The Use of Wheat In Modern Feeding Programs for Other Poultry and Game Birds

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Introduction

Comprehensive reviews on the utilization of wheat in the feeding of turkeys, broilers and replacement pullets, and layer hens have been presented in this Proceedings by Sullivan, Nelson, and Carlson, respectively. Very little research has been reported in the literature in which wheat and wheat by-products were compared to other cereal grains in the feeding of game birds, ducks and geese. This means that in those cases where data are lacking, research findings obtained in studies with turkeys and chickens will need to be adapted to meet the needs of other classes of poultry, and used to supplement available data in the formulation of practical feeding recommendations. This is the approach which has been followed in compiling this summary paper.

Replace Corn and Milo on an Equivalent Nutrient Basis

It is standard practice to use wheat and in some instances wheat by-products to replace corn or milo in rations for all classes of poultry. This has been the procedure to a more limited degree insofar as oats and barley are concerned. The nutritionist doing the formulating must make it a point to utilize the wheat or wheat by-products on an equivalent nutrient basis rather than on a pound for pound basis. This involves not only protein, but amino acids, energy, minerals and vitamins. Nutrient analysis tables must be representative of the wheat sample being used or actual analysis values must be obtained if major errors are to be avoided.

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The use of grain sorghums in poultry feeds is a prime example of the difficulties which can be encountered unless the nutrient composition values which are used in formulation are typical of the specific lot of grain which is being used. Experience has shown that the crude protein level of grain sorghums can vary from a low of 4% or 5% to a high of 12% or 14%. Systematic sampling coupled with routine chemical analyses by a number of feed manufacturers during the past three or four years has established this fact. Instances can be cited with turkeys where poor growth and inefficient feed utilization were observed. Grain sorghums were used in these rations on the assumption that the actual protein values approximated average figures, when actually they were significantly below these figures. Considerable economic loss was suffered and could have been avoided if actual nutrient composition could have been established prior to use.

A parallel situation has been reported by Summers *et. al.,* (1959) in some feeding trials in which growing pullets were used. In one feeding trial a comparison was made of corn and wheat with the corn included at a ration level of 51% and wheat included at a ration level of 55.5%. In the formulation procedure, protein was replaced on a equivalent basis, but no attention was given to the final energy content of the two experimental rations. In addition, no attempt was made to standardized insofar as mineral and vitamin content were concerned. Four-week body weights and units of feed per unit of gain were the same for the growing pullets fed the corn and the wheat (Table 1). In a second trial in which

Table 1. Comparison Wheat vs. Corn on an Equivalent Protein Basis.

Grain in Diet	Four week mean wt. (gm.)	Feed/Gain
All Corn	444	1.71
All Wheat	449	1.72

Summers *et al.,* (1959).

Table 2. Comparison Wheat vs. Corn on an Equivalent Nutrient Basis.

Diet	Four week mean wt. (gm.)	Feed/Gain
Basal, all corn (U.S. No. 2)	382	1.88
Basal + 5% wheat	399	1.93
Basal + 10% wheat	396	1.85
Basal + 25% wheat	417	1.78

Summers *et al.,* (1959).

the corn was progressively replaced by 5%, 10%, and 25% of wheat (Table 2), there was an improvement in growth which was statistically significant at the 1% level of probability. However, there was no improvement in efficiency of feed utilization. This improvement in growth response was due in part to a difference in energy intake. The authors indicated that the wheat samples which were fed provided a higher energy intake than was anticipated from average analysis tables.

Regardless of the nutrient or nutrients responsible for the progressive improvement in growth, this example illustrates the critical need to make use of actual nutrient content figures when wheat and wheat by-products are to be included on an equivalent nutrient basis in feed formulation.

Formulate Based Upon Anticipated Feed Intake

Ration formulation must involve the use of a feed intake figure which it is anticipated will be obtained under the environmental conditions in which the ration is to be fed. Daily nutrient intake requirements should be established, and all nutrients should be included in the anticipated daily feed intake at levels which will meet these requirements. If ration formulation is done with a realistic daily feed intake in mind, requirements for growth and egg production can be met without any difficulty.

