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Sprouted Wheat

Its Nutritive Value For Beef, Swine, Poultry

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Summary

This study evaluated the effects of sprouting on feeding value of Gaines wheat for yearling steers, weanling pigs, and 2-day-old chicks. Replacement of normal wheat in the diets with wheat containing 60 percent sprouted kernels did not reduce weight gains of cattle, swine, or poultry.

Efficiency of gains of steers and chicks was apparently not affected by sprouted wheat. With swine, however, feed required per unit body gain increased with increasing amounts of sprouted wheat. A statistical evaluation of feed efficiency was not possible for swine and cattle, since the animals were group fed.

The metabolizable energy for combinations of normal and sprouted wheat was significantly higher ($P \leq .05$) than when either was fed alone to chicks. Coefficients of digestion with cattle were slightly higher for dry matter, fiber, NFE, and ash for the diet containing sprouted wheat.

The data show that wheat sprouted to the extent of that used in this study contains essentially the same feeding value as normal wheat per unit weight for cattle, swine, and poultry. Reduced test weight represents the major loss due to sprouting.

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Adverse moisture conditions during harvest sometimes cause grain to sprout in the head. During the 1968 harvest season, unusually rainy weather occurred in much of Idaho and a large amount of sprouted wheat unsuitable for milling purposes became available for livestock feeding.

U.S. grade standards discount wheat on the basis of percent of sprouted kernels. Wheat showing more than 2 percent sprouted kernels is classified as sprouted wheat. Grade is lowered with increased sprouting until, at 15 percent, the grain is classified as sample grade. In 1968, sample grade wheat was discounted 14 cents per bushel. Wheat having over 50 percent sprouted kernels could have received a maximum discount of 45 cents per bushel.

When discounts due to sprouting drop the price of wheat, the nutritive value of the sprouted wheat should be evaluated to establish a fair price to both livestock feeders and grain growers. To date, only limited information on feeding value of sprouted wheat has been reported, and none has been reported for cattle and swine.

The purpose of the studies reported here was to obtain data which could be used in determining value of sprouted wheat for livestock feeds.

Literature Review

Previous experiments at the University of Idaho have demonstrated that high levels of normal wheat can be used satisfactorily in cattle finishing rations (Dahmen, Keith, and Bell, 1965a). Gaines wheat at levels up to 74 percent of the ration produced acceptable gains in yearling cattle (Bris and Dyer, 1967).

Little has been reported on the effects of sprouting or other weathering on wheat feeding value. Swanson (1942) noted that a weathered appearance of wheat was not sufficient criteria for discounting grain unless other reasons for discount were evident. Artificially imposed sprouting of Avon wheat did not change its nutritive value for chicks as measured by chick gain, feed efficiency, or metabolizable energy content (Sibbald, Slinger, and Pepper, 1962).

Bartlett (1917) reported that 14.5 percent dry matter was lost by artificially sprouting oats to increase its nutritive value for chickens. Nutrient losses included 3.5 percent of crude protein, 27 percent of nitrogen-free extract, and 12.8 percent of fat. Cheldelin and Lane (1943) also observed that sprouted grains tend to contain less dry matter.

The effects of freezing and molding on feeding value of grains have been studied much more extensively. Whiting and Bezeau (1954) found no reduction in net protein utilization by pigs fed frost-damaged or early harvested wheat. However, digestible energy was reduced significantly. Daily gains and feed efficiency of swine were also not affected by moldy oats or moldy wheat, though lambs fed moldy oats made slower and less efficient gains (Jones et al., 1955). No differences were observed in animal acceptance of moldy or non-moldy grain.

Whiting (1957) summarized the comparative feed values of damaged and non-damaged grains for cattle, sheep, swine, and poultry and concluded that sprouted grain had a feeding value similar to that of frozen grains of equal weight per bushel. Estimates of feed value of frozen wheat as a percent of normal wheat ranged from 87 to 96 percent for cattle and sheep, 67 to 100 percent for swine, 78 to 99 percent for poultry.

Bell (1958) concluded that the reduced feeding value of frozen wheat could be attributed to the preponderance of bran and shorts as opposed to endosperm, which reduced the amount of available energy.

