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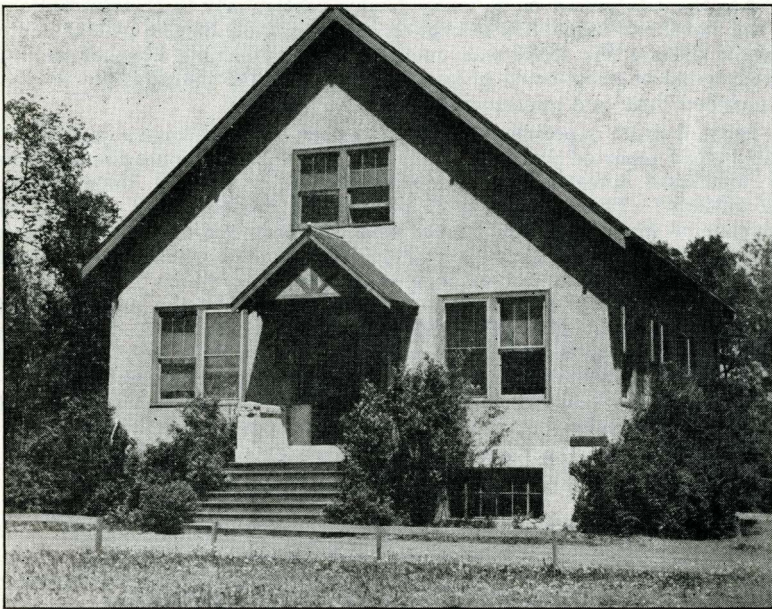
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Wheat and Wheat By-Products for Laying Hens

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Wheat and Wheat By-Products for Laying Hens

Wheat is the second largest grain crop in South Dakota and is grown extensively in many parts of the state. It has long been recognized as being second only to yellow corn as an individual grain for poultry. Wheat bran and middlings have for many years been a recognized part of starting, growing, and laying mash for chick and poultry feeding but definite experimental work on their actual individual values seems to be lacking.

As wheat is grown on so many farms, particularly in certain sections in the state, and as poultry is kept on approximately 85 per cent of South Dakota farms, this study was undertaken to determine whether ground wheat could be substituted in laying mash for the more commonly recommended bran and middlings.

Little definite experimental work has been done on this subject. Carrick' (1932) reported that in a "one year's test with Plymouth Rock pullets no significant differences in egg production were actually found for the two rations." This was where 35 per cent of ground wheat replaced 17 per cent of wheat bran and 18 per cent of wheat middlings in the mash part of two rations otherwise complete. The kind of wheat used was not reported, and the work did not include the use of additions of wheat bran and wheat middlings separately to replace one half of the ground wheat used in the mash. Halnan^{2,3} (1926) (1928) has shown in digestibility trials with wheats, using White Leghorn cockerels, that weak and strong wheats are equally suitable as sources of supply of food nutrients for poultry. A strong wheat is one that furnishes flour which has a good loaf value or which makes better bread than flour from a weak wheat.

Table I shows the percentages of nutrients in wheat, wheat bran, wheat middlings, flour, and for comparison whole yellow corn.

TABLE 1.—Percentages of nutrients in wheat, wheat bran,
wheat middlings, flour, and yellow corn

| | Moisture | Ash | Crude protein | Carbohydrates | | Fat |
|----------------------|----------|----------|---------------|---------------|------------------------|----------|
| | | | | Crude fibre | nitrogen-free extract. | |
| | per cent | per cent | per cent | per cent | per cent | per cent |
| Wheat ----- | 10.6 | 1.8 | 12.3 | 2.4 | 71.1 | 1.8 |
| Wheat bran ----- | 9.6 | 5.9 | 16.2 | 8.5 | 55.6 | 4.2 |
| Wheat middlings ---- | 10.1 | 3.5 | 16.3 | 4.3 | 61.6 | 4.2 |
| Flour ----- | 12.3 | 0.5 | 10.9 | 0.4 | 74.6 | 1.8 |
| Yellow corn ----- | 12.9 | 1.3 | 9.3 | 1.9 | 70.3 | 4.3 |

It is seen from the above table that bran and middlings are of considerably different composition than wheat and it would not be expected that ground wheat could satisfactorily replace an equal amount of 50 parts of bran and 50 parts of middlings in a ration otherwise complete. However, chemical analyses often prove of little value in determining the useful-

ness of any product for feeding purposes. Biological tests—feeding tests carried out, with laying birds in this particular study, under carefully controlled conditions—are essential to disclose the values. Biological tests often do not give the results expected when chemical analyses are used as the criterion.

