California wheat as a feed ingredient for turkeys

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Although wheat is normally considered a grain primarily for human food, it has been used successfully in poultry diets for many years. The amount of wheat included in a least-cost ration formulation depends largely on the price of wheat relative to that of corn or other energy-providing feedstuffs and, to a lesser extent, the price of fat and protein sources. In recent years, considerable amounts of wheat have been included in least-cost formulations for poultry because of a variety of agronomic, economic, and political circumstances.

The renewed interest in the use of wheat for turkey feed has generated questions on its nutritional and practical feeding value. Many feed manufacturers and turkey producers have been reluctant to use wheat in rations, even when least-cost formulation has dictated its use. Much of the reluctance has resulted from a lack of experience with this feedstuff. Also, the limited number of publications on feeding wheat to poultry have not considered California wheat varieties, most of which are genetically different from those grown in the rest of the country.

Many varieties of wheat are available for animal feeds in most regions of California. Tests at the University of California at Davis, as well as at other experiment stations, have demonstrated substantial variability in energy and protein composition between varieties. Even within a variety, energy and protein values are more variable than those of corn. This variability makes it essential that the nutrient content of the wheat available for purchase be used in formulating least-cost rations.

As an example, table 1 lists the protein and amino acid content of Yecora Rojo, a high-protein variety of hard red winter wheat grown in central California. This wheat is slightly lower in energy and higher in protein than corn. The amino acids most likely to limit the growth rate of turkeys fed rations containing this wheat with soybean meal as the protein source are lysine, followed by sulfur-containing amino acids (methionine plus cystine) and threonine. High-protein wheat varieties have considerably more lysine and slightly more sulfur amino acids than corn. Consequently, using wheat in place of corn decreases the quantity of soybean meal or other protein source needed in the ration to supply these amino acids. Since high-protein feeds are generally more expensive than wheat, the cost of the ration is decreased.

To take full advantage of the higher amino acid content of wheat, the producer needs accurate information on the content. Since the cost and time required for amino acid analysis are prohibitive in commercial poultry feeding, it is common practice to calculate the amino acid content from the protein content. Individual amino acids, however, do not make up a constant proportion of the protein. Generally, as the amount of protein in a grain increases, several essential amino acids, such as lysine and methionine, form a lower proportion of the protein, and many nonessential amino acids are present in a higher proportion. This relationship is well documented for corn and soybean meal, and regression equations have been published that permit prediction of essential amino acid content from the protein content. Similar equations have not been available for wheat, and the lack of accurate information on amino acid content has resulted in misformulation of rations and poor performance of growing poults.

Equations for prediction

We developed regression equations that permit the prediction of amino acid content from the protein content of wheat. The equations were based on analysis of 35 representative wheat samples obtained from feed mills in California and from California Department of Food and Agriculture grain inspection stations. Protein content was analyzed by the Kjeldahl method, and amino acid content of hydrolyzed samples was determined by reverse phase chromatography.

Separate regression equations were developed for all of the wheat samples analyzed together and for the wheat samples obtained from feed mills only. Since there were few differences between these two groups, we have reported results for the entire set of samples. The average protein, lysine, sulfur amino acid, and threonine content of the samples was 12.4, 0.34, 0.49, and 0.38 percent, respectively. Wheat from southern California tended to have less moisture and more protein than that from northern California.

Statistical analysis of the lysine and sulfur amino acid content of wheat showed that their relationship to protein content is not direct. The use of regression equations thus gives a better prediction of lysine and total sulfur amino acid content of wheat than assuming that these amino acids are a constant percentage of the protein. The equation to predict total sulfur amino acid content is: % methionine + % cystine = 0.142 + .029 (% protein). The equation to predict lysine content is: % lysine = 0.098 + .019 (% protein).

Prediction of the threonine content of wheat protein, however, was not significantly improved by the use of a regression equation. It can thus be assumed that the concentration of this amino acid in wheat is a constant percentage of the protein.

In addition to the uncertainties of the exact amino acid content in various lots of wheat, several other factors offset the advantage of the higher protein. First, the Yecora Rojo wheat that we have worked with has a true metabolizable energy of 3330 kcal/kg, as determined by the Sibbald rooster assay. This is 11 percent lower than the value we found for ground corn (3750 kcal/kg). The lower metabolizable energy of wheat requires addition of higher levels of fat in some rations; consequently, the price of fat will influence the selection of wheat by least-cost ration formulation programs. Second, wheat is a poor source of xanthophyll pigments, especially when compared with corn. Other sources of xanthophyll therefore must be included in the ration if maximal pigmentation of the skin is desired. It has also been reported that feeding wheat with high levels of moisture can have pathological effects on the turkey's upper digestive tract.

The handling characteristics of wheat have also been a concern when feeding the ration as a mash. Wheat tends to produce a fine powder when ground, and its high gluten content causes sticking problems in feed handling machinery. Severe cases can also result in caking in feeders and on the beaks of birds. These problems can be reduced by precise adjustment of grinders and proper selection of screen size, or by using cracked wheat. Because of the high gluten content, wheat has excellent pellet-forming characteristics and therefore may be used in preference to corn in pelleted rations.

