

[1]**Differences in gains (6 lbs. over 2 lbs.) highly significant.
[2]TDN c/m means corrected for maintenance requirements.

barley fed steers over those fed oats. A closer look at the results shows that the variation of gains within treatment is as great as between treatments in this experiment and one must conclude that there was no difference between grains in this phase.

A summary of the pertinent results from phase 2 (the fattening phase) of this experiment is presented in Tables 4 and 5. The steers fed the barley rations gained significantly faster (P = 0.05) than those fed oats in either form (2.58 lbs. vs. 2.29 lbs. per day). The barley-fed steers consumed more energy per day and this was very evident when the carcasses were evaluated at slaughter. Marbling was lacking in the steers fed the oats rations, reflecting lack of finish. Dressing percentages for the oats-fed steers were disappointing. Perhaps the design of the experiment should have been changed to allow for a longer finishing period for the steers on the oats rations.

Comparisons of the results obtained from the steers on the high moisture oats with those on conventional oats show the gains to be similar (2.28 vs. 2.30 pounds per day). The steers in lot 9 (Table 4) did not consume the oats on an energy basis, but in lot 11 the intake was better. The steers on the high moisture oats were slightly more efficient in feed utilization, as evidenced from less feed intake (lots 9, 11 vs. lots 8, 12; Table 5) and by the TDN required per pound of gain or the TDN c/m values. Apparently, the estimation of 75 per cent TDN for the barley and 70 per cent for the oats was reasonable. Adding 30 per cent of a pelleted molasses beet pulp to the rations reduced the intake of grain but did result in greater energy intake for the oats-fed lots, but did not increase feed efficiency.

In measuring the "carry-over" effect of feeding two vs. six pounds of grain during the wintering phase on the gains during the fattening period, the differences were not as great as anticipated. The steers on the two pound per day level tended to catch up. These steers gained 1.26 pounds per day during the wintering phase and 2.44 pounds per day during the fattening. The steers on the six pound per day level during wintering gained 1.50 pounds per day and slightly less, 2.36 pounds per day during the fattening phase. Thus, the steers wintered at the lower energy level tended to compensate by increasing gain during the fattening period. The design of the experiment did not permit any measure of feed efficiencies of this treatment.

Although all the steers were fed the same amount of Vitamin A in the supplement, the oats fed steers had larger liver stores at slaughter than those fed barley. Use of beet pulp did not appear to have any effect (Table 5).

EXPERIMENT C-24

Methods

To get more information on the use of high-moisture oats and the effectiveness of zinc bacitracin in preventing foot rot and liver abscesses, 36 Hereford heifer calves were purchased for an experiment of a 2 X 3 factorial design. The grain treatments were as those used in Experiment C-22,

Table 4. Summary of results, C-22, Phase 2 (fattening) 210 days.

Treatment	No Beet Pulp			30% Beet Pulp		
Lots	HM Oats 9	Oats 8	Barley 4	HM Oats 11	Oats 12	Barley 13
Initial weight, lb.	491	501	532	498	490	504
Final weight, lb.	937	983	1082	1011	971	1020
Average daily gain, lb.*	2.12	2.30	2.62	2.44	2.29	2.54
Supp. per day, lb.	2.9	2.9	2.9	2.9	2.9	3.0
Grain per day, lb.	13.7[1]	14.8	14.4	10.7[1]	11.4	10.4
Beet pulp per day, lb.	—	—	—	4.6	4.2	4.0
Total feed/day, lb.	16.6	17.7	17.3	18.2	18.5	17.4
Total feed/lb. lb.	7.83	7.70	6.60	7.46	8.08	6.85
TDN/lb. gain, lb.	4.92	5.16	4.72	4.81	5.44	4.89
TDN c/m/lb., lb.	2.58	2.94	2.94	2.68	3.22	2.87
Footrot-cases	2	1	1	1	1	1
Abscess livers, no.	3	1	1	3	1	0
Dressing %[2]	53.5	54.5	58.7	56.7	57.9	58.6
U.S. Grade[3]	8	8	10	8	9	9
Vitamin A u/gm liver[4]	23	24	8	22	28	13

[1]Corrected to 90% dry matter.
[2]Calculated on hot carcass weights.
[3]8 equals average good, 9 equals high good, 10 equals low choice, etc.
[4]Measured as micrograms per gram wet liver.
*Barley significantly better than oats (P = 0.05).