Experimental Procedure

Experiments were conducted with cattle, swine, and poultry using Gaines soft white winter wheat. Both normal and sprouted wheat were obtained from the same field in southern Idaho, the only difference being that the normal wheat was harvested before the rain and the sprouted wheat after the rain. Sprouted wheat was classified by grain dealers as having 60 percent sprouted kernels. The wheat was characterized and analyzed chemically to determine changes which had occurred during sprouting.

Beef Cattle Experiments

Experimental rations (Table 1) containing 60 percent wheat were fed free-choice for 140 days to 40 yearling steers at the Caldwell Branch Experiment Station. Initial average weight of the steers was 744 pounds.

The dietary treatments were (1) only nonsprouted wheat; (2) 1/3 sprouted wheat; (3) 2/3 sprouted wheat; and (4) only sprouted wheat.

Ten steers were randomly allotted to each treatment. The steers were group-fed and feed consumption was recorded by group. The animals were weighed individually every 28 days. Carcass measurements were obtain following slaughter.

Table 1. Compositon of rations fed to yearling steers.[1]

Feed ingredients	Treatments			
	1	2	3	4
	%	%	%	%
Sprouted wheat[2]	0.0	20.0	40.0	60.0
Nonsprouted wheat	60.0	40.0	20.0	0.0
Dried molasses beet pulp	28.0	28.0	28.0	28.0
Alfalfa hay	10.0	10.0	10.0	10.0
Dicalcium phosphate	1.0	1.0	1.0	1.0
Trace mineralized salt	1.0	1.0	1.0	1.0
Vitamin A[3]	+	+	+	+

[1] Each steer implanted with 30 mg. DES at beginning of trial.
[2] Sprouted wheat contained 60% sprouted kernels.
[3] Added to supply 20,000 IU per head per day.

Digestibility of the nutrients in sprouted and nonsprouted wheat was compared in a 10-day trial conducted at the University's livestock research barns in Moscow using diets 1 and 4 (Table 1). Experimental animals were comparable to the steers used in the feeding trial. Fecal bags were used to collect feces. Aliquots were taken from 12-hour collections and mixed to make a composite sample for each 24-hour period.

Swine

Forty weanling pigs were randomly allotted to four different rations containing 50 percent wheat. Wheat treatments were (1) only nonsprouted wheat; (2) 1/3 sprouted wheat; (3) 2/3 sprouted wheat; and (4) only sprouted wheat. Each ration was formulated to a specified nutrient level (Table 2).

All rations were pelleted and fed free-choice to the pigs from an initial weight of approximately 61 pounds until they reached a final weight of 205 pounds. Body weights and feed consumption were recorded to assess rate and efficiency of gain.

Poultry

Sprouted and non-sprouted wheat were compared in a high-energy starter ration containing 61 percent Gaines wheat (Table 3). Wheat treatments were (1) only non-sprouted wheat; (2) 1/4 sprouted wheat; (3) 1/2 sprouted wheat; (4) 3/4 sprouted wheat; and (5) only sprouted wheat.

A group of 200 White Leghorn cockerel chicks was housed in a battery at one day of age and fed the normal (non-sprouted) wheat diet

Table 2. Composition of rations fed to weanling pigs.

Ingredient	Treatments			
	1	2	3	4
Sprouted wheat[1]	0.00	16.67	33.33	50.00
Nonsprouted wheat	50.00	33.33	16.67	0.00
Oats	34.94	34.94	34.94	34.94
Cottonseed meal	11.67	11.67	11.67	11.67
Dehydrated alfalfa	0.34	0.34	0.34	0.34
Limestone	0.98	0.98	0.98	0.98
Defluorinated phosphate	0.95	0.95	0.95	0.95
Vitamin mix	0.11	0.11	0.11	0.11
Methionine	0.22	0.22	0.22	0.22
Lysine	0.29	0.29	0.29	0.29
Trace mineralized salt	0.50	0.50	0.50	0.50

[1]Sprouted wheat contained 60% sprouted kernels.