Factors Other Than Nutritive Value

Specific characteristics other than nutritive value must be taken into consideration when wheat or wheat by-products are used. The fineness of grind of the wheat or wheat by-products, and the crude fiber content of the entire ration must meet acceptable standards especially when whole ground wheat is fed. The gluten content of the wheat protein tends to make the final ration sticky and gummy, particularly when moisture is encountered. When the physical characteristics of the ration are not favorable, feed particles accumulate in the tips of the mandibles of the poultry eating the feed and cause necrosis. By grinding the wheat rather coarsely and by including fiber from oats or barley, this adverse condition can be largely counteracted. When wheat does replace corn, a combination of ground wheat and pulversized oats in a ratio of five to one should be employed.

Wheat and Wheat By-Products Used Routinely

Recommended rations which are being used extensively for ducks, pheasants, and quail contain wheat or wheat by-products in varying

amounts. (Baldini *et. al.*, 1953; Ewing, 1963; Heuser and Scott, 1951; Heuser *et. al.*, 1951; Nestler *et. al.*, 1942; Nestler *et. al.*, 1944; Norris *et. al.*, 1936; Roberts, 1934; Schaible, 1970; and Skoglund, 1940). No actual research data are available in which these feed ingredients have been compared to other cereal grains and cereal grain by-products, but favorable results under a wide range of feeding conditions dictate their continued use. Rations for growing ducks contain wheat middlings at levels of from 10% to 15%. Up to 10% of whole ground wheat has been included. In those rations where wheat middlings were replaced by whole ground wheat, pulverized oats was included at the level indicated in the preceeding paragraph.

Rations for pheasants of all ages contain from 12.5% to 25% wheat middlings and from 5% to 15% of wheat bran. As will be pointed out later, the amount of fiber and the type of fiber are factors to be considered insofar as rations for pheasants are concerned. The level of wheat middlings in rations for bobwhite quail range up to 10%.

Why Grains are Included

There are a number of reasons why grains should be included in rations for game birds. A variety of seeds are normally available in the wild environment, and substitutes for these seeds must be used in rations where game birds are raised in confinement. Grains are an excellent source of carbohydrates and are fed primarily as a source of energy. However, grains contain substantial quantities of protein. Amino acid levels and amino acid ratios in this protein are such that a significant amount of protein of a very high quality is added to the ration when grains are included. The crude fiber which is present in cereal grains contributes bulkiness to the ration, and in so doing aids in the digestion and absorption of food nutrients. The cereal grains are also high in B complex vitamins and Vitamin E. Although it is now a standard practice to add mineral supplements to mixed rations, considerable quantities of certain trace minerals are contributed through the cereal grains.

Need for Vitamin A Supplements

When wheat or wheat by-products are used in rations to replace corn, an adequate intake level of Vitamin A should be provided by supplementation. This is equally true in the case of grain sorghums which are lower in Vitamin A than corn, but the problem may be more acute when wheat is used. Studies with game birds indicate that a Vitamin A deficiency can reach major proportions in a rather short period of time. This is most frequently observed with bobwhite quail. In the wild environment it is difficult to accurately evaluate the true situation since

Table 3. Palatability for Game Birds in Wild Environment.

Grain	Amt. eaten %
Corn	100
Wheat and scratch feed	50
Buckwheat	45
White corn, popcorn and barley	40
Sweet corn and sudan grass seed	35
Sorghum seed	25
Soybeans, oats and rye	15

Hawkins *et. al.* (1937).

quail which are suffering from a Vitamin A deficiency are weakened to such a degree that they easily fall prey to predators. However, enough evidence has been accumulated to indicate that Vitamin A supplementation is important, and this is particularly true when cereal grains are fed which are low in Vitamin A.

Palatability

Ration palatability is a factor which must be given consideration in selecting feed ingredients. Some idea as to the relative palatability of different grains was obtained in a study conducted by Hawkins *et. al.*, 1937. The grains as listed in Table 3 were made available in the wild environment in equal quantities. When the corn had been consumed completely, the amounts of the other grains which had been consumed were measured. The values listed in Table 3 represent the amount of each grain which was consumed in relation to corn at 100%. From these data it is obvious that wheat rates second to corn from a palatability standpoint. It can be concluded from these results that wheat is palatable and compares favorable with corn in this respect.