Experimental.—The first experiment was started May 1, 1931 and lasted only four months until August 31. Twenty-eight S. C. White Leghorn hens and pullets made up each of four pens. These were equally divided among pens according to age, and in each age group by weights and previous productions so that the breeding of the birds in each pen was the same as far as could be controlled. It was inadvisable to use hens and pullets in this experiment but necessary because of a temporary shortage of pullets. Only some of the few birds which died during the trial were replaced but all records were computed on a hen-day basis. The rations used are given in Table II, the only variants being the ground wheat, wheat bran, and wheat middlings. In pens II and III, 30 per cent ground wheat was compared with 15 per cent each of bran and middlings; in Pen IV 15 per cent of bran was used with 15 per cent of ground wheat, and in Pen V 15 per cent of flour middlings was used with 15 per cent of ground wheat. These last two rations were used to determine whether either bran or flour middlings, when used with an equal amount of ground wheat, would give better results than 30 per cent of ground wheat in an otherwise complete ration.

TABLE 2.—Laying mash used in four pens—May 1 to August 31, 1931

| | Pen II per cent | Pen III per cent | Pen IV per cent | Pen V per cent |
|-----------------------------|--------------------|---------------------|--------------------|-------------------|
| Ground durum wheat ----- | 30 | | 15 | 15 |
| Wheat bran ----- | | 15 | 15 | |
| Wheat flour middlings ----- | | 15 | | 15 |
| Ground oats ----- | 10 | 10 | 10 | 10 |
| Ground yellow corn ----- | 34 | 34 | 34 | 34 |
| Meat and bone meal (50%) -- | 14 | 14 | 14 | 14 |
| Dried buttermilk ----- | 5 | 5 | 5 | 5 |
| Alfalfa meal ----- | 5 | 5 | 5 | 5 |
| Steamed bonemeal ----- | 1 | 1 | 1 | 1 |
| Common salt ----- | 1 | 1 | 1 | 1 |
| Totals ----- | 100 | 100 | 100 | 100 |

The mash was fed ad libitum (in front of hens at all times). The grain ration was the same for all pens and was fed in hoppers which were opened only half an hour late each afternoon. The grain mixture was made up of the following:

| | |
|-------------------------|----------|
| | per cent |
| Whole yellow corn ----- | 45 |
| Durum wheat ----- | 45 |
| Heavy oats ----- | 10 |
| | 100 |

Table III shows the feed consumption for both grain and mash and production per bird all on a hen day basis, for the four months of the experiment.

TABLE 3.—Results of four months experiment 1931
(All figures computed on a hen-day basis)

| Pen No. | Grain used | Mash used | Production |
|--|------------|-----------|------------|
| | per bird | per bird | per bird. |
| | pounds | pounds | eggs |
| II (ground wheat) ----- | 9.59 | 9.76 | 54 |
| III (bran and middlings) ----- | 9.92 | 10.15 | 58 |
| IV (bran and ground wheat) ----- | 9.96 | 11.18 | 50 |
| V (flour middlings and ground wheat) --- | 8.49 | 10.10 | 55 |

There was little difference in feed consumption of the various pens. Pen II and III used only slightly more mash than grain per bird, while in the other pens more than a pound more mash than grain was used.

No significant differences were found in egg production among any pens.

1931-32 Experimental Work

The second experiment started October 1, 1931, and was continued for almost eleven consecutive months until August 23, 1932. Fifty S. C. White Leghorn pullets of the College strain were used in each of the four pens. Pullets were equally divided among pens by weight, and production to the start of the experiment of those that had laid.

The mash rations for the four pens were similar to the previous experiment except that as the trial was to run through the winter one per cent of a tested cod liver oil was added to the mash of each pen, at the expense of an equal amount of ground yellow corn. This vitamin D supplement was continued until May 5, 1932, when it was considered no longer necessary as all of the pens in the west-wing of the main long house used had ample open window space to admit sufficient direct sunlight. Pullets were confined to their pens throughout the experiment.

The grain ration for all pens, while of the same composition as that of the previous trial, was fed differently. At the start of the experiment four pounds of grain were fed daily to each pen. However, this was insufficient and after three days five pounds were used. Approximately one-quarter of this was litter fed in the morning, the rest similarly fed in late afternoon. However, this system of grain feeding, after a long and accurate trial was criticized as it was difficult to properly balance the ratio of grain to mash and the number of birds in each pen varied. Accordingly, beginning with June 1, 1932, grain was again hopper fed ad libitum as was the laying mash.

