Minimizing Pollution from Poultry Manure: 2. Phosphorus

Poultry FACTSHEET

Environmental pollution from phosphorus (P) in animal manure is a serious issue in areas such as the Lower Mainland of BC because of the concentration of animals and a limited land base for disposal. Run-off can lead to pollution of surface waters. New technology exists that allows the P content of diets to be reduced. This technology can be applied in poultry production units to reduce the quantity of P excreted in the manure, thus enhancing the sustainability of poultry production. A major reduction in the P content of poultry manure would have a significant and positive effect on the environment.

Concept

The P contained in feed grains and plant proteins is poorly utilized by poultry (or swine) because these species do not possess the gut enzymes necessary to digest much of the organic P in feed. As a result, poultry diets have to be supplemented with inorganic P, such as dicalcium phosphate, to meet the P requirement. This adds to the cost of the feed, and increases the amount of P excreted in the manure. A commercial phytase enzyme is now available as a feed supplement. Previous research has shown that its use in poultry feed gives better utilization of organic P. This should allow the amount of inorganic P supplementation to be reduced and result in less P excreted in the manure.

Research Undertaken

Work at the University of British Columbia Avian Research Centre, in collaboration with the Pacific Agriculture Research Station, Agassiz, BC has shown the benefits of using reduced P diets supplemented with phytase for both layers and broilers. Researchers involved in the study include Drs Bob Blair, Jacqueline Jacob, and Tom Scott, and graduate student Sami Ibrahim.

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Broiler Experiment.

The broiler study involved 2650 birds fed practical diets. Four levels of dicalcium phosphate (DiCal) were used - 25, 50, 75 and 100% of the level required to supply the standard level of 0.47% and 0.45% available P in starter and grower diets, respectively. The levels of DiCal averaged 0.34, 0.67, 1.00 and 1.32%, respectively, in the starter and grower diets. Natuphos (a commercial phytase) was added to each diet at 0, 50, 100 or 150% of the recommended rate (600 FTU/kg) to give a total of 16 dietary treatments. The results showed that supplementation with phytase increased P retention especially with the low levels of DiCal. They suggest that inclusion of DiCal could be reduced to 50% of the usual rate even without phytase supplementation. This would give an average reduction in manure P from 1.6 to 1.3%. However, it is recommended that industry not reduce the amount of DiCal without phytase addition. Further reduction in total dietary P to 25% of the usual inclusion rate was shown to be possible with phytase supplementation, resulting in an average reduction in manure P to 1%. Providing phytase supplementation of 150% of the recommended rate did not further increase phosphorus retention. A high level of mortality due to culling (16.6%) was found with the diet containing the lowest level of DiCal without phytase. Mortality rate did not differ with the other diets.

GROWTH PERFORMANCE* OF BROILERS

(0 - 6 WEEKS)

DiCal %	Total P in diet &	Phytase FTU/kg diet	Market wt. grams	FCR**	P*** retention %
0.34	0.47	0	1491	1.58	46.5
0.34	0.47	300	1967	1.57	53.3
0.34	0.47	600	2103	1.56	54.4
0.34	0.47	900	2102	1.63	54.1
0.67	0.54	0	2039	1.64	50.2
0.67	0.54	300	2198	1.64	56.3
0.67	0.54	600	2180	1.62	54.9
0.67	0.54	900	2191	1.59	53.3
1.00	0.63	0	2241	1.64	51.2
1.00	0.63	300	2205	1.67	53.4
1.00	0.63	600	2232	1.63	56.4
1.00	0.63	900	2269	1.64	54.5
1.32	0.70	0	2223	1.68	50.2
1.32	0.70	300	2236	1.64	48.4
1.32	0.70	600	2244	1.63	50.6
1.32	0.70	900	2243	1.68	46.1

***** **Average of 3 treatments per test group.**
****** **Feed conversion.**
******* **Starter period**

Layer Experiment.

A total of 8 diets was used with 1248, 48 week old hens, for a test period of 8 weeks. The diets contained 3.6% or 3.24% Ca and 0.58% or 0.52% P, with or without phytase supplementation. There were no significant effects of diets on egg production, egg weight, or egg specific gravity. The results indicate that it is possible to reduce the total P content of layer diets by 10%, even without phytase supplementation, with no loss in performance. However, it is recommended that producers do not reduce the amount of DiCal without phytase addition.

PRODUCTION*

Diets	Ca % in diet	Total P in diet %	Phytase in diet	Egg prod. %	Feed/doz eggs, kg	Egg wt. grams
1**	3.6	0.58	0	81.9	2.00	66.6
2	3.6	0.58	+	81.5	2.02	66.1
3	3.6	0.52	0	81.6	1.99	65.6
4	3.6	0.52	+	82.4	1.94	65.1
5	3.24	0.58	0	80.9	1.98	66.2
6	3.24	0.58	+	81.8	1.98	66.0
7	3.24	0.52	0	85.0	1.96	66.0
8	3.24	0.52	+	82.0	1.98	66.5

* Average of 3 replicates per test group.
** Control

Manure from the layers receiving the diet with reduced dietary Ca and P and supplemented with phytase had the lowest P content (diet 8). In addition, daily P output was 34.9% lower, as compared to control (diet 1), for layers on this diet. N percent in manure was unaffected.

DAILY P AND N OUTPUT AND MANURE COMPOSITION (DRY MATTER BASIS)

Diets	Ca % in diet	Total P in diet %	Phytase in diet	P output /day g	P % in manure DM*	N output /day g	N % in manure DM*
1**	3.6	0.58	0	0.43	1.74	2.31	6.99
2	3.6	0.58	+	0.36	1.46	2.18	6.35
3	3.6	0.52	0	0.34	1.33	2.18	5.58
4	3.6	0.52	+	0.35	1.42	2.17	5.79
5	3.24	0.58	0	0.35	1.39	2.07	6.68
6	3.24	0.58	+	0.40	1.61	2.23	5.88
7	3.24	0.52	0	0.36	1.45	1.96	6.05
8	3.24	0.52	+	0.28	1.11	1.89	6.37

* Dry matter basis.
** Control

Conclusions

Technology exists for the efficient handling of manure after it has been produced. Technology also exists to minimize the important nutrients in manure before it is produced. Both technologies should be incorporated into a logical overall strategy for pollution abatement. Producers need to consider the effects on costs/returns in making a decision to use reduced P diets supplemented with phytase. Enzyme supplemented diets may cost more, but the manure disposal costs are likely to be less and the sustainability of the enterprise enhanced. The overall effect on profitability and sustainability of the enterprise need to be assessed.

Using reduced P diets supplemented with phytase enzyme is only one component of a feeding/management strategy to complement the manure handling and disposal strategy. A complete feeding/management strategy is as follows:

1. Use superior stock that grows fast and converts the dietary nutrients efficiently.
2. Formulate diets as close as possible to requirements, and avoid excesses that will show up in the manure.
3. Use highly digestible feeds.
4. Keep the animals as healthy as possible and raise them with adequate space and in a good environment.
5. Use approved growth promoters.
6. Optimize the inclusion of essential AAs in diets to allow the dietary protein (nitrogen component) to be minimized.
7. Use supplemental enzymes, particularly phytase, in the feed to increase digestion of nutrients and thus reduce their content in the manure.
8. Use a life-cycle feeding approach, i.e. use diets tailored to the stage of production. This avoids overfeeding and the excretion of excess nutrients in the manure.

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