Feather Picking With Pheasants

The problem of feather picking is encountered frequently when pheasants are grown in confinement. This is particularly true when they are grown in batteries, and management or nutritional measures must be taken to control this vice. Research studies in which wheat and wheat by-products were used, and nutritional measures taken to reduce the incidence of feather picking are reported by Scott *et. al.*, (1954), and Scott and Reynolds (1949).

Scott *et. al.*, (1954) raised pheasants in batteries. During the first three weeks of the growing period the ration contained 28% of protein. Starting when the pheasants were three weeks of age, a 24% protein ration was fed and observations made until the pheasants were five weeks of age. The basal ration which was fed contained 30% of corn, 18% of

Table 4. Effect of Ground Oats in a 24% Growing Ration Upon Growth and Feather Picking in Pheasant Chicks.

Treatment after 3 wks. of age	Average weight at 5 wks. (gms)	Week Picking started	Incidence of picking %
No oats (corn)	242	3½	100
23% oat groats	227	3½	100
22% ground oats	222	5	50 (slight)
10% oat groats	240	3½	100
11% ground oats	233	5	75 (slight)

Scott *et. al.* (1954).

Table 5. Effect of Wheat on the Incidence of Feather Picking with Pheasant Chicks.

Combination	Percent fiber	Week feather picking started	Severity of feather picking	Average Weight 5 weeks (gm.)
A. Whole wheat Rolled oats	2.8	2	5	256
B. Whole wheat Pulverized oats	3.6	2	3	250
C. Wheat middlings Pulverized oats	4.2	4	1	292
D. Whole wheat Rolled oats Alfalfa meal	3.6	2	4	246
E. Whole wheat Pulverized oats	4.4	4	2	247
F. Wheat middlings Pulverized oats Alfalfa meal	4.8	2	3	244

Scott and Reynolds (1949).

standard middlings, and 10% of oats. Modifications were made in this basal (Table 4) so that the levels of oat groats and ground oats were varied as indicated.

There was no difference in average body weight at five weeks of age. The levels of ground oats as fed were tolerated very well, and apparently has no adverse effect on growth response. It is obvious however, that the incidence of feather picking was not reduced through the use of oat groats as compared to corn.

The pheasant chicks which were fed the ground oats did not feather pick until the last two days of the feeding trial. At this time hot weather was encountered, and this was thought to be a contributing factor. Nevertheless, the incidence of feather picking was slight, although it reached an incidence of 50% to 75% for the two treatments involved. This would seem to indicate that the addition of ground oats was a desirable ration modification, and significantly reduce the incidence of feather picking.

Scott and Reynolds (1949) utilized whole oats and wheat middlings, in combination with rolled oats, pulverized oats, and alfalfa meal in an attempt to eliminate feather picking with pheasant chicks. The pheasant chicks used in this feeding trial were housed in batteries under well lighted conditions. The respective experimental rations contained 18% of corn, either 14% or 9% of wheat, 14% of wheat middlings, 10% of rolled oats, 10% of pulverized oats, and 5% of alfalfa meal in the combinations as listed in Table 5.

The results which were obtained indicate that growth was not decreased and that energy intake was entirely adequate. The incidence of perosis was zero. Feather picking was not prevented entirely, although results were significantly different among the different treatments tested.

Apparently a combination of wheat middlings and pulverized oats was most effective in eliminating the feather picking vise. Whole wheat in combination with pulverized oats was nearly as effective. It was concluded that level of fiber as well as source of fiber were important considerations. The data would indicate that a crude fiber level of approximately 4% was somewhere near optimum. Crude fiber provided by pulverized oats was more effective in preventing feather picking than was crude fiber from alfalfa meal. These results are in line with previous experience in which crude fiber from pulverized oats has been very effective in preventing cannabilism and feather picking in all classes of poultry.

Availability of Niacin

An adequate level of niacin must be provided in rations which contain wheat middlings. Feeding trials have indicated that the niacin which is found in wheat middlings is not readily available to either laying hens or growing ducks. Vitamin supplementation is a standard practice in ration formulation and substantial quantities of niacin are included in these vitamin supplements. However, care must be exercised to be sure that the total niacin intake is adequate without having to depend upon the niacin from the wheat middlings as a major contributor.

