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Leucaena Leaf Meal and Local Limestone in the Diet of Laying Hens

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Abstract—Two experiments were conducted to evaluate *Leucaena* leaf meal (LLM) with or without local limestone (crushed fossil coral) as a source of calcium and to compare LLM's merit with commercial dehydrated alfalfa meal (ALM). In Experiment 1, one hundred and twenty-eight layers of the commercial "Gold Links" cross were randomly assigned to 4 dietary treatment groups of 32 birds each in a completely randomized design. Treatments consisted of 3% ALM, 3% LLM, 0.1 mg/kg supplemental riboflavin, and a control. In Experiment 2, post molt layers were fed diets that consisted of two levels of LLM (0, 3%) and two sources of calcium (commercial limestone, crushed coral). Results of Experiment 1 indicates that LLM, at 3% inclusion without supplemental iron salts, is comparable to imported ALM. Both LLM and ALM diets significantly improved feed consumption ($p < 0.05$). In Experiment 2, LLM significantly improved feed consumption and hen-day egg production ($p < 0.05$), however shell thickness was significantly decreased ($p < 0.05$). Hens receiving crushed coral diets maintained significantly higher egg production and body weight ($p < 0.05$), compared to those on commercial limestone. Source of calcium, and source of calcium × LLM interaction were also significant ($p < 0.05$) with respect to body weight.

Introduction

Leucaena leucocephala, locally known as tangantangan or leucaena, was introduced to Guam as a soil conservation measure. In addition to leucaena's value as a pasture plant for livestock, dried leucaena leaf is a valuable feed ingredient for poultry. Leucaena leaf meal (LLM) contains 20–24% crude protein (PCARR, 1978), and has high levels of riboflavin, xanthophylls, beta carotenes, and vitamin K (Chou & Ross 1965) that equal or surpass those in alfalfa leaf meal. However, leucaena leaf meal contains mimosine, tannin and a trypsin inhibitor (Acamovic 1988) that limit its use in poultry and swine feeds. D'Mello et al. 1987 observed that 5 and 10% LLM without any supplements depressed efficiency of feed utilization and severely reduced growth of broilers at 10% inclusion, whereas pigmentation of feed and shanks were markedly improved. According to Acamovic, the reduction in chick performance can be prevented by supplementing with Fe (III), polyethylene glycol and cholesterol. Lopez et al. 1979 did not observe any significant decrease in layer production at 5% LLM, however, production was significantly reduced at 10% feeding level without ferrous sulfate supplementation. Research at the University of the Philippines indicated that LLM at low levels (2.5%, 7.5%) stimulated growth, whereas growth depression occurred with LLM at 30% of the diet (PCARRD 1984). Another factor that limits maximum use of LLM is its relatively low metabolizable energy content. Devegowda et al. 1986 determined that the true metabolizable energy of leucaena leaf meal was 983 kcal/kg. However, possible improvements in metabolizable energy through iron sulfate supplementation, enzyme supplementation or processing have not been examined. In addition to its feed value, LLM incorporation in layer and broiler diets improves pigmentation of yolk and skin which is desirable specially with tropical diets based on cassava. In view of the fact that Guam imports nearly all of its poultry feed at a high price, it was of interest to study the potential of LLM and other local feed resources, as a feedstuff substitute.

Materials and Methods

Two experiments were conducted to evaluate LLM in the diet of laying hens. *Leucaena* was harvested every 6 weeks by cutting the branches and allowing the leaves to dry for 2 to 3 days in the sun. The branches were then shaken to harvest the dry leaves. The dried leaves were passed through a hammer mill prior to incorporation in the diets. In Experiment 1, one hundred and twenty-eight 56-week old brown layers of the commercial "Gold Links" cross were randomly assigned to 4 dietary treatment groups of 32 birds each. A treatment consisted of 8 replications of two consecutive pair caged layers in a completely randomized design experiment. Diets were calculated to be isocaloric and isonitrogenous, providing 16% crude protein and 2980 kcal/kg of metabolizable energy. Water was provided *ad libitum.* Egg production was recorded daily. Feed consumption and body weight changes were measured monthly at the end of each 28 day periods over 5 consecutive periods. Egg weight and shell thickness were measured from 3 consecutive collections at the end of each 28-day period. Feed efficiency was computed for each period.

Prior to conducting Experiment 2, the 76-week old hens from Experiment 1 were forced into molting by withdrawing water for 3 days and withdrawing feed for 7 days. The hens lost 25% of their initial body weight. In Experiment 2, Ninety two layers were selected from the post molt stock. Hens were randomly allocated to 4 treatments of 6 replicates per treatment with 4 pair-caged layers per replicate in a completely randomized design experiment. Diets were calculated to be isocaloric and isonitrogenous providing 16% crude protein and 2980 kcal/kg of metabolizable energy. Egg production was recorded daily. Egg weight and shell thickness were measured twice a week. Feed consumption and body weight were measured monthly. Data were collected over a 4 month period.

