INVESTIGATIONS INTO THE EFFECT OF FEEDING LAYING HENS COMPLETE DIETS WITH WHEAT IN WHOLE OR GROUND FORM, ON PERFORMANCE AND OOCYST OUTPUT AFTER BEING CHALLENGESD WITH COCCIDIOSIS

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Abstract
A preliminary investigation was conducted to examine the effects on performance of feeding a complete balanced layer diet to laying hens late in lay (70 weeks of age) for 16 weeks where wheat was presented in whole and unground forms and zeolite (insoluble grit) was presented in powdered (<250 μm) and particulate forms (2.0-4.00 mm), a total of 4 treatments. There was no significant effect of grain form on egg production, egg weight, feed intake, egg mass or feed conversion. Zeolite presented in grit form significantly improved egg production, egg mass and feed conversion with whole grain with grit having significantly better egg production, egg mass and feed conversion compared to birds fed the ground grain with zeolite in powdered form. The apparent metabolisable energy (AME) of the diets was determined before and after the same birds were challenged with vaccine strains of coccidia. Before and after the coccidiosis challenge the addition of zeolite in grit form gave a significant improvement in the AME of the diet compared to those diets where zeolite was provided in powdered form. The form of grain had no effect on the AME of the diets either before or after the coccidiosis challenge. Birds fed on whole wheat had a significantly lower (2.5 times) oocyst output than birds fed on ground wheat. The zeolite form had no effect on oocyst output. These experiments demonstrate that balanced diets containing wheat in whole form have economic and health benefits when fed to laying birds. The use of insoluble grit in diets, particularly in diets containing whole wheat, has nutritional benefits.

Introduction
The renewed interest in alternative forms of poultry management, such as free range and organic poultry keeping in developed countries where the natural social and physical functions of the birds are fundamental, and limited availability and the high cost of drugs in developing countries, now requires answers on how best to feed, manage and control disease, in particular, coccidiosis, without chemotherapy. The practice of whole grain feeding is encouraged in these alternative management and feeding systems. Feeding whole grain based diets also provides an opportunity to reduce costs through not having to process the grain prior to feeding. This creates opportunities for poultry keepers in developing countries to use cheap, locally available cereal feed ingredients without having to process them prior to feeding. Research has shown that whole grain feeding has significant effect on gizzard development (Cumming, 1990) and have unchanged or improved egg production and feed efficiency equal to that of birds fed on all mash diets where the grain has been pre-ground prior to feeding (Blair *et al*., 1973; Karunajeewa & Tham, 1984; Ouart *et al*., 1986). In addition, the use of insoluble hard grit may play a major role by improving bird performance and feed efficiency compared with birds fed whole grain without grit (Cumming, 1990).

Whole grain feeding in conjunction with grit has been shown to reduce oocysts shedding in crossbred cockerels challenged with coccidiosis (Cumming, 1990).

The purpose of experiment 1 was to investigate the feeding to laying hens late in lay (70 weeks and older) a complete layer diet with the wheat presented in whole and ground form, and with zeolite presented in powder and insoluble grit form (2 to 4 mm) on bird performance. The purpose of experiment 2 was to investigate the effect of a coccidiosis challenge on these same birds on oocyst output and the change in apparent metabolisable energy (AME) of the diets before and after the challenge.

Materials and Methods

Two experiments were conducted, the first involved a total of 128 laying birds, 70 weeks of age were divided into 4 treatments with 4 replicates (blocks). Within the treatments there were 2 factors, wheat presented in ground or whole form and zeolite presented in grit or powdered form. Each replicate consisted of 8 birds in 4 cages, 2 birds per cage. Birds were fed the same specification wheat-based diet for layers eating 100 g/head/day. The composition of the layer diet is shown in Table 1.