Table 3. Composition of basal diet fed to chicks in evaluation of normal and sprouted wheat.[1]

Ingredient	Percent of diet
Normal wheat	61.00
Dehydrated alfalfa meal	2.50
Soybean meal (48%)	22.00
Herring fish meal	5.00
Meat and bone scraps	5.00
Stabilized animal fat	2.50
Trace mineralized salt	0.25
Limestone	0.75
Vitamin concentrate[2]	1.00

[1]Chromic oxide added at 0.2 percent level for use in metabolizable energy determinations.
[2]Supplied adequate amounts of A,D,E,K, riboflavin, niacin, pontothenic acid, choline and B_{12}.

for two days. All chicks were then individually weighed and 150 were assigned to the experimental lots so that each lot contained 15 chicks of similar weights.

Duplicate lots were fed the experimental rations for 28 days. Feed and water were supplied free-choice, and feed consumption was recorded for each lot. Body weights were recorded at 7, 14, 21, and 28 days. Chromic oxide was added to the diets 10 days before a 3-day fecal collection period. Metabolizable energy was determined by the procedure of Hill and Anderson (1958).

Results and Discussion

Characterization of Wheat

Samples of the nonsprouted and sprouted Gaines wheat used in the feeding trials were subjected to physical and chemical tests to identify changes which occurred as a result of sprouting.

Normal wheat had a test weight of 60.4 pounds per bushel. Sprouted wheat weighed 55.9 pounds per bushel.

Results of the analyses are shown in Table 4. Protein, crude fiber, and fat were slightly higher in the sprouted wheat and nitrogen-free extract (NFE) was lower. These changes that occurred during sprouting agree with what happens during the first stages of respiration. Respiratory losses of carbon dioxide and heat occur in the conversion of starch to sugar during early stages of sprouting. This would explain the loss in NFE, which includes sugars and starches, and the larger percentage values for protein, ash, and fat, which are not changed appreciably during early sprouting. Increased enzymatic activity

Table 4. Chemical composition and dry matter of sprouted and nonsprouted Gaines soft white winter wheat.

	Nonsprouted[1]	Sprouted[2]
Dry matter	92.99	92.01
Protein	12.32	13.16
Fat	0.79	0.88
Crude fiber	3.22	3.57
Ash	2.19	1.93
NFE	74.47	72.47
Ca	1.88	1.56
P	1.16	1.24

[1] Test weight nonsprouted wheat 60.4 pounds per bushel.
[2] Test weight sprouted wheat 55.9 pounds per bushel.

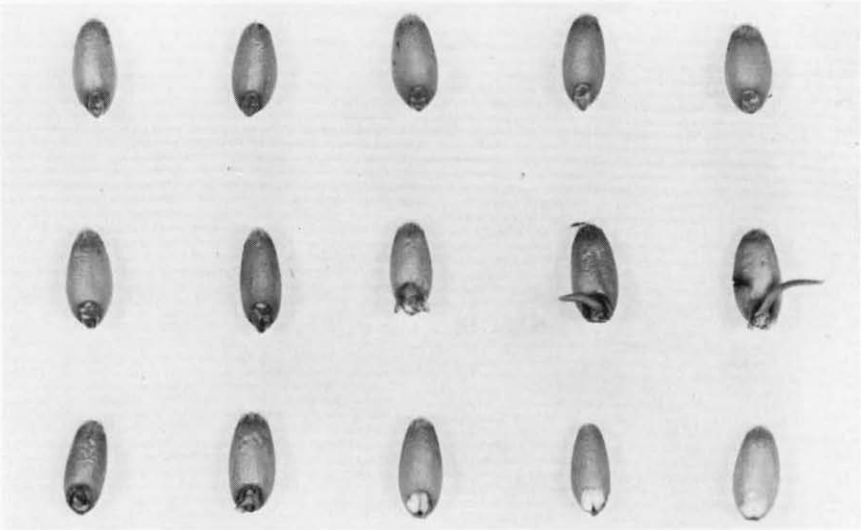

Fig. 1. Sprouted and unsprouted grain are difficult to distinguish without close examination. Gaines wheat kernels in the top row are normal. Those in the other two rows are sprouted. The middle row includes kernels with obvious sprouts and kernels with a broken germ face as a result of coleoptile expansion. A visible sprout is not required as a grading factor, provided sprout development is evident under the split pericarp covering the germ (kernels at left, middle row). If the pericarp is not split, as in the top row, the kernel is considered not to have germinated. Kernels from which sprouts have broken off (bottom row) are graded as sprouted wheat.

