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Barley and Fat for Corn

In Broiler Rations

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Summary and Conclusions

An economic analysis has been conducted on the feeding value of barley and fat as compared to that of corn when fed to broilers. The analysis involves experiments reported by the Department of Poultry Husbandry at Oregon State College.

Feeding values, based on feed conversion data adjusted to a constant body weight, indicate that barley with 3% to 4.5% added fat may profitably replace 1/4 to 1/2 the corn in mash rations. Pelleting the all-corn rations increased the feeding value only 4%, as compared to a 13% increase for the all-barley rations. Within the prices used, the most profitable ration was a 50-50 corn-barley pelleted feed with 3% fat.

Savings from feeding the 50-50 corn-barley pellets with 3% fat as compared to the all-corn mash amounted to about one-half cent per pound of broiler under the assumed prices. The procedure for determining the least-cost combination of corn, barley, and fat under any set of price conditions is presented.

Break-even prices for barley that permit economical substitution of barley for one-half the corn have been computed. According to these calculations, when corn ranges from $50 to $70 per ton, barley is worth from $36 to $61 respectively with 4.5% fat in the mash. Even higher break-even prices ($45 to $69) are permitted when barley replaces one-half the corn in a pelleted ration with 3% fat.

Source of Data

Floor-pen trials of 8-9 weeks have been conducted. These were designed to determine the relative value of Hannchen barley, and corn, at various fat levels with broiler rations in mash or pellet form. The data, including the experimental procedure and rations fed which provided a basis for this economic analysis, have been reported in another publication.[1] The results are briefly summarized as follows: on the basis of performance efficiency data, evidence has been presented showing that barley may replace 1/2 and 3/4 of the ground corn in all-mash rations containing 3% and 6% fat respectively. Results were comparable to an all-corn ration containing no added fat. The addition of 3% and 6% fat to all-corn rations resulted in further improvements in performance efficiency. All-barley mash rations produced inferior results from the standpoints of growth, and of feed efficiency, regardless of presence or absence of fat.

1/ G. H. Arscott, W. H. McCluskey, and J. E. Parker, 1957. The Use of Barley in High-Efficiency Broiler Rations. 2. Effect of Stabilized Animal Fat and Pelleting on Efficiency of Feed Utilization and Water Consumption. Poultry Science (In Press). Experiments three through eight were utilized for this study.

Pelleting rations that contain all-corn, 1/2-barley and 1/2-corn, or all-barley, with either 3% fat, or none at all, effected a marked improvement in performance. This improvement was particularly noticeable with lots fed all-barley pellets with 0% and 3% fat. The all-barley pellets with 3% fat compared favorably to the all-corn mash with no fat. Litter conditions appeared adversely affected in all trials when barley replaced more than one-half of the corn.

Relative Feeding Values of Barley, Corn, and Fat

Growth relationships for various combinations of corn, barley, and fat in the ration were first estimated. Based on these estimates, feed requirements were computed and are presented in Table 1. From these feed requirements, the relative values for rations containing different proportions of barley, corn, and fat can be readily determined, since each quantity of feed produces the same weight (1 pound) of broiler.[1/]

According to these figures, one pound of broiler could be produced by feeding either 2.484 pounds of all-corn mash or by feeding 3.119 pounds of mash containing all-barley as the grain component. The relative value of an all-corn mash compared to one containing all-barley is 3.119/2.484 = 1.26. Thus, corn mash would be worth 26% more. However, if a 50-50 mix of corn and barley is used in the mash, only 2.662 pounds of feed are required. The relative value of an all-corn mash to a 50-50 mix is 2.662/2.484 = 1.07 or only 7% in favor of the mash containing corn as the grain component. Barley is obviously much more valuable when used in combination with corn than when used alone.

Feed requirements in Table 1 can also be used to make fairly accurate estimates of the value added to feed by pelleting. Pelleting value depends on whether barley or corn is used as the energy source. If corn is used, feed value is increased about 4% by pelleting versus 13% when barley is used. Thus, if a mash containing corn costs $100 per ton, the same mix would be worth slightly less than $104 per ton if pelleted, while a barley mash costing $90 per ton would be worth about $102. Similarly, pelleting 50-50 corn-barley with 3% fat would add 6% to the feed value.