Dietary treatments for Experiments 1 and 2 are summarized in Table 1. Experimental diets with calculated composition are presented in Tables 2 and 3.

All data were subjected to statistical analysis using the GLM-ANOVA procedure of NCSS computer software package. Means were compared using Fisher's New Least Square Difference (LSD) Test (Hentze 1990).

Table 1. Dietary treatments[1].

Treatment	Experiment 1	Experiment 2[2]
1	Regular (Control)	0% LLM, crushed coral
2	Regular + Riboflavin[3]	3% LLM, crushed coral
3	3% ALM	0% LLM, Commercial limestone
4	3% LLM	3% LLM, commercial limestone

[1] ALM = Alfalfa Leaf Meal, LLM = Leucaena Leaf Meal.
[2] Crushed coral was obtained from Hawaiian Rock Company, Mangilao, Guam.
[3] Riboflavin was supplemented at 0.1 mg per kg of diet.

Table 2. Composition of experimental diets.

	Experiment 1			
	1	2	3	4
Ingredients:		%		
Yellow corn	67.7	67.7	64.7	65.3
Soybean meal 48% C.P.	15.3	15.3	14.6	14.2
Meat & Bone Meal 50%	5.0	5.0	5.0	5.0
Fat (A-V blend)	2.2	2.9	3.0	2.9
Biophosphate	0.9	0.9	0.9	0.9
Salt	0.4	0.4	0.4	0.4
Vitamin-Mineral Premix[1]	0.3	0.3	0.3	0.3
Methionine	0.2	0.2	0.2	0.2
Limestone	8.0	8.0	7.9	7.8
Alfalfa meal	—	—	3.0	—
Leucaena meal	—	—	—	3.0
Riboflavin	—	0.0002	—	—
Calculated analysis:				
Energy, Kcal of ME per kg	2981	2981	2980	2982
Crude Protein %	16.0	16.0	16.0	16.0
Lysine %	0.76	0.76	0.75	0.74
Methionine %	0.45	0.45	0.45	0.45
Methionine+ Cystine %	0.70	0.70	0.70	0.70
Calcium %	3.80	3.80	3.80	3.80
Available Phosphorus %	0.49	0.49	0.49	0.49

[1] Vitamin-Mineral Premix provided the following /kg of diet: 5500 IU vitamin A, 1800 ICU vitamin D_3, 0.75 mg menadione sodium bisulfite, 11 mg vitamin E, 6.6 mg riboflavin, 11 mg ca-pantothenate, 77 mg niacin, 0.22 mg d-biotin, 0.66 mg folacin, 0.011 mg B_{12}, 500 mg choline.Cl, 5 mg copper, 50 mg iron, 50 mg manganese, 50 mg zinc, 1.5 mg iodine, 0.5 mg cobalt and 46 mg calcium.

Table 3. Composition of experimental diets.

	Experiment 2			
	1	2	3	4
Ingredients:		%		
Yellow corn	56.8	54.4	59.9	57.4
Soybean meal 48% C.P.	22.4	21.3	21.9	20.8
Fat (A-V blend)	5.8	6.5	4.6	5.4
Biophosphate	2.0	2.0	2.0	2.0
Salt	0.5	0.5	0.5	0.5
Vitamin-Mineral Premix[1]	0.3	0.3	0.3	0.3
Methionine	0.2	0.2	0.2	0.2
Commercial limestone	—	—	10.5	10.4
Crushed coral	12.0	11.8	—	—
Leucaena leaf meal	0	3.0	0	3.0
Calculated analysis:				
Energy, Kcal of ME per kg	2979	2979	2980	2978
Crude Protein %	16.0	16.0	16.0	16.0
Lysine %	0.83	0.82	0.82	0.81
Methionine %	0.45	0.45	0.45	0.45
Methionine+ Cystine %	0.70	0.70	0.70	0.70
Calcium %	4.50	4.50	4.50	4.50
Available Phosphorus %	0.58	0.58	0.58	0.58

[1] Refer to footnote of Table 2.

Table 4. Effect of alfalfa meal, leucaena meal and supplemental riboflavin on the performance of laying hens, Experiment 1[1,2]

Treatment	Feed consumption g/hen/day	Feed efficiency kg/doz	Feed efficiency kg/kg egg	Hen-day egg production (%)	Egg weight (g)	Shell thickness (mm) × 10^2
Control	100[a]	2.16[a]	2.70[a]	56.8[a]	66.6[ab]	31.6[a]
Riboflavin	108[b]	2.41[a]	3.12[a]	56.3[a]	65.1[a]	29.8[a]
Alfalfa	108[b]	2.14[a]	2.62[a]	61.9[a]	68.2[b]	30.1[a]
Leucaena	110[b]	2.25[a]	2.75[a]	62.1[a]	67.7[ab]	30.7[a]

[a-b] Means within each column with no common superscripts differ significantly (P<0.05) according to Fisher's New LSD Test.

[1] Eight replicate pens containing 4 hens in paired cages received each treatment.

[2] Figures are mean values of five 28-day production periods.