Table 5. Chemical composition and test weight of Gaines soft white winter wheat at 0, 25, 50, and 75 percent sprouting, 1968 harvest. [1]

Lot No. [2]	Sprouted kernels	Test weight	Protein	Ash	Fat	Crude fiber	Nitrogen free extract
	%	lb.	%	%	%	%	%
1	0	59.3	10.48	1.33	1.32	2.57	74.75
2	25	56.2	10.64	1.53	1.40	2.65	74.39
3	50	55.8	10.91	1.54	1.37	2.74	73.74
4	75	54.2	10.94	1.60	1.42	2.73	73.81

[1] From Murray and Huber (1968).
[2] Each level of sprouting represents a composite of approximately five separate grain samples received from Ogden, Utah.

and synthesis during early stage of germination could account for some of the increase in protein content. Other samples of Gaines wheat from southern Idaho (Twin Falls, Burley, and American Falls areas) submitted to the University of Idaho for analysis during the 1968 harvest season showed similar changes in chemical composition (Table 5).

Reductions in test weight with increasing percent of sprouting likely were caused in part by dry matter loss in the form of CO_2 and heat. Loss of sprouts from kernels would also contribute to a reduced test weight. Some of the reduction in test weight may have been caused by incomplete shrinking of the wheat kernel as absorbed moisture was lost. Failure of swollen kernels to shrink back to original size as water is lost would result in a less dense wheat.

Moisture content of sprouted wheat (Table 4) did not differ appreciably from normal wheat and did not present any problems in storage. Mold organisms require moisture levels considerably higher than those observed in the samples tested. This explains why Murray and Huber (1968) found only common airborne fungi on moldy wheat samples taken from the field in various wheat growing areas of Idaho. About the same amounts of **Alternaria, Stemphyllium, and Fusarium,** (the primary molds isolated) were present on grain harvested before the rains as after. Spores of these fungi are common contaminants of cereal grains; however, because of the moist conditions, the organisms grew profusely and were more obvious in 1968.

Aflatoxin (**Aspergillus flavus** Link ex Fries), a mold that produces toxin harmful to animals in stored grains of 16 percent moisture or above, was not isolated from any of the wheat samples tested.

The observations on mold organisms indicate that no harmful effects should result from feeding grain similar to wheat samples analyzed.

Tests performed at the Idaho State Laboratory at Boise on wheat used in the feeding trials showed that nonsprouted wheat had a germination rate of 84 percent, whereas sprouted wheat had a rate of 44 percent. The low germination rate of sprouted wheat indicates that it would be worthless for seed.

Falling number, which indicates degree of sprouting, was determined on sprouted and nonsprouted wheat at the Aberdeen Branch Station. Falling numbers ranged from 80 to 98 for wheat classified as 60 percent sprouted. These are quite low and confirm that the wheat was well sprouted. Nonsprouted wheat had an average falling number of 310.

Inspection of sprouted wheat used in the feeding trials showed that 60 percent or more of the kernels were sprouted. However, many of the sprouts were just beginning to appear and could be seen only by close observation. The general appearance of the sprouted wheat was not greatly different from the normal wheat.

Even though the sprouted wheat appeared much the same as normal wheat, it was classified as **sample** grade wheat and could have re-

ceived a maximum discount of 45 cents a bushel. Wheat similar to lot numbers 2, 3, and 4 (Table 5) could be discounted at least 18, 30, and 45 cents per bushel, respectively, based on test weight and percent of sprouted kernels.

Table 6. Average daily gain by weigh periods of steers fed normal or sprouted wheat.