Selection of Optimum Ration

To select the most economical ration from figures in Table 1, assume the following costs: corn, $62 a ton; barley, $45 a ton; the non-grain portion of the mash (protein supplement, vitamins, minerals, etc.), $122 a ton; and mixing, selling, and delivery, $15 a ton.

Using these prices, the cost of mash made with corn as the only energy source would be figured as follows:

1. Grain component cost (61% of total mix) would be .61 x $62 = $37.82 per ton.

2. The non-grain portion of the ration (39% of total mix) would cost .39 x $122 or $47.58 per ton.

3. Mixing, selling, and delivery would add another $15 per ton. Adding these costs, $37.82 + $47.58 + $15 = $100.40 per ton for mash with all-corn as the energy supplement.

[1/] Since feed requirements were adjusted to the same broiler weight for all rations, birds on faster growing rations are not "penalized" by having higher feed conversion as a result of reaching heavier weights by the end of the experiment.

Table 1. Pounds of mash or pellets required per pound (liveweight) of broiler

Grain component in mash	Percent added fat in mash				
	0*	1.5*	3.0*	4.5	6.0*
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
0% Barley, 100% Corn*	2.484	2.421	2.374	2.338	2.313
25% Barley, 75% Corn	2.552	2.478	2.422	2.378	2.347
50% Barley, 50% Corn*	2.662	2.569	2.498	2.444	2.404
(Adverse litter conditions have been observed when barley exceeds 50% of the grain component)					
75% Barley, 25% Corn	2.834	2.707	2.614	2.543	2.490
100% Barley, 0% Corn*	3.119	2.923	2.787	2.687	2.614

Grain component in pellets	Percent added fat in pellets		
	0*	1.5	3.0*
	Lbs.	Lbs.	Lbs.
0% Barley, 100% Corn*	2.393	2.338	2.296
25% Barley, 75% Corn	2.425	2.362	2.314
50% Barley, 50% Corn*	2.487	2.413	2.356
(Adverse litter conditions have been observed when barley exceeds 50% of the grain component)			
75% Barley, 25% Corn	2.589	2.496	2.424
100% Barley, 0% Corn*	2.749	2.622	2.528

*Actual treatments employed in broiler test.

Using the same prices, the cost of mash made with barley as the sole energy source would be .61 x $45 = $27.45 plus .39 x $122 = $47.58 plus $15 = $90.03 per ton. Thus, mash containing corn would cost $100.40 ÷ 2000 = $0.0502 per pound and barley mash would cost about $0.0450.

Feed cost per pound of broiler with all-corn mash would be $.0502 x 2.484 = 12.47 cents. Getting the same gain with barley as the energy source would cost $.045 x 3.119 = 14.04 cents. These feed costs per pound of broiler are shown in Table 2.

Under the preceding prices, a 25% barley-75% corn mash would cost .25 x .045 plus .75 x .0502 or $.0489 per pound. Using this mix, feed cost per pound of broiler would be $0.0489 x 2.552 = 12.48 cents, almost the same as for the all-corn mash. These figures agree very closely with earlier work where it was shown that barley could replace one-fourth of the corn in the mash without added fat.[1/]

Cost of mash with added fat is computed in a similar way. Assume the same ingredient prices. Also, assume that fat costs $0.08 per pound and soybean meal costs $0.045 per pound. (For each percent of added fat, .2333 pound of grain was replaced by an equal amount of soybean meal to maintain the protein percentage.)

[1/] G. H. Arscott, L. E. Johnson and J. E. Parker, 1955. The Use of Barley in High-Efficiency Broiler Rations, 1. Poultry Science: 34: pp. 655-662.

