

**Dried distiller grains with soluble (DDGS) in poultry diets and
manure phosphorus content - implications for feeding
strategies to decrease phosphorus loading**

Dr. Juan Carlos Rodriguez-Lecompte

FINAL REPORT

January 14, 2011



UNIVERSITY
OF MANITOBA

Introduction

Monogastric animals lack the ability to utilize phytate bound phosphorus (P) in poultry diets which are mainly comprised of seeds (cereal grains) or their products (oil seed meal and grain by products) in which about two-thirds of the P is present in the form of phytate-P. Lack of enzymatic phytase in the gastro-intestinal tract of chickens is the main reason for the lower bioavailability. Producers often try to mitigate deficiencies in dietary available P by the addition of inorganic phosphorus to the diet at a higher safety margin. However, with the addition of inorganic P at a higher safety margin, there is a high risk on the environment especially fresh water bodies where the loss of P in the manure gets access to surface waters resulting in eutrophication of the water bodies. One of the major efforts to minimize the pressure of the poultry industry on the environment is by improving the nutritive values of feedstuffs by using exogenous enzymes. Some of the most commonly used enzymatic supplements to poultry diets include phytase, to improve P bioavailability; carbohydrases, to improve energy utilization by chickens.

With the expansion of ethanol production in Canada in recent years, the availability of distillers dried grains plus soluble (DDGS) as a feedstuff for poultry has increased in parallel. Different studies have shown that DDGS can be successfully fed to poultry (Parsons et al., 1983). With the introduction of DDGS to poultry diet, it becomes highly relevant to reevaluate the nutritional profile of this dietary component as there is a scant of literature on the effect of supplementing DDGS in poultry diet on the environment. One of the areas of main interest is the excretion of P from animals fed DDGS. According to NRC (1994), DDGS contains a substantial amount of total P (0.72%) with some studies reporting for even a higher amount of total P (E.g. Shurson, 2003). A strategy for the improvement of availability of P to poultry from DDGS supplementation

can contribute in the mitigation of P excretions from poultry operations thereby ensuring the sustainability of such operations. As with all other ingredients, phytic acid effect on availability of P from DDGS can be improved with the addition of microbial phytase. Therefore, the current study was conducted to determine the effect different inclusion rates of DDGS to poultry diet with or without the inclusion of microbial phytase on manure P levels.

Materials and Methods

An *in vivo* study with laying hens was conducted to determine the effect of different inclusion rate of DDGS, with/without enzymatic supplementation (a combination of phytase and multi-carbohydrase), on nutrient utilization and growth performance. Two phases of feeding strategy was used where both Phases I and II lasted for 10 weeks (24-33 and 34-43 weeks of age, respectively). Shaver white hens at 24 week of age (92% hen day production) to 43rd week of age (92% hen day production) were used in this study. Ten dietary treatments that included DDGS with/without enzyme supplementation were used where the product was incorporated into the diets at the inclusion rates of 0, 5, 10, 15, and 20%. Each experimental diet was fed to 6 replicate pens of 12 hens.

1. Wheat / barley /corn/ SBM diet + 0 % DDGS – Enzyme
2. Wheat / barley /corn / SBM diet + 0 % DDGS + Enzyme
3. Wheat / barley /corn / SBM diet + 5 % DDGS – Enzyme
4. Wheat / barley /corn / SBM diet + 5 % DDGS + Enzyme
5. Wheat / barley /corn / SBM diet + 10 % DDGS – Enzyme

6. Wheat / barley /corn / SBM diet + 10 % DDGS + Enzyme
7. Wheat / barley /corn / SBM diet + 15 % DDGS – Enzyme
8. Wheat / barley /corn / SBM diet + 15 % DDGS + Enzyme
9. Wheat / barley /corn / SBM diet + 20 % DDGS – Enzyme
10. Wheat / barley /corn / SBM diet + 20 % DDGS + Enzyme

The experiment was conducted at the Poultry Research units located at the Department of Animal Science, University of Manitoba, Winnipeg Manitoba, from December 15 2009 to May 4 2010. All experimental procedures were reviewed and approved by the University of Manitoba Animal Care Protocol Management and Review Committee, and birds were handled according to the guidelines described by the Canadian Council on Animal Care.

Hen-day production, egg weight, egg mass, feed efficiency, and nutrient digestibility was monitored. Titanium dioxide (TiO₂) was used as an internal marker. Sample excreta were collected twice (in the intermediate period of each phase) from each pen for the further P and TiO₂ content analysis. The P digestibility will be calculated. Combination of phytase and carbohydrase was used in the study. Diets with enzyme were contained 20% less available P, 5% Ca, 3.5% energy and 3% CP than diets without enzyme premix. Summary of dietary ingredients and compositions of dietary treatments are shown in Tables 1 and 2 for phases I and II, respectively.

Results of phosphorus balance in laying hens

The inclusion of DDGS in phase I showed mixed results in the retention of P where inclusion rates at the lowest (5%) and highest (20%) DDGS showed a reduction in the retention (by 1.6 and 4.7%, respectively), and at 10 and 15% showed an increased (8 and 3%, respectively) retention of P. However, manure P increased as a result of 5 and 10% DDGS, and decreased at 15 and 20%. Similarly, the addition of enzyme regimens showed mixed results in the retention of P where a 3.3 and 3.8% increase in retention was observed in the control and 20% DDGS diets; and a 1.7, 15 and 0.4% decrease in retention was observed in the 5, 10 and 15% DDGS in the diet, respectively. In all treatments in phase I, addition of enzyme resulted in a reduction of P excretion in the manure of animals. A 6.7, 17.5, 0.4, 6.1 and 20 g/kg reduction in P was observed in treatments control, 5, 10, 15 and 20% DDGS plus enzyme, respectively (Table 3).