Weigh periods	Percent sprouted wheat in diet			
	0	20	40	60
	lb.	lb.	lb.	lb.
28 days	4.32	3.41	3.50	3.71
56 days	2.18	2.55	2.68	1.95
84 days	1.29	1.43	1.36	1.66
112 days	2.91	3.02	3.13	2.73
140 days	0.72	1.15	1.48	1.69
Average daily gain	2.29	2.32	2.44	2.35

Table 7. Average feed consumption by weigh periods of steers fed normal or sprouted wheat. [1, 2]

Weigh periods		Percent sprouted wheat in diet			
		0	20	40	60
28 days	Hay, lb.	101	102	103	107
	Conc., lb.	453	425	466	491
	Total	554	527	569	598
56 days	Hay, lb.	58	56	58	58
	Conc., lb.	515	497	530	517
	Total	573	553	588	575
84 days	Hay, lb.	54	52	53	52
	Conc., lb.	485	465	472	482
	Total	539	517	515	534
112 days	Hay, lb.	58	58	58	58
	Conc., lb.	518	515	509	514
	Total	576	573	567	572
140 days	Hay, lb.	56	57	56	57
	Conc., lb.	501	513	503	517
	Total	557	570	559	574

[1] Hay and concentrate fed separately but in ratio shown in Table 1. Extra hay used in first period to bring cattle to full feed.
[2] Ten steers group fed in each group.

Cattle Experiments

Average daily gain and average feed consumed by weigh periods are shown in Tables 6 and 7. Weight gain and efficiency of gain data are shown in Table 8. No real differences were apparent in the performance of cattle on different treatments as the feeding trial progressed. The cattle on normal wheat made slightly faster gains during the first 28-day period on nearly the same amount of feed and slower gains during the last period. Unfavorable weather conditions may have contributed to lower and less efficient gains during the third and fifth periods. There appeared to be a trend for increased gains by steers receiving increasing amounts of sprouted wheat during those periods of lowered gains. Level of sprouted wheat in the diet did not affect any of the carcass characteristics studied (Table 9).

The digestion trial included three steers fed normal wheat and three steers fed sprouted wheat during January 1969. Because extremely cold weather made it difficult to keep all animals on feed, data from only two animals per treatment were used in evaluating digestibility of sprouted wheat. Results (Table 10) indicate that apparent digestion of crude protein was not affected by sprouted wheat. There appeared to be a trend toward greater digestion of total dry matter, fiber, nitrogen-free extract, and ash in the diet containing sprouted wheat. These differences were not reflected in live animal performance in the feeding trials. However, average rate of gain and efficiency of gain of animals receiving sprouted wheat were equal to or slightly higher than those for nonsprouted wheat.

Results of the cattle experiments indicate that wheat in which 60 percent of the kernels were sprouted had a feed value for cattle equal to that of nonsprouted wheat. Gains during the 140-day feeding trial with sprouted wheat were comparable to those in previous tests with normal wheat (Dahmen et al., 1965b, Bris and Dyer, 1967).

Table 8. Weight gain and efficiency of gain of yearling steers fed normal or sprouted wheat.

Percent sprouted wheat	Number of animals	Initial live weight	Final live weight	Total gain	Average daily gain	Feed per pound gain
		lb.	lb.	lb.	lb.	lb.
0	10	729	1048	319	2.28	8.94
20	10	751	1073	322	2.30	8.56
40	10	742	1080	338	2.41	8.46
60	10	753	1080	327	2.34	8.89

Table 9. Average carcass measurements obtained at slaughter from steers fed normal or sprouted wheat.

Carcass Measurements	Percent sprouted wheat in diet			
	0	20	40	60
Hot carcass weight, lb.	641	662	660	653
Chilled carcass weight, lb.	633	654	652	644
Dressing percent (chilled wt.)	60.4	60.9	60.3	59.5
Carcass quality grade[1]	10.0	9.9	10.4	10.2
Loin eye area, sq. in.	12.0	12.1	12.1	11.7
Marbling score[2]	5.1	4.8	5.4	5.3
Maturity[3]	1.8	1.7	1.3	1.9
Fat thickness, 12th rib, in.	0.71	0.77	0.69	0.68
Kidney fat, %	2.9	3.0	3.0	3.1
Carcass yield grade[4]	3.4	3.7	3.4	3.5
Incidence of abscessed liver, %	70.0	70.0	40.0	80.0

[1] Based on numerical scores: Prime 14; Choice 11; Good 8
[2] Based on numerical scores: Slight amount 4; Small amount 5; Modest amount 6
[3] Based on numerical score: 1 youngest (A-); 6 oldest (B+)
[4] Based on numerical scores: Highest cutability 1; Lowest cutability 5.