Results and Discussion

Results of Experiment 1 are summarized in Table 4. Diets containing LLM, ALM and supplemental riboflavin significantly improved feed consumption ($p < 0.05$). Since both *Leucaena* and alfalfa are rich sources of riboflavin, the effects on feed consumption may be due to riboflavin. Egg weight was significantly higher for ALM treatment compared to riboflavin supplemented diets, confirming numerous observations by various researchers that green forages contain some unidentified growth factors. These unidentified factors may be trace minerals for which poultry requirements have not been established (NRC 1984). There were no significant differences in egg size between LLM, ALM and the control, although a trend towards heavier egg weights in favor of alfalfa and *Leucaena* was observed. Feed efficiency, hen-day egg production and shell thickness, did not differ significantly among treatments.

The rationale for conducting Experiment 2 was to evaluate LLM in conjunction with crushed coral for possible interactions towards a goal of developing local feed mixes substituting imported feed as much as possible. Results of Experiment 2 are summarized in Tables 5 and 6. Addition of 3% LLM to the diet increased feed consumption ($p < 0.0002$) over the control diets. Diets containing LLM also improved hen-day egg production ($p < 0.002$). Shell thickness, however, was lower for the LLM treatments ($p < 0.02$). This reduction may be partially explained by the significantly higher egg production associated with the LLM diets. Source of calcium had a significant effect on hen-day egg production ($p < 0.02$) and body weight ($p < 0.01$). Hens receiving crushed coral diets maintained body weight and higher egg production compared to those on commercial limestone. There may be some beneficial trace elements in the crushed coral

Table 5. Effect of leucaena leaf meal and source of calcium on the performance of laying hens, Experiment 2.[1,2]

Treatment	Feed consumption g/hen/day	Feed efficiency kg/doz	Body weight change[3] %	Hen-day egg production %	Egg weight g	Shell thickness 10^{-2} mm
3% Leucaena Leaf Meal						
Crushed coral	108[a]	1.92[a]	100[ab]	67.9[a]	68.0[a]	28.8[ab]
Commercial limestone	107[a]	2.27[a]	98[ab]	56.5[ab]	69.2[a]	27.6[a]
0% Leucaena Leaf Meal						
Crushed coral	87[b]	2.03[a]	107[a]	51.1[bc]	65.8[a]	31.3[b]
Commercial limestone	75[b]	2.11[a]	92[b]	43.5[c]	66.1[a]	29.4[ab]
			Probability Levels			
Leucaena leaf meal	0.0002	0.84	0.85	0.002	0.18	0.02
Source of calcium	0.25	0.11	0.01	0.02	0.70	0.09
Interaction	0.28	0.31	0.04	0.61	0.82	0.75

[a-c] Means within each column with no common superscripts differ significantly (P<0.05) according to Fisher's New LSD Test.

[1] Six replicate pens containing 4 hens in paired cages received each treatment.

[2] Figures are mean values of 4, 28-day period post molt production.

[3] Body weight change based on initial body weight = 100%.

Table 6. Effect of leucaena leaf meal and source of calcium on the performance of laying hens, Experiment 2.[1,2]

Factor	Feed consumption g/hen/day	Feed efficiency kg/doz	Body weight change[3] %	Hen-day egg production %	Egg weight g	Shell thickness 10^{-2} mm
Leucaena Leaf Meal						
0%	81[a]	2.07[a]	99[a]	47.3[a]	66.0[a]	30.2[a]
3%	107[b]	2.10[a]	100[a]	62.2[b]	68.6[a]	28.2[b]
Source of Calcium						
Crushed coral	97[a]	1.98[a]	103[a]	59.5[b]	66.9[a]	29.9[a]
Commercial limestone	91[a]	2.19[a]	95[a]	50.0[a]	67.6[a]	28.5[b]

[a-b] Means within each column with no common superscripts differ significantly (P<0.05) according to Fisher's New LSD Test.

[1] Six replicate pens containing 4 hens in paired cages received each treatment.

[2] Figures are mean values of 4, 28-day period post molt production.

[3] Body weight change based on initial body weight = 100%.

deposits of Guam. However, further studies are needed to substantiate this observation. There was a significant source of calcium × LLM interaction ($p <$ 0.04) with regard to body weight. Crushed coral increased body weight in the absence of LLM. However, with 3% LLM added, there appears to be no significant differences between the sources of calcium.

From the results of Experiments 1 and 2, it can be concluded that *Leucaena* leaf meal at low level is comparable to alfalfa meal with beneficial effects on the performance of laying hens before and after forced molt. High level of riboflavin and the presence of some unidentified growth factors may be involved. In addition, *Leucaena* leaf meal improves yolk pigmentation similar to alfalfa leaf meal, which may be important in cassava based tropical feeds. Addition of iron salts is necessary only when higher levels of *Leucaena* is used, in order to counteract the negative effects of mimosine. Since Guam is totally dependent on imported feed, substitution of locally competitive feed ingredients such as *Leucaena* leaf meal and crushed coral could substantially reduce cost of production and stimulate the animal industry.

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