Feeding studies

We know by laboratory analysis that wheat can have higher levels of protein, methionine, and lysine and slightly less energy than corn, but such analyses can be a poor indication of actual poult performance. In two feeding studies, we supplemented practical rations with Yecora Rojo wheat in place of corn, on a one-for-one basis, up to 100 percent replacement. A mash and a pelleted ration were used in the first and second experiments, respectively. Poults were started on the experimental rations on the day of hatch and fed for four weeks. There were four replications of five male poults per treatment, raised in heated stainless steel brooders with wire floors. Poults were weighed, feed consumption was determined, and leg soundness was scored weekly.

Results indicate that substituting wheat for corn on a one-for-one basis does not affect rate of weight gains, feed intake, or efficiency of feed conversion up to four weeks of age with either a mash or a pelleted ration (table 2). The data shown are cumulative for all four weeks. Analysis of the data within each one-week period showed a significant decrease in week 2 of experiment 1 in feed efficiency for poults fed the highest level of wheat compared with those fed the highest level of corn. These differences, however, disappeared in subsequent weeks (data not shown).

After four weeks, half of the poults were killed and examined. No pathological effects were found in the crop, gizzard, or any other organ. The rest of the poults were grown to nine weeks of age, during which time no differences were seen in growth rate, feed intake, or feed efficiency. Birds were observed for incidence and severity of leg problems or drop crop syndrome. These problems did not occur on any dietary treatment. Also, wheat did not cake on the birds' beaks, even when it was used as the only energy feedstuff in mash diets.

Poults consuming pelleted diets had greater feed intakes and growth rate than those on mash rations, but feed efficiency was similar in both groups. Interestingly, feed efficiency on pelleted rations was significantly poorer during the first week of the experiment, but significantly better during the third and fourth weeks. There were no interactions between pelleting and diet, demonstrating that pelleting did not influence wheat-based diets differently than corn-based diets.

TABLE 1. Amino acid composition of Yecora Rojo wheat compared with corn

Amino acid	Yecora Rojo wheat		Corn		Protein requirement
	As fed	Protein	As fed	Protein	
	%	%	%	%	%
Methionine	.22	1.5	.20	2.3	1.9
Cystine	.18	1.2	.15	1.7	1.9
Lysine	.40	2.8	.24	2.7	5.7
Threonine	.37	2.5	.39	4.4	3.6
Arginine	.65	4.4	.50	5.7	5.7
Phenylalanine	.72	4.5	.47	5.3	3.6
Valine	.59	4.1	.52	5.9	4.3
Histidine	.37	2.3	.20	2.3	2.1
Isoleucine	.45	3.1	.37	4.2	3.9
Tryptophan	.19	1.2	.09	1.0	0.9
Leucine	.93	6.4	1.10	12.5	6.8
Glycine	.60	4.1	.37	4.2	1.8
Serine	.56	3.8	.40	4.5	1.8
Aspartate	.86	5.9			
Glutamate	3.34	22.9			
Proline	1.40	9.6			
Alanine	.48	3.3			

NOTE: This wheat variety had a protein content of 14.8% on an as-fed basis. True metabolizable energy = 3330 kcal/kg; moisture = 9%. Amino acid composition of corn is taken from National Research Council, Nutrient Requirements of Poultry (1984).

TABLE 2. Effect of substituting wheat for corn on poult performance from hatch to four weeks of age

Corn	Wheat	Gain		Feed		Efficiency	
		Mash	Pelleted	Mash	Pelleted	Mash	Pelleted
%	%	*g/poult/day*		*g/poult/day*		*gain/feed*	
48	0	30.4	33.8	43.4	50.4	.70	.67
43.2	4.0	29.3	33.4	42.5	48.4	.69	.69
36	12	30.1	32.4	44.3	49.1	.69	.66
24	24	28.5	34.4	43.2	49.9	.66	.69
12	36	30.6	33.0	46.4	49.3	.66	.67
0	48	29.1	32.5	43.4	47.8	.67	.68
Pooled SEM*		0.7	0.9	1.7	1.9	.02	.01

NOTE: All diets contained 46.7% soybean meal, 2.4% decalcium phosphate, 1.4% limestone, 0.6% corn oil, 0.3% salt, 0.3% methionine, and 0.3% vitamin-mineral premix. Diets meet or exceed NRC requirements for amino acids, vitamins, and minerals. There are no significant differences between means within each experiment.
*Standard error of the mean.

Conclusions

When wheat is being considered for inclusion in a least-cost turkey ration, the amounts of the essential amino acids lysine and methionine plus cystine can be predicted from the protein content of a wheat sample by the use of regression equations. Threonine content of wheat can be predicted by assuming a direct relationship with protein content.

Our feeding studies showed that, when accurate information on the nutritional value of the wheat is used in formulating a ration, performance of a wheat-based ration is comparable to that of corn-based rations.

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