Table 5. Summary by treatments, Experiment C-22, Phase 2.

Treatment	HM Oats[1]	Oats	Barley	No Beet Pulp	+30% Beet Pulp
Lots	9,11	8,12	4,13	4,8,9	11,12,13
Initial weight, lb.	495	496	518	508	497
Final weight, lb.	974	977	1051	1000	1000
Average daily gain, lb.*	2.28	2.30	2.58	2.35	2.42
Supp. per day, lb.	2.9	2.9	2.9	2.9	2.9
Grain per day, lb.	12.2	13.1	12.4	14.3	10.8
Beet pulp per day, lb.	2.3	2.1	2.0	0.0	4.3
Total feed/day, lb.	17.4	18.1	17.4	17.2	18.0
Total feed/lb., lb.	7.63	7.87	6.72	7.32	7.45
TDN/lb. gain, lb.	4.87	5.23	4.81	4.93	5.05
TDN c/m/lb., lb.	2.63	3.08	2.91	2.82	2.92
Foot rot - cases	3	2	2	4	3
Abscess livers, no.	6	2	1	5	4
Dressing %[2]	55.1	56.2	58.7	55.6	57.7
U.S. Grade[3]	8	8.5	9.5	8.7	8.7
Vitamin A u/gm liver[4]	24	26	16	22	21

[1]Corrected to 90% dry matter.
[2]Calculated on hot carcass weights.
[3]8 equals average good, 9 equals high good, 10 equals low choice, etc.
[4]Measured as micrograms per gram wet liver
*Barley significantly better than oats (P—0.05).

but the replicate lots received zinc bacitracin instead of different amounts of grain or beet pulp.

Procedures for handling and weighing were similar to those reported for Experiment C-22.

Because the "high moisture" oats matured and dried more rapidly than expected during the excellent harvesting weather, the oats were too dry when harvest was completed. A calculation was made as to the amount of water to add in order to get a moisture content of 25 to 27 per cent. The water was metered and added as a spray as the oats were circulated by using the bottom unloader over to the elevator and back to the top of the Harvestor bin. Reasonable success was achieved in bringing the oats to the desired moisture content for this experiment (25 per cent average moisture as fed).

The supplement (C-24) was formulated to be fed at level of three pounds per head daily. The formula was alfalfa (suncured), 50; soybean oil meal, 30; limestone, 3; dicalcium phosphate, 3; trace mineral salt, 3 and wheat bran, 10. Added to the wheat bran, which served as carrier, were stilbestrol to provide 10 mgm per head daily, Vitamin A to supply 15000 IU per head daily and Vitamin D to supply 1500 IU per head daily. Supplement C-25X was the same except each pound contained 23 mgm of zinc bacitracin per pound and was fed to replicate lots to provide 69 mgm of zinc bacitracin per head daily.

Silage was fed during phase 1. It was intended to use a legume grass silage (alfalfa) for this wintering phase, but because of spoilage, supplies were insufficient and a change was made. After depletion of the grass silage, all the lots were shifted to a mixed corn-sorghum silage. The legume silage contained 6.5 per cent protein and 35 per cent dry matter as fed. The corn-sorghum silage con-

Table 6. Summary of Results Phase 1 (Wintering) Exp. C-24, 105 days, 6 Heifers/Lot.

Treatment	No Antibiotic			69 mgm Zinc Bacitracin[1]		
Grain	HM Oats	Oats	Barley	Oats	Barley	HM Oats
Lots	1	2	3	4	5	6
Initial wt., lb.	389	385	384	384	383	385
Final wt., lb.	545	551	537	537	533	536
Ave. daily gain, lb.	1.49	1.58	1.46	1.46	1.43	1.44
TDN/lb. gain lb.	4.9	4.7	5.0	5.0	5.0	5.0
TDN c/m/lb[3]	2.5	2.5	2.5	2.6	2.6	2.6
Supp./day, lb.	2.8	2.8	2.8	3.0	3.0	3.0
Grain/day, lb.	3.8[4]	3.9	3.6	3.9	3.6	3.7[4]
Silage/day, lb.[2]	20.0	20.0	20.0	20.0	20.0	20.0
Beet pulp	0.3	0.2	0.2	0.2	0.2	0.3

[1]Fed only last two periods (42 days).
[2]Silage offered — wastage not weighed back.
[3]TDN corrected for maintenance requirements.
[4]High moisture oats corrected to 90% dry matter.