Cost of the 4.5% fat, all-corn mash would be computed as follows. The grain component would make up 61% of the ration less the percentage of fat (4.5) and less the amount of soybean meal which needs to be added to maintain a constant level of protein (4.5% x .2333 = 1.05%). Thus, for mash with 4.5% fat, the amount of grain in the ration would be .61 - .045 - .0105 = .5545. Cost of the all-corn grain component would then be .5545 x $62 = $34.38 per ton. Cost of extra soybean meal because of the added 4.5% fat would be .0105 x $90 = $0.94 per ton. The vitamin, mineral, and protein portion of the ration would add .39 x $122 = $47.58 per ton. Fat would cost .045 x $160 = $7.20 per ton. Mixing, selling, and delivery costs could add another $15 a ton. Total cost per ton to the poultryman would be approximately $34.38 + $0.94 + $47.58 + $7.20 + $15 = $105.10 per ton, or about $.05255 per pound for the 4.5% fat, all-corn mash.[1/]

Similarly, costs for the rest of the rations listed in Table 1 can be computed. Multiplying these computed costs for each ration by the corresponding feed requirements in Table 1 gives the cost of feed required per pound of broiler. These costs are given in Table 2.

Of the various corn, barley, and fat combinations used in the mash in Table 2, a 25% barley-75% corn mash with 4.5% added fat proved most profitable. However, several other rations were as good or better than the all-corn mash without added fat. For example, the 50-50 corn-barley mixture with 3% added fat compared favorably with the all-corn mash without fat.[2/]

Greater savings are also possible by pelleting the ration if pelleting costs do not exceed $3 per ton (as in Table 2). Under preceding prices, the most profitable ration would be a 50-50 corn-barley pellet with 3% added fat. Feed cost per pound is reduced from 12.47 cents for all-corn mash without added fat to 11.98 cents for the pelleted, 3% fat, 50-50 barley-corn ration. Feed savings on a 10,000-bird lot would be about $.0049 x 30,000 pounds or $147.

Actually, fat levels higher than 3% were predicted to give even cheaper costs per pound for the pelleted ration, just as for mash. These figures are not shown, however, since they are beyond fat levels added to the pelleted feeds in these experiments. Also, with lower barley and fat prices relative to corn, savings from substituting barley and fat for corn would be greater.

Optimum Rations with Changing Corn, Barley, and Fat Prices

Feed requirements in Table 1 can be used for a guide as costs of corn, barley, fat, or other ingredients change.

For example, assume barley prices fall to $35 per ton, while other prices remain the same. (Corn was assumed to cost $62 per ton; vitamin, protein, mineral supplement was $122 per ton; fat was $160 per ton; soybean meal was $90 per ton.)

Without added fat, mash made with straight barley as the grain component would cost .61 x $35 + .39 x $122 + $15 = $83.93 per ton or $0.04196 per pound.

1/ No charge has been made for extra equipment needed for mixing fat into the ration. For feed-mixing plants without this equipment, the cost of such machinery would have to be considered in deciding whether to add fat to the ration.

2/ These results are in agreement with the report by Arscott, McCluskey, and Parker, 1957. The Use of Barley in High-Efficiency Broiler Rations, 2. Poultry Science (In press).

Table 2. Cost of feed per pound of broiler with various combinations of corn, barley, and fat as the energy source for the ration.

Grain component for mash	Percent added fat in mash				
	0*	1.5*	3.0*	4.5	6.0*
	Cents	Cents	Cents	Cents	Cents
0% Barley, 100% Corn*	12.47	12.34	12.29	12.29	12.34
25% Barley, 75% Corn	12.48	12.32	12.24	12.22	12.25
50% Barley, 50% Corn*	12.67	12.45	12.32	12.27	12.27
(Adverse litter conditions have been observed when barley exceeds 50% of the grain component)					
75% Barley, 25% Corn	13.12	12.78	12.58	12.47	12.43
100% Barley, 0% Corn*	14.04	13.43	13.07	12.86	12.75

Grain component for pellets	Percent added fat in pellets		
	0*	1.5	3.0*
	Cents	Cents	Cents
0% Barley, 100% Corn*	12.37	12.27	12.23
25% Barley, 75% Corn	12.22	12.10	12.04
50% Barley, 50% Corn*	12.21	12.06	11.98
(Adverse litter conditions have been observed when barley exceeds 50% of the grain component)			
75% Barley, 25% Corn	12.38	12.16	12.03
100% Barley, 0% Corn*	12.78	12.44	12.23

*Actual treatments employed in broiler test.