Recent findings by Manoukas *et. al.,* (1968) with laying hens indicate that wheat middlings are a very poor source of niacin. These workers employed a quantitative bioassay in which hatchability was the independent variable. The laying hens in this feeding trial were fed a niacin deficient ration which contained 0.134% of tryptophan.

The results obtained in this study are summarized in Table 6. It is obvious that the niacin from both yellow corn and wheat middlings is poorly utilized by White Leghorn layers. On the other hand, dehulled soybean meal provides a readily available source.

Table 6. Niacin Availability for White Leghorn Hens.

Feed Ingredient	Availability %
Yellow corn	30
Wheat middlings	36
Dehulled soybean oil meal	100

Manoukas *et. al.* (1968).

Table 7. Niacin Availability for Ducklings.

Supplement	Incidence Bowed Legs %
None	100
Niacin, 5 mg/lb	45
Niacin, 10 mg/lb	0
Niacin, 10 mg/lb + antibiotics and sulfa	5
Dried brewers' yeast, 3.8%	25
Dried brewers' yeast, 7.5%	0
Wheat standard middlings, 28%	100
Vitamin mix	0
Vitamin mix (except niacin)	100
Vitamin mix (except niacin) + antibiotics	100

Heuser and Scott (1953).

Research studies have established the fact that bowed legs in ducklings is caused by a deficiency of niacin. Studies conducted by Heuser and Scott (1953) evaluated wheat standard middlings as a source of this important vitamin. Pekin ducks were used and were maintained on wire floors. The rations which were fed contained 40% of corn, 15% of wheat flour middlings, 15% of wheat standard middlings, and 10% of pulverized oats, in addition to other ingredients. The basal ration was supplemented as indicated in Table 7. The incidence of bowed legs on a percentage basis was used as a measure of the availability and the adequacy of niacin intake from the various supplements.

The 100% incidence of bowed legs observed in the ducklings fed wheat standard middlings indicates that the availability of niacin from this feed ingredient is very poor. A supplemental level of 10 milligrams of niacin per pound was required to eliminate the bowed legs entirely. These data would indicate that niacin intake is a critical factor insofar as growing ducklings are concerned, and that wheat standard middlings should not be dependent upon to provide substantial quantities.

Physical Form

The physical form in which feeds are fed have some bearing upon their nutritive value as reflected in weight gain and efficiency of feed conversion. It has become standard procedure to pellet feeds for growing

Table 8. Effect of Physical Form and Levels of Wheat on Weight Gain and Feed Efficiencies.

Wheat	15 Wks. of Age	
	Wt. Gain (Lbs.)	Feed/Gain
Whole	2.54	3.89
Ground	2.68	3.78
Pelleted	2.41	3.91
Mean	2.54	3.86
Wheat + Corn		
Whole	2.74	3.68
Ground	2.73	3.80
Pelleted	2.71	3.79
Mean	2.73	3.76

McIntosh *et. al.* (1962).

ducks and, for this reason, whole or ground wheat in mash form probably does not warrant consideration. For game birds, on the other hand, these three physical forms might be of importance on a comparative basis since game birds in the wild eat whole grain and pelleting would constitute the most desirable form for rations to be fed under confinement conditions. Since no data are available in which wheat in these three forms was fed to game birds, data obtained with growing pullets would seem to have an application.

McIntosh *et. al.,* (1962) grew pullets in floor pens. Wheat was used as the sole cereal, and in a 50-50 combination with corn. The data summarized in Table 8 indicate that there were no differences in energy due to the form in which the ration was fed. However, it would appear that the wheat-corn combination was superior to the wheat alone.

Conclusions and Recommendations

Based upon the data available for game birds, ducks, and geese, and upon inferences which can be drawn from available data on turkeys and chickens, the following recommendations would seem to apply:

1. Use wheat and wheat by-products in the feeding of game birds, ducks, and geese based upon their nutrient content in rations designed to meet nutrient intake requirements.

2. The nutritionist should be aware of the limitations of wheat and wheat by-products from the standpoint of nutrient availability, and their effect on the physical characteristics of the final ration. These two factors must be taken into consideration if adequate rations are to be formulated.

3. Substantial amounts of wheat and/or wheat by-products can be used successfully depending upon their price and availability.

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