Table 7. Summary of Results Phase 2 (Fattening) Exp. C-24, 147 days, 6 Heifers/Lot.

Treatment	No Antibiotic			69 Mgm Zinc Bacitracin		
Grain Lots	HM Oats[1] 1	Oats 2	Barley 3	Oats 4	Barley 5	HM Oats[1] 6
Initial wt., lb.	545	551	537	537	533	536
Final wt., lb.	858	869	844	840	845	844
Ave. daily gain, lb.	2.13	2.17	2.09	2.06	2.12	2.10
TDN/lb. gain, lb.	5.54	5.27	5.12	5.53	5.05	5.49
TDN c/m/lb., lb.[2]	3.23	3.00	2.83	3.20	2.80	3.19
Feed/lb. gain, lb.	8.16	7.79	7.23	8.17	7.14	8.09
Feed/day, lb.	17.36	16.87	15.12	16.85	15.14	16.96
Supp. lb.	2.96	2.96	2.99	2.96	2.96	2.96
Grain, lb.	12.42	11.93	10.15	11.91	10.20	12.02
Beet pulp, lb.	1.98	1.98	1.98	1.98	1.98	1.98
Abscessed livers	1	2	4	0	2	1
Dressing %[3]	56.5	56.8	57.9	55.9	58.0	56.5
U.S. Grade[4]	9	9.3	9.3	9.2	8.3	8.8
Vit. A u/gm[5]	3.7	3.3	2.7	3.0	2.3	3.8

[1]High moisture oats (25% moisture) corrected to 90% dry matter.
[2]TDN corrected for maintenance requirement.
[3]Calculated on hot carcass weights.
[4]8 equals average good, 9 equals high good, 10 equals low choice, etc.
[5]Vitamin A reported as micrograms per gram of wet liver.

tained about 1.8 per cent protein and dry matter as fed of about 26 per cent.

Results — Experiment C-24

The gain of the heifers during the growing-wintering phase was very satisfactory. The pertinent results are summarized in Table 6. Statistical analysis indicated no real difference between gains of the lots receiving the different grains. This is in agreement with other experiments that when limited amounts of grain were fed with silage, all grains had similar values. The feed efficiencies were very good when it is considered that some of the silage offered was wasted and not consumed. It was not possible to accurately weigh back the feed refusal.

The zinc bacitracin was included only the last 42 days of phase 1. For this period there were no noticable effects of adding the antibiotic.

The pertinent results of phase 2, the fattening phase, are summarized in Tables 7 and 8. The heifers were of the smaller, early maturing type that appeared finished at sale weights of 850 pounds. The efficiency of feed conversion was only fair for the cattle during this period. The barley-fed heifers (lots 3 and 5, Table 7) were slightly above average when the TDN required per pound of gain and corrected for maintenance requirement (TDN c/m) was considered. In these calculations, barley was estimated to have 75 per cent TDN and the oats, on a 90 per cent dry matter basis, 70 per cent TDN. Since the supplement

Table 8. Summary of results by treatment, Experiment C-21, Phase 2.

Treatment Lots	HM Oats[1] 1,6	Oats 2,4	Barley 3,5	No Antibiotic 1,2,3	Plus Antibiotic 4,5,6
Initial weight, lb.	541	544	536	544	535
Final weight, lb.	851	855	845	857	843
Average daily gain, lb.	2.12	2.12	2.11	2.13	2.08
TDN/lb. gain, lb.	5.51	5.40	5.09	5.31	5.36
TDN c/m/lb., lb.[2]	3.21	3.10	2.81	3.02	3.06
Feed/lb. gain, lb.	8.13	7.98	7.18	7.73	7.80
Feed/day, lb.	17.16	16.86	15.13	16.45	16.32
Supplement, lb.	2.96	2.96	2.97	2.97	2.96
Grain, lb.	12.22	11.92	10.18	11.50	11.38
Beet pulp, lb.	1.98	1.98	1.98	1.98	1.98
Abscess livers, no.	2	2	6	7	3
Dressing %[3]	56.5	56.4	57.9	57.1	56.8
U.S. Grade[4]	8.9	9.3	8.8	9.2	8.8
Vitamin A u/gh[5]	3.8	3.2	2.5	3.2	3.0