Table IV shows the feed consumption for both grain and mash and production per bird all on a hen day basis, for the duration of the experiment. It is important to remember that only the variable parts of each mash ration, which made up only 30 per cent of the total, are shown in the table. In addition to these, other ground grains, animal proteins, and minerals were used as in the previous shorter experiment.

TABLE 4.—Mortality; mash, grain, and total feed consumption per pen, and average production per pullet for the 10 months and 23 days of the experiment. All figures on a hen day basis

| | Grain used per bird. | Mash Used per bird. | Total feed per bird. | Production per bird. | Mortalities per pen. |
|---------------------------|-------------------------|------------------------|-------------------------|-------------------------|-------------------------|
| Pen I | lbs. | lbs. | lbs. | Eggs | pullets |
| 30% ground wheat ----- | 39.99 | 29.00 | 68.99 | 172 | 17 |
| Pen II | | | | | |
| 15% wheat bran ----- | 34.85 | 31.26 | 66.11 | 169 | 17 |
| 15% wheat flour middlings | | | | | |
| Pen IV | | | | | |
| 15% bran ----- | 41.67 | 25.83 | 67.50 | 169 | 26 |
| 15% ground wheat | | | | | |
| Pen V | | | | | |
| 15% flour middlings ----- | 41.19 | 23.03 | 64.22 | 166 | 23 |
| 15% ground wheat | | | | | |

There is little difference in total feed consumed by the various pens. There is considerable variation in the proportions of the grain to mash used in the different pens, but this was not at all likely due to the palatableness of any particular mash, but probably due to the method of grain feeding as previously discussed.

There was no significant difference in egg production among any of the pens. In fact, the average production per bird in each pen is closer than might often be obtained in four similar pens but where all were fed the same ration. All of the rations used were apparently quite satisfactory not only from a production standpoint, but also from their effects on the birds themselves. Mortality was very heavy in all pens, but almost half of this was directly due to an outbreak, in December and January, of an infectious disease for which no reliable control has been found. The very satisfactory production for the experiment undoubtedly would have been much better without the set-back that the birds were subject to in these two months.

1933 Experimental Work

In order to re-check results obtained in the previous two trials the third experiment was started January 1, 1933, and continued for eight months until the end of August. Forty-three S. C. White Leghorn pullets of the College strain were used in each of the four pens. Pullets were equally divided among pens by weight, and as most of the birds were already in production due to the later start of this trial, their records until January 1 were also used. This resulted in a fairly accurate distribution of birds by breeding in each pen.

The mash and grain rations were exactly the same as in the previous experiment. Both mash and grain were fed ad libitum. Water, granite grit and oyster shell were continually available. Green feed in the form of sprouted oats or occasionally mangels was fed approximately twice a week but not continually during the trial. However, as far as succulent supplements were used, all pens were treated alike. Cod liver oil was used until the end of April.

TABLE 5.—Mortality; mash, grain, and total feed consumption per pen; average production per pullet for the eight months of the experiment.
All figures are on a hen-day basis

| | Grain used per bird. | Mash Used per bird. | Total feed per bird. | Production per bird. | Mortalities per pen. |
|---------------------------|-------------------------|------------------------|-------------------------|-------------------------|-------------------------|
| Pen I | lbs. | lbs. | lbs. | Eggs | pullets |
| 30% ground wheat ----- | 28.2 | 22.2 | 50.4 | 129 | 16 |
| Pen II | | | | | |
| 15% wheat bran ----- | 32.1 | 19.9 | 52.0 | 125 | 13 |
| 15% wheat flour middlings | | | | | |
| Pen IV | | | | | |
| 15% bran ----- | 30.2 | 21.3 | 51.5 | 125 | 9 |
| 15% ground wheat | | | | | |
| Pen V | | | | | |
| 15% flour middlings ----- | 30.5 | 21.9 | 52.4 | 128 | 12 |
| 15% ground wheat | | | | | |

Total feed consumption varied but little in any of the pens. Each pen used feed in the proportions of approximately three pounds of grain to each two pounds of mash. Pen I showed the greatest variation from this.

Production per bird per pen checked very closely in all of the four pens. In this trial certainly no one pen was significantly better than any other. While this trial was not continued as long as was the previous one, average production on a time basis was practically the same. Any of the rations used could be classed as good judging the results either from egg production or by the health of the birds.

