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Note

Enzyme and Amino Acid Supplementation of Leucaena Leaf Meal-Based Diet for Broiler Chicks

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Abstract—A total of 336 broiler chicks were used in a study to evaluate the effects of feeding high levels of leucaena leaf meal (LLM) with or without cellulase enzyme (ENZ) and/or supplemented amino acids (AA). Cellulase enzyme preparation from *Penicillium funiculosum* was incorporated at a rate of 5g/100kg per diet. D-L methionine and L-lysine were added to supply these amino acids at 15% above the NRC (1994) requirements. Results indicated a significant decrease ($P < 0.05$) in feed intake and body weight gain when chicks were fed diets containing 10% LLM. Addition of enzyme did not affect feed intake or weight gain as compared to the control group. Addition of amino acids and enzyme alone or in combination significantly improved feed conversion when compared to group fed LLM with no supplement.

Introduction

The requirement of dietary fiber for poultry remains unspecified by the National Research Council (NRC 1994), although earlier reports indicate its adverse effect on growth rate and feed conversion (Sibbald et al. 1960, Isaksson et al. 1982, Abdelsamie et al. 1983, Fengler & Marquardt 1988). Soluble fibers from in vitro studies have been found to inhibit the activities of lipase, amylase and trypsin (Isaksson, et al. 1982, Fengler and Marquardt, 1988). Classen et al. (1988) observed that the majority of growth differences noted between broilers fed barley or wheat versus corn diets occurred during the starter period. This observation was later confirmed by Leeson et al. (1991) who reported that diet dilution by cellulose from rice hulls resulted in a significant reduction ($P < 0.05$) in body weight with no change in overall efficiency of feed utilization. Abdelsamie et al. (1983) conclude that since chicken in all treatments consumed equal amounts of metabolizable energy, the fiber may have affected the efficiency of protein utilization. Observations by Leeson et al. (1991) suggest that chicken fed the high fiber diets used energy efficiently during undernutrition. Abawi & Diambra (1993) reported that 3% leucaena

leaf meal (LLM) significantly improved feed consumption when fed to laying hens. In addition to its feeding value, LLM incorporation in layer and broiler diets improves pigmentation of the yolk and skin which is desirable specially with non-conventional diets based on wheat, barley or cassava (Abawi & Diambra, 1993).

Commercial enzymes will become essential feed additives as their ability to improve feed utilization of fibrous material becomes evident. Reports indicate that β-glucanase enzymes added to barley diets and fed to chicks improve weight gain and feed efficiency, as opposed to chicks given diets without enzymes (Classen et al. 1988). Brenes et al. (1993) also reported improved chick performance when raw lupin diet was supplemented with enzyme. However, Perez-Escamilla et al. (1988) indicated that incorporation of 1% hemicellulase did not improve body weight gain of chicks.

The present study was undertaken to investigate the effects of feeding a relatively high level of leucaena leaf meal (LLM at 10%), with or without cellulase from *Penicillium funiculosum* at or above recommended NRC (1994) levels for lysine and methionine. Considering the high cost of imported feed and abundance of leucaena on Guam, increasing intake of LLM with the help of enzyme and amino acid supplements could have a significant impact on reducing feed cost.

Materials and Methods

A total of 336 day-old broiler chicks, obtained from a commercial hatchery, were wing-banded and randomly allocated to 6 treatments. Each treatment consisted of 4 replicates of 14 birds each. The experiment was conducted on broiler cages measuring 90 cm long 60 cm wide and 34 cm deep. Temperature was maintained at about 32 °C during the first 10 days of brooding. Light was provided at all times to encourage night feeding. A typical corn-soy diet with 2% crude fiber served as control. A second diet with 10% LLM was formulated to contain the same nutrients as the control diet, except for crude fiber (4%). Methionine and lysine were added to the third LLM based diet, to supply these amino acids at 15% above the NRC (1994) requirements. Three additional diets were formulated with cellulase from *P. funiculosum* at a rate of 5g/100 kg diet for a total of 6 dietary treatments (Table 1). Feed and water were provided ad libitum throughout the experiment. All feeds were in mash form.

Individual body weight and feed intake per each replicate group were recorded weekly. Feed utilization was also monitored. Data were collected for about 4 weeks (25 days) on the starter diets. Data were analyzed using the GLM ANOVA procedures; the means were compared using Duncan's multiple range test (SAS 1982).

Results and Discussion

Treatment mean values of feed intake for each weekly period are presented in Table 2. Broiler chicks fed the LLM diets, with or without supplementation, consistently consumed less feed than the controls. However, the volume of feed that the

Table 1. Composition of the Basal Starter Diets for broiler chicks fed for 4 weeks[1]

Ingredients	Control	Leucaena amino acids	Leucaena + 15%
	----------% ----------		
Corn	58.69	49.07	49.69
Soybean Meal	35.39	32.68	31.39
leucaena Leaf Meal	—	10.00	10.00
Limestone	1.50	1.30	1.20
Dicalcium Phosphate	1.21	1.31	1.25
Coconut Oil	1.12	4.09	4.01
Fish Meal	0.98	0.36	1.00
Vitamin and Mineral Premix[2]	0.50	0.50	0.50
Salt (NaCl)	0.48	0.50	0.50
DL-Methionine	0.13	0.15	0.22
L-Lysine	—	0.05	0.25
Calculated Analysis[3]			
ME, kcal/kg	2992.00	2990.00	2992.00
Protein, %	23.00	23.00	23.00
Calcium, %	0.99	1.10	1.09
Phosphorus (available), %	0.45	0.45	0.45
Crude Fiber	2.20	4.00	4.00
Lysine	1.30	1.30	1.49
Methionine	0.50	0.50	0.59

[1]Cellulase enzyme was added at a rate of 5g/100kg diet from Penicillium funiculosum (5.0 units/mg solid) obtained from The Sigma Company.
[2]Vitamin-Mineral premix contains per kg: 5500 IU vitamin A, 1800 ICU vitamin D3, 0.75 mg menadione sodium bisulfite, 11mg vitamin E, 6.6mg riboflavin, 11 mg Ca-pantothenate, 77 mg miacin, 0.22 mg biotin, 0.66 mg folacin, 0.011 mg B12, 500 mg choline, 5 mg Cu, 50 mg Fe, 50 mg Mn, 50 mg Zn, 1.5 mg Co, 46mg Ca.
[3]Based on NRC (1994).