Table 1 – Composition of Experimental Diet

Component	Content (g/kg)	Component	Content (g/kg)
Wheat (whole or ground)	600.0	Sodium Bicarbonate	1.1
Soybean meal	167.0	Choline Chloride 60	1.0
Meat Meal (50%)	80.0	DL Methionine	1.7
Tallow	20.0	Yolk Pigment	2.0
Sunflower Oil	12.0	Vitamin/Mineral Premix	2.0
Limestone Fine	81.5	Natural Zeolite	3.0
Salt	1.7	(powder or grit)	

Since the birds had not been fed whole grain previously, birds on the whole grain treatment had the proportion of whole grain increased by 10% (of the diet) each week until 100% of the grain was in whole form, a period of 6 weeks. Diets were fed *ad-libitum* for 17 weeks. Water was freely available. Egg production was recorded daily and feed intake and egg weight was recorded weekly.

At the end of the experiment forty eight birds were kept for experiment 2 and the remaining birds were weighed and then killed by cervical dislocation and their gizzard and proventiculus removed and weighed. The results were subjected to analysis of variance and gizzard weight was subject to analysis of covariance using bird weight as the covariate. The means presented are adjusted for the covariate.

The second experiment had a total of 48 birds, selected from experiment 1, 12 birds were selected from each treatment and allocated to 48 metabolism cages. The birds were allowed to settle into the cages for 2 weeks and the apparent metabolisable energy (AME) was determined according to the conventional total collection method outlined by Fisher (1988). AME was corrected to zero nitrogen balance using the constant 36.5 kJ/g nitrogen retained.

The birds were challenged with a commercially available coccidiosis vaccine (Eimeriavax 4m) sourced from Bioproperties Pty Ltd, Australia. Eimeria species of coccidia in the vaccine were *acervulina, brunetti, maxima, necatrix and tenella.* Immediately after the challenge clean collection trays were placed under the birds to collect faeces. Faeces were collected for

3 successive days, pooled and a 50 g sample taken for oocyst count determination. Oocyst count was determined according to the method outlined by Work Instruction 33 (Animal Research Institute, Qld). After 1 week the AME of the diets was again determined. The results were subjected to analysis of variance and oocyst count was transformed using the $\log_e(X+1)$ transformation prior to analysis.

Results and Discussion

Table 2 summarises the performance data after 16 weeks into the first experiment. There was no significant effect of the way wheat grain was presented to the birds (ground or whole) on egg production, egg weight, feed intake, egg mass or feed conversion.

Table 2 Performance and gizzard weight of 70 week old laying hens fed a diet with grain presented in whole or ground form and zeolite presented in powdered or grit form

		Lay %	Egg wt. g	Egg Mass g/b/day	DFI g/b/day	FCR gFeed/gEgg	Gizz Wt. g
Grain Form							
	Whole	79.5	64.4	51.1	103.6	2.04	31.0[a]
	Ground	76.5	64.6	49.5	103.3	2.10	26.8[b]
	Pooled SE	1.23	0.50	0.91	1.01	0.032	1.20
Zeolite Form							
	Grit	80.9[a]	65.2	52.7[a]	104.3	1.98[a]	29.3
	No Grit	75.1[b]	63.8	47.9[b]	102.5	2.15[b]	28.5
	Pooled SE	1.23	0.50	0.91	1.01	0.032	1.20
Grain Form x Zeolite Form							
Whole	Grit	82.5	63.7[ab]	52.5	104.4	1.99	30.7[a]
	No Grit	76.4	65.0[ab]	49.7	102.8	2.08	31.4[a]
Ground	Grit	79.2	66.7[a]	52.8	104.2	1.98	28.0[ab]
	No Grit	73.8	62.6[b]	46.1	102.3	2.22	25.6[b]
	Pooled SE	1.74	0.70	1.29	1.43	0.046	1.69
Significance							
Grain Form		NS	NS	NS	NS	NS	**
Grit		**	NS	**	NS	**	NS
Grain Form x Grit		NS	**	NS	NS	NS	NS

[ab]Means within a column for grain form or grit with the same superscript do not differ a $P<0.05$