Discussion

Reference to Table I shows that wheat is three per cent higher in crude protein than yellow corn. The wheat proteins are of somewhat higher quality than are those from corn. For the poultryman, however, the chief distinction between wheat and yellow corn is that the latter is a good source of vitamin A, whereas wheat has none. Practically, corn is the chief grain for poultry in the corn sections of the state, and wheat is used where corn is not grown or where the imported price of corn would be higher than local wheat.

Not much mill-feed is sold where wheat is raised, but a considerable amount is sold where wheat is not raised.

Wheat in most cases, is higher in price than corn and usually, except in that part of South Dakota where corn must be shipped in, it is not economical to substitute wheat for corn.

Bran and middlings have been used in poultry mashes for years. Primarily their use has been to supplement the proteins supplied by other grains, to add mineral, and in the case of bran to increase the fibre content of the mash. These experiments have shown that for the ration used, ground wheat is equally satisfactory. In addition the use of 15 per cent of either wheat bran or flour middlings to replace half of the ground wheat in the same ration was of no benefit.

Price And Availability The Determining Factors.

Where wheat is available for grinding, and the cheapest variety or No. 2 Red Durum was used in these experiments, if it is cheaper than the local price of bran and middlings there is no reason whatever for buying the latter. In many cases it would result in a saving to buy the wheat and have it ground.

Table VI shows the approximate average retail price of 100 pound bags of bran and middlings as compared to the paying price for No. 2 Red Durum wheat for the last ten years in Brookings. In 7 out of 11 years it would have been more economical to use ground durum wheat than bran and middlings to supply this probably essential part of the laying mash.

TABLE 6.—Approximate average wheat and by-products prices in Brookings

| | Bran | Middlings | No. 2 Red |
|-------------------|--------------|--------------|-----------------------------|
| | 100-lb. bags | 100-lb. bags | durum wheat. Cwt. |
| | Retail | Retail | Wholesale (paying price) |
| 1923 | \$1.53 | \$1.57 | \$1.17* |
| 1924 | 1.44 | 1.46 | 1.54 |
| 1925 | 1.49 | 1.57 | 1.91 |
| 1926 | 1.39 | 1.38 | 1.78 |
| 1927 | 1.60 | 1.70 | 1.77 |
| 1928 | 1.76 | 1.84 | 1.35* |
| 1929 | 1.61 | 1.67 | 1.28* |
| 1930 | 1.41 | 1.42 | 0.86* |
| 1931 | 0.96 | 0.96 | 0.54* |
| 1932 | 0.81 | 0.82 | 0.35* |
| 1933 (first half) | 0.81 | 0.80 | 0.38* |

* In 7 out of 11 years it would have been more economical to use ground durum wheat than wheat bran and middlings to supply this essential part of the laying mash.

However, Brookings prices mean little in other parts of the state. South Dakota has three main flour mills; these are located at Rapid City, Belle Fourche, and Redfield. A fourth is located at Gettysburg. In the territory of these mills bran and middlings may be cheaper than ground wheat for feeding laying hens. The price of both wheat and its by-products not only in Brookings but in most of the state is determined by Minneapolis prices. As most of South Dakota is further from Minneapolis than the Brookings section, in the majority of the state wheat on the farm will be lower than in Brookings and bran and middlings correspondingly higher.

According to the United States Department of Agriculture 100 pounds of milling wheat yields approximately 70 pounds of flour, 16 pounds of bran, and 14 pounds of shorts or middlings. Considering that mill-products are only a by-product of the very extensive flour milling industry, they have always sold at a much too high price. It is evident therefore that in a great many parts of South Dakota, it will be cheaper and result in production just as good to use ground red durum wheat to make up 30 per cent of the laying mash for hens.

It is interesting and important to know that ground wheat cannot be used to replace the customary bran and middlings in chick starting mashes until further experimental work is done. Some work done at Purdue University indicated rather definitely that ground wheat gave inferior results when used to substitute bran and middlings in an all-mash starting ration.

Summary

1. Thirty per cent of ground red durum wheat gave equally satisfactory results when used to replace 15 per cent each of bran and flour middlings in the mash part of a complete grain and mash ration for laying pullets.

2. Under similar conditions 15 per cent of either wheat bran or wheat flour middlings when used to replace one half of the ground wheat in the mash resulted in no improvement over the check pen using production as the criterion.

3. Any of the rations in table II, if used without change, will give good results. Price and availability only should be the deciding factors in the use of wheat or its by-products.

4. Substitutions as given above may by no means be true with other laying mash formulae.

5. These substitutions will not give good results in a chick starting mash.

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