Table 10. Coefficients of digestion by yearling steers of diets containing either 60 percent normal or 60 percent sprouted wheat.[1]

	Dry matter	Protein	Crude fiber	Ash	N-free extract
Normal wheat					
Steer no. 4	70.0	90.2	37.7	39.4	73.6
Steer no. 5	75.4	93.2	42.7	42.4	79.1
Average	72.7	91.7	40.2	40.9	76.4
Sprouted wheat					
Steer no. 1	75.8	91.2	48.4	52.1	79.0
Steer no. 3	76.4	92.6	45.2	43.1	83.0
Average	76.1	91.9	46.8	47.6	81.0

[1] Values represent 10 observations per animal.

Swine

The average daily gain of swine was not affected by feeding sprouted grain, either as the sole source of wheat or in various combinations with normal wheat (Table 11). However, the feed required per unit body gain increased with increasing amounts of sprouted wheat in the ration. Approximately 8.4 percent more feed for each unit of gain was required when sprouted wheat was substituted for nonsprouted grain. Since the pigs were group fed, statistical analysis was not possible on feed efficiency. This makes it difficult to evaluate the significance of this difference.

Poultry

Two-day-old chicks were included in this evaluation because they would be sensitive to small changes in nutritive content of wheat. Substitution of sprouted for normal wheat at any level in their diet caused no differences in average gain or efficiency of feed utilization (Table 12). Thus, in terms of weight gain or feed efficiency, no deleterious effect was found from feeding sprouted wheat to young birds.

No significant difference in metabolizable energy was found between the two wheats when each made up 100 percent of the grain portion of the ration. However, metabolizable energy was significantly ($P \leq .05$) higher for combinations of sprouted and normal wheat than for either wheat fed alone. The chicks tended to metabolize more energy with the 1:1 ratio of the two grains, but there was no statistical difference in metabolizable energy when the ratios of normal to sprouted wheat were 1:3, 1:1, or 3:1.

Based upon the early chick growth data from this study and results obtained by Sibbald et al. (1962) with 2-week-old chicks, sprouted wheat can be used successfully in rations for poultry.

Table 11. Average weight gains and efficiency of gain of weanling pigs fed normal or sprouted wheat.

Percent sprouted wheat	No. of pigs per lot	Initial live weight	Slaughter weight	Average daily gain	Feed per lb. gain
		lb.	lb.	lb.	lb.
0	10(10)[1]	61.4	206.1	1.71	3.68
20	10(9)	58.1	204.4	1.65	3.83
40	10(10)	61.8	204.8	1.64	3.95
60	10(10)	62.5	208.1	1.72	3.99

[1] Number of animals completing the test.

Table 12. **Average weight gains and efficiency of gain of White Leghorn cockerel chicks fed normal or sprouted Gaines wheat to 4 weeks of age.**

Percent wheat in diet		Body weight	Feed per	Metabolizable
Normal	Sprouted	gain	lb. gain	energy[1]
%	%	lb.	lb.	Kcal/lb.
61.00	-----	0.89	2.07	1180[a]
45.75	15.25	0.92	1.95	1235[b]
30.50	30.50	0.89	2.06	1245[b]
15.25	45.75	0.90	2.05	1227[b]
-----	61.00	0.88	1.97	1187[a]

[1] Means with different letters differ significantly ($P \leq .05$).

General Discussion

Although results showed that sprouting of wheat did not noticeably affect performance of cattle, swine, and poultry, a word of caution is necessary in relation to the degree of sprouting (length of sprouts and duration of sprouting). The sprouted wheat used in these studies was classified as having 60 percent sprouted kernels. Yet, to the untrained observer, much of the grain appeared to be normal.

The nutritional value of wheat containing very long sprouts may be different from normal wheat. Loss of extremely long sprouts during handling might also affect the feed value.

Percentage of sprouted kernels alone is not an adequate measure of the effect of sprouting on nutritional value for livestock and should not be the only guide for discounting grain below feed grade prices.

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