In phase II, retention of P by birds decreased as a result of supplementing 5% DDGS while an increased P retention was observed with 10, 15 and 20% DDGS in the diet compared to the control (by 6.4, 6.9 and 5.1% respectively). The retention of P in the animals was improved as a result of inclusion of the enzyme combinations. There was a 6, 11, 3, 2, and 2.3% increase in the retention of P when birds were fed control, 5, 10, 15 and 20% DDGS in the diets, respectively. These values were 18, 19, 17, 13 and 21 g/kg, respectively (Table 4).

Table 3. Phosphorus balance in laying hens from 24 to 33 wk of age (phase I) fed adequate or low-P diets containing different levels of distillers dried grains with soluble (DDGS) without or with enzyme supplementation.

Treatment	Total P (%)		Non-phytate P (%)		P retention (%)	P retained (% of diet)	P excreted (% of diet)	P excreted (g/kg manure)
	Calculated	Determined	Calculated	Determined				
Control	0.64	0.73	0.45	0.52	40.5	0.294	0.431	10.53
Control + Enzyme	0.56	0.62	0.36	0.41	43.8	0.270	0.345	9.82
5% DDGS	0.64	0.81	0.45	0.60	38.9	0.313	0.492	12.66
5% DDGS + Enzyme	0.56	0.65	0.36	0.44	37.2	0.241	0.407	10.45
10% DDGS	0.64	0.70	0.45	0.50	48.2	0.336	0.362	10.88
10% DDGS + Enzyme	0.56	0.70	0.36	0.49	33.3	0.230	0.463	10.84
15% DDGS	0.64	0.69	0.45	0.50	43.5	0.298	0.387	9.67
15% DDGS + Enzyme	0.56	0.62	0.36	0.43	43.1	0.265	0.350	9.08
20% DDGS	0.64	0.66	0.45	0.46	35.8	0.236	0.424	10.25
20% DDGS + Enzyme	0.56	0.56	0.36	0.36	39.6	0.222	0.338	8.20

Table 4. Phosphorus balance in laying hens from 34 to 43 wk of age (phase II) fed adequate or low-P diets containing different levels of distillers dried grains with soluble (DDGS) without or with enzyme supplementation.

Treatment	Total P (%)		Non-phytate P (%)		P retention (%)	P retained (% of diet)	P excreted (% of diet)	P excreted (g/kg manure)
	Calculated	Determined	Calculated	Determined				
Control	0.60	0.65	0.40	0.44	33.5	0.218	0.432	10.90
Control + Enzyme	0.53	0.60	0.32	0.39	39.1	0.234	0.366	8.96
5% DDGS	0.60	0.66	0.40	0.44	30.7	0.203	0.457	10.30
5% DDGS + Enzyme	0.53	0.57	0.32	0.35	41.6	0.235	0.330	8.39
10% DDGS	0.60	0.63	0.40	0.41	39.9	0.251	0.379	10.10
10% DDGS + Enzyme	0.53	0.56	0.32	0.34	42.5	0.245	0.310	8.42
15% DDGS	0.60	0.64	0.40	0.43	40.4	0.258	0.382	9.54
15% DDGS + Enzyme	0.53	0.54	0.32	0.33	42.0	0.227	0.313	8.33
20% DDGS	0.60	0.64	0.40	0.44	38.6	0.245	0.390	9.23
20% DDGS + Enzyme	0.53	0.51	0.32	0.31	40.9	0.207	0.298	7.28

Implications:

The experiment showed that the availability of phytate-P from DDGS can be improved by the addition of microbial phytase. This strategy can help mitigate the P output from poultry operations, hence their pressure on the environment. In this study, 20% DDGS level with enzyme supplementation showed a higher reduction in the excreted P suggesting that with regards to addition of DDGS to poultry diets, the recommended 10% level could be increased to as high as 20% with minimal pressure on the environment. However, this recommendation should take in to account the effect of high DDGS levels in the diet on performance of animals. The higher retention of P in the higher DDGS margins was possibly observed due to the high levels of available P in DDGS compared to commonly used ingredients in poultry diet. This higher bioavailability of P has been reported to be mainly as a result of the fermentation process involved in ethanol production (El Hag et al., 2002). With the consideration for the account of higher levels of available P in laying hen diets and incorporating phytase, increases in manure concentrations can be made even at higher DDGS inclusion rates. Future studies which take in to account the variability in nutrient compositions of DDGS originating from different ethanol plants should be carried out to develop a concerted and successful P mitigation from poultry operations.

Reference

- El Hag, M. E., A. H. El Tinay, and N. E. Yousif. 2002. Effect of fermentation and dehulling on starch, total polyphenols, phytic acid content and in vitro protein digestibility of pearl millet. *Food Chem.* 77:193–196.
- NRC. 1994. *Nutrient Requirements of Poultry*. 9th rev. ed. National Academy Press, Washington, DC.
- Parsons, C.M., D. H. Baker, and J. M. Harter-Dennis. 1983. Distillers dried grains with solubles as a protein source for the chick. *Poult. Sci.* 62:2445–2451.