[1]High moisture oats (25% moisture) corrected to 90% dry matter.
[2]TDN corrected for maintenance requirement.
[3]Calculated on hot carcass weights.
[4]8 equals average good, 9 equals high good, 10 equals low choice, etc.
[5]Vitamin A reported as micrograms per gram of wet liver.

and molasses beet pulp were fed in equal amounts and only the grain varied between lots, it is logical to assume that any differences in energy use was due to the grain consumed. The oats were all harvested from the same field. On a 90 per cent dry matter basis, the oats averaged 30.1 pounds per bushel with protein levels of 11.4 per cent and crude fiber at 13.4 per cent. These figures indicate that the oats were poorer than ordinarily harvested in North Dakota. The barley was poorer than usual, averaging 42.8 pounds per bushel, with protein and fiber of 13.0 and 7.3 per cent, respectively. Thus, it is likely that the oats were overevaluated by 8 per cent and actually contained 65 per cent TDN.

There were no significant differences between gains of the various lots (2.12 pounds, 2.12 pounds and 2.11 pounds per day for HM oats, oats and barley, respectively). In contrast to the steers in the previous trial, the heifers on this experiment were consuming grain on an energy basis. They consumed enough more pounds of oats to make equal gains compared to the barley lots. The TDN c/m as reported in Table 8 shows the oats-fed lots to be much less efficient, but if the TDN for oats is considered as 65 per cent instead of 70 per cent, the efficiencies are similar and the TDN intake per day can be calculated to show only a 0.2 pound TDN variation in daily intake of energy. None of the lots were as efficient in feed conversion as expected. Even the barley-fed lots required 7.18 pounds of feed per pound of gain and a TDN c/m of 2.81 pounds per pound of gain. For comparison, the steers finished to 1,050 pounds required 6.72 pounds of feed per pound of gain (Table 5), or lot 4 of the steers (Table 4) required only 6.60 pounds when fed similar rations.

The carcass data were disappointing. The dressing per cent was poor and the carcass grades averaged only about high good. Lack of marbling reflected lack of finish in all lots.

As reported in previous experiments, zinc bacitracin had no effect on gain nor feed efficiency. There was no trouble with foot rot, so no measure could be made of effectiveness of the antibiotic in preventing this condition. However, zinc bacitracin appeared to reduce the incidence of abscessed livers. Only three out of 18 livers were abscessed in the antibiotic fed lots, as compared to seven out of 18 in the control lots. This was a reduction of over 50 per cent in the incidence of abscesses.

The Vitamin A content of the livers, reported as micrograms per gram of wet liver, was less than usual. However, no symptoms of deficiency were noted. It is interesting to note that as in the previous experiment, all lots received the same Vitamin A supplementation, the barley fed lots also had less Vitamin A stores.

Discussion

The results from these two experiments suggest no real differences in the feed value of high moisture oats stored in sealed oxygen-free storage and conventionally harvested oats when compared on equal dry-matter basis. The variation between the two forms was less than two per cent. A measure of dry matter loss of oats in the sealed storage showed that storage losses were negligible (less than one per cent).

In comparisons of oats (either dry or high moisture) to barley as the sole grain for fattening, the results were different between the two experiments. In Experiment C-22, the steers did not consume enough more oats to have similar energy intakes to those fed barley. In this experiment, it took 15 per cent more feed per pound of gain and they gained 11 per cent slower. Yet, the oats fed to the steers were plump, heavy oats, whereas the barley quality was only fair. In contrast, the heifers (Exp. C-24) receiving the poor quality oats did eat on energy basis and gained as well as those fed barley. However, it took over 11 per cent more feed per pound of gain. Oats usually contain about 30 per cent hull by weight as compared to 15 per cent for barley. It is understandable that oats would have a lower digestible energy content and require more feed per pound of gain. However, in rations where roughage is fed in limited amounts, this extra hull content should act as a "built-in" roughage and permit intake on an energy rather than pounds of feed basis. This happened in only one of the experiments reported here. Further research is needed to determine why the variability of intake on oats when it is used as the only grain.

The use of zinc bacitracin did reduce the incidence of abscessed livers by over 50 per cent in Experiment C-24. No effect was noted on feed intake or rate of gain.

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