These results are consistent with those found by other researchers (Blair *et al.*, 1973; Karunajeewa, 1978; Karunajeewa & Tham, 1984; Ouart *et al*., 1986). This demonstrates there is an opportunity for making a significant economic savings by not having to grind the wheat, the major component of the diet, without any adverse effects on bird performance. In addition, the use of insoluble hard grit may play a major role in enhancing gizzard function, again with additional improvements in bird performance and feed efficiency compared with birds fed whole grain without grit (Cumming, 1990). Whole grain feeding in conjunction with grit has been shown to reduce oocysts shedding in crossbred cockerels challenged with coccidiosis (Cumming, 1990). Zeolite presented in grit form significantly improved egg production, egg mass and feed conversion but did not influence daily feed intake or egg weight. Hard insoluble grit has not routinely been used in commercial diets for poultry for decades. However, there is evidence from earlier years (Heuser and Norris, 1946; Balloun and Phillips, 1956; Scott and Heuser, 1957) that there is an increase in egg production when insoluble grit was fed in conjunction with whole grain. Our work would support the work of these early researchers. There is less evidence of a need for insoluble grit when all-mash laying diets are fed. Again, earlier researchers (MacIntyre and Jenkins, 1952); Fuller, 1958)) observed no increase in egg production or feed efficiency from feeding grit with all-mash

layer diets. However, our work would support the feeding of grit even when the grain was ground.

Table 3 summarises the AME of the diets before and after a coccidiosis challenge and the back-transformed means of oocyst number output in the faeces in the second experiment. Before and after the coccidiosis challenge the addition of zeolite in grit form gave a significant improvement in the AME of the diet compared to those diets where zeolite was provided in powdered form. The form of grain had no effect on the AME of the diets either before or after the coccidiosis challenge. This is consistent with the findings of McIntosh *et. al.*, (1962) who found no consistent effect of the grain form on the ME of the grain. Whole grain fed in conjunction with zeolite in grit form significantly improved the AME of the diet both before and after the coccidiosis challenge. Again, this is consistent with the findings of McIntosh *et. al.*, (1962) who found grit feeding consistently increased the ME of cereal grains. They also found the responses due to grit were greater when whole, rather than ground or pelleted grains were fed. There was a significant interaction for the AME of the diets between grain form and zeolite form after the coccidiosis challenge. This indicated that the diet which contained whole grain had a significantly inferior AME when zeolite was not presented in grit form, but had a superior AME when zeolite was in grit form. Ground grain with and without zeolite in grit form had the same AME and was an inferior AME to the diet with whole grain and zeolite grit but superior to the diet with whole grain and zeolite in powdered form. This AME interaction did not occur prior to the coccidiosis challenge.

Birds fed on whole wheat had a significantly lower (2.5 times) oocyst output than birds fed on ground wheat. This is in agreement with Cumming (1990) who found that when grain was fed in whole form to crossbred cockerels challenged with coccidiosis, oocyst shedding was reduced. The zeolite form had no effect on oocyst output.

Table 3 AMEn of Diets fed to laying hens before and after a coccidiosis challenge and oocyst count in faeces after the coccidiosis challenge.

		AME Before MJ/kg DM	AME After MJ/kg	Oocyst Count Back-Trans Means Number/g faeces
Grain Form				
	Whole	13.82	13.42	54208[b]
	Ground	13.68	13.66	140877[a]
	Pooled SE	0.125	0.127	
Zeolite Form				
	Grit	14.07[a]	13.86[a]	88545
	No Grit	13.44[b]	13.22[b]	86246
	Pooled SE	0.125	0.127	
Grain Form x Zeolite Form				
Whole	Grit	14.22[a]	14.08[a]	55409[a]
	No Grit	13.42[b]	12.76[b]	53032[a]
Ground	Grit	13.92[ab]	13.64[a]	141496[b]
	No Grit	13.45[b]	13.68[a]	140261[b]
	Pooled SE	0.176	0.179	
Significance				
Grain Form		NS	NS	**
Zeolite Form		***	***	NS
Grain Form x Zeolite Form		NS	***	NS

[ab]Means within a column for grain form or grit with the same superscript do not differ a P<0.05

Conclusions

These experiments demonstrate that balanced diets containing wheat in whole form have economic and health benefits when fed to laying birds. The use of insoluble grit in diets, particularly in diets containing whole wheat has nutritional benefits. The implications of these findings have consequences for poultry keepers in developing countries where chemotherapy may not always be available to control coccidiosis. The use of whole wheat in diets for laying hens appears to be one mechanism whereby birds can help to control a challenge from coccidiosis.

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