Table 2. Weekly feed intake of broiler chicks fed for 4 weeks.

Age (Wk)	Treatments[1]						
	MSE	Control	Leucaena +AA	Leucaena +ENZ	Leucaena +AA+ENZ	Leucaena +ENZ	Control
1	18.55	122.85^{a}	99.96^{b}	99.96^{b}	114.52^{ab}	99.96^{b}	122.85^{a}
2	6.09	230.30^{a}	194.60^{b}	201.74^{b}	196.42^{b}	203.56^{b}	230.30^{a}
3	82.81	442.82^{a}	373.17^{b}	373.17^{b}	373.17^{b}	396.41^{b}	444.57^{a}
4	162.05	596.82^{b}	546.84^{bc}	540.54^{c}	565.60^{bc}	531.16^{c}	653.10^{a}

[1]Means within a row with the same superscript are not different ($P > 0.05$).
AA = Amino Acid; ENZ = Enzyme; MSE = Mean Standard Error.

birds can consume is limited to the gastrointestinal capacity and thus could prevent birds from consuming enough feed to satisfy their energy needs. In this study, the bulk in the high fiber diet was apparently a limiting factor in feed intake. Enzyme and/or amino acid supplements did not improve feed intake throughout the 4-week period. One of the most important physical properties of dietary fiber is its capacity to expand by holding water inside the gastrointestinal tract and thus increase the bulk of the intestinal content (Hedge et al. 1978). Savory & Gentle (1976) and Abdelsamie et al. (1983) reported that high dietary fiber caused an increase in gut size over time.

Mean values for weekly weight gain are presented in Table 3. LLM significantly ($P < 0.05$) reduced weight gain during the 4 week period. Adding amino acids or enzyme separately to the LLM-diet did not improve weight gain of the LLM-fed birds. However, the combination of amino acid and enzyme supplements significantly ($P < 0.05$) improved weight gain during the second week.

The tendency of overcoming the growth difference with age was earlier reported by Classen et al. (1988) who found that weight gain from 21 to 42 days did not differ significantly among treatments. The results of this study confirm that differences were largely confined to the 0 to 21 day-period.

Table 4 presents feed conversion data. Birds fed the control diet (without LLM) were more efficient in converting feed into weight gain. The enzyme im-

Table 3. Weekly weight gain of broiler chicks fed for 4 weeks.

Age (Wk)	Treatments[1]						
	MSE	Control	Leucaena +AA	Leucaena +ENZ	Leucaena +AA+ENZ	Leucaena +ENZ	Control
1	3.22	102.62^{a}	82.32^{b}	86.45^{b}	86.24^{b}	84.77^{b}	105.56^{a}
2	4.34	157.92^{a}	122.43^{c}	126.98^{c}	127.47^{c}	135.73^{b}	164.92^{a}
3	43.40	254.17^{a}	198.94^{b}	204.19^{b}	200.48^{b}	218.47^{b}	250.46^{a}
4	90.02	323.12^{a}	267.05^{b}	268.80^{b}	280.35^{b}	281.05^{b}	351.75^{a}

[1]Means within a row with the same superscript are not different ($P > 0.05$).
MSE = Mean Standard Error

Table 4. Feed conversion of broiler chicks fed for 4 weeks.

Age (Wk)	Treatments[1]						
	MSE	Control	Leucaena +AA	Leucaena +ENZ	Leucaena +AA+ENZ	Leucaena +ENZ	Control
1	0.005	1.19^{ab}	1.21^{ab}	1.15^{b}	1.30^{a}	1.16^{b}	1.16*b*
2	0.00	1.44^{c}	1.58^{a}	1.45^{d}	1.54^{b}	1.50^{c}	1.39^{f}
3	0.002	1.73^{c}	1.87^{a}	1.82^{ab}	1.85^{ab}	1.81^{ab}	1.78^{bc}
4	0.00	1.85^{c}	2.05^{a}	2.00^{c}	2.02^{b}	1.89^{d}	1.85^{c}

[1]Means within a row with the same superscript are not different ($P > 0.05$).
MSE = Mean Standard Error

proved feed conversion in the second and fourth week only. For that same period AA improved feed conversion when LLM is fed, but failed to reach the level of the control group. The combined effect of amino acids and enzymes resulted in a better-feed efficiency in the fourth week as compared to the group receiving LLM with or without amino acids or enzymes. This suggests that LLM based diet supplemented with both amino acids and enzymes perhaps could sustain growth efficiently at a higher level of enzymes.

It appears that the slow growth observed with LLM-diet was not related to lysine and methionine deficiency alone, or to fiber digestibility, but rather to a compound effect of all of the above including physical constraints of the guts holding capacity, limiting optimum calorie and protein intake. Long term effects of LLM-diet may change as gut dimensions increase, allowing sufficient intake of calories and proteins as a result of increased absorption area in the small intestine. Further studies are needed to evaluate long-term effects of the LLM-diet in relation to gut size on market age broilers with higher levels of cellulase.

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