If 4.5% fat were added, the cost would be .39 x $122 + .045 x $160 + .0105 x $90 + .5545 x $35 + $15 = $90.13 per ton, or $0.04507 per pound.

Cost of feed per pound then is multiplied by feed requirements in Table 1 to give feed costs per pound of broiler for mash with 4.5% added fat. (Only the 4.5% fat level is presented, since this level was again the most profitable under the assumed prices.)

Grain component, 4.5% fat in mash	Cost per pound of feed	Cost of feed per pound of broiler
	Dollars	Cents
0% Barley, 100% Corn	0.05255	12.29
25% Barley, 75% Corn	0.05068	12.05
50% Barley, 50% Corn	0.04881	11.93
75% Barley, 25% Corn	0.04694	11.94
100% Barley, 0% Corn	0.04507	12.11

For these prices, a 50-50 mix of corn and barley provided the cheapest feed cost. Feed cost per pound of broiler would be reduced.

Even greater savings are predicted for pelleted rations when barley is used under these prices, with 75% to 100% barley indicated as being cheapest.

Grain component, 3.0% fat in pellets	Cost per pound of pelleted feed	Cost of feed per pound of broiler
	Dollars	Cents
0% Barley, 100% Corn	0.05327	12.23
25% Barley, 75% Corn	0.05133	11.88
50% Barley, 50% Corn	0.04940	11.64
75% Barley, 25% Corn	0.04747	11.51
100% Barley, 0% Corn	0.04553	11.51

Feed cost is reduced almost one cent per pound of broiler for the 3% fat pellets if compared to all-corn mash without fat (Table 2). However, adverse litter conditions have been observed for rations in which barley exceeded 50% of the grain component.

Break-Even Values for Barley

Break-even prices for barley, based on feeding values from Table 1, have been computed and are shown in Table 3 for 50-50 corn-barley mash with 4.5% fat or 50-50 corn-barley pellets plus 3% fat. When the market price of barley falls below the break-even price for a given corn-price situation, it becomes economically possible to replace one-half the corn with barley.

Table 3. Break-even prices for barley in the broiler ration at given corn prices [a]

Price of corn to be used in all-corn mash	Break-even prices for barley per ton	
	50-50 Corn-barley mash with 4.5% added fat	50-50 Corn-barley pellets with 3% added fat
$50	$36	$45
55	42	51
60	48	57
65	55	63
70	61	69

[a] Non-energy portion of ration is assumed to cost $122 per ton; fat, $160 per ton; soybean meal, $90 per ton; mixing, handling, and delivery, $15 per ton; and pelleting, $3 per ton.

With increased corn prices, the difference between the break-even price of barley and the corn price becomes less. Break-even values for barley at higher corn prices over-estimate the worth of barley in these calculations because the cost of energy from corn increases, while the cost of fat and pelleting is held constant. At higher corn prices, pelleting and adding fat to the ration would also increase the all-corn mash value with which the 50-50 corn-barley combinations were compared. However, any such distortions can be eliminated by using the more detailed procedure presented in the preceding section where actual costs can be determined. Similarly, feed savings per pound of broiler can also be estimated by using actual prices. The important thing to remember is that the final cost used should be the most economical feed cost to the poultryman.

Limitations

Many factors can affect the applicability of the preceding economic analysis to specific situations confronting feed manufacturers or poultrymen. One factor which could affect the relative values of barley, corn, and fat would be the amount and composition of the protein, mineral, and vitamin supplement used. Generally, with higher levels of protein, higher energy rations become more profitable. Experimental rations upon which the preceding analysis was based were held constant at a recommended level of 21% protein.

Weight at which broilers are marketed is another important factor affecting the choice of a "best" ration. At heavier weights, higher energy rations appeared to become increasingly profitable. However, because the experiments were completed in 8-9 weeks and some of the birds fed lower energy rations did not reach sufficiently heavy weights, the effect of final marketing weight on the optimum ration could not be adequately evaluated.

Recent experimental work also indicates that barley's feeding value for poultry is enhanced by soaking, or treatment with enzymes. Effects of such treatments were not investigated in the preceding economic analysis.

Despite these specified limitations, the feed requirements given in Table 1 should be useful guides to feed manufacturers and poultrymen when choosing among alternative energy sources.