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Effect of Dietary Inclusion of Leucaena (Leucaena leucocephala) and Banana Flour (Musa cavendishii) on Performance of Laying Hens

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ABSTRACT

The aim of the present study was to evaluate the effects of Leucaena (*Leucaena leucocephala*) and Banana flour *(Musa cavendishii)* on performance of laying hens. Fifty laying hens (3 months of age) were randomly distributed into five experimental groups, each consisting of 10 laying hens. The groups were control (10 laying hens); L_6 (Leucaena, 6 g/day (10 laying hens)); L_8 (Leucaena, 8.0 g/day (10 laying hens)); L_{10} (Leucaena, 10 g/day (10 laying hens)); and L_{12} (Leucaena, 12 g/day (10 laying hens)), in addition, five levels of Banana flour control (10 laying hens); 25% (10 laying hens); 50%, (10 laying hens); 75% (10 laying hens); and 100% (10 laying hens), were assessed respectively. The experimental period lasted from 4 to 8 weeks. The results of this study showed that there were no significant differences between of treatments L_6, $L_{8,}$ $L_{10,}$ and L_{12} for body weight during the first 30 days compared with the control, whereas for weight gain, statistically significant differences were observed between the control compared with the treatments L_6, $L_{8,}$ $L_{10,}$ and L_{12} for days 10, 20 and 30 (p<0.05).

Additionally, statistically significant differences were found between different levels of Banana flour for weight gain (g) between the control with the levels 25, 50 75, 100%, respectively for days 20 and 30. In the case of feed intake (g) statistically significant differences were found during day 30 between the control and 100%, also between the control and levels 25, and 75%, respectively. From the results, it can be concluded that the inclusion of Leucaena and banana flour have effects on weight gain, body weight and feed intake of laying hens.

INTRODUCTION

Many of the traditional ingredients used in hen's diets are forecast to be in short supply within ten years. Leucaena (*Leucaena leucocephala*) is a plant native to Central America, it is grown extensively in many parts of the world (Agbede, 2003). This plant is considered as a protein source for the poultry sector (Alkarkhi *et al.,* 2011). It is a plant rich in nutrients with high digestibility fibers, however, it contains toxic amino acid as the mimosine that are found mainly in the leaves and the dried seeds (Atawodi *et al.,* 2010; Mutayoba *et al.,* 2011). According to Dilger *et al.* (2004), the use of ingredients with high fiber levels in poultry diets may reduce the digestibility of nutrients and increase nitrogen excretion. Safwat *et al.* (2014) have reported the importance of Leucaena in the laying hen's diets. Studies on Leucaena showed that the leaves are rich in energy, protein, and vitamins (Nieves *et al.,* 2004; Ayssiwede *et al.,* 2011). Limited research was published about the use of Banana flour in animal feed, in particular laying hens.

Banana, is the fourth plant more produced in the world with over 7 million tons (Ribiero *et al.,* 2012). It contains as high as 74% starch

on dry matter basis (Babatunde 1992). Banana is rich in dietary fibre, proteins, essential amino acids, cellulose, hemicelluloses, lignin, starch, resistant starch, polyunsaturated fatty acids and potassium (Rodríguez-Ambriz *et al.,* 2008; Sarawong *et al.,* 2014). Currently, industrial flour production from green banana is of interest in view of its nutritional value, especially the high quantity of resistant starch between 40.9-58.5 % and dietary fibre 6.0-15.5 % (Tribess *et al.,* 2009; Sarawong *et al.,* 2014). It has high starch content and is widely used in animal feed (Martinez *et al.,* 2009). Despite of being a valuable nutritional component, the lack of use in animal diet constitutes a very nutritional due to contains extractable bioactive compounds, which can be used as value-added materials (Safwat *et al.,* 2014). It is projected that the utilization of Leucaena and Banana flour is to be a sustainable resource for laying hens production and diet, as they are easily available and contain a considerable amount of nutrients. The purpose of this study was to assess the effects of *Leucaena leucocephala* and Banana flour on performance of laying hens.

MATERIALS AND METHODS

Animals, experimental treatments and diet

The experiment was performed housing a total of 50 laying hens in a poultry facility at the University of State (Haiti). They were randomly selected from State University farm, and each laying hen was placed in individual cages. The facility was 10× 25 meters with four ventilators and 4 windows, and a total of 15 land-pens (1.6 × 0.8 m) were used. Ventilation was turned on to optimize the climate 24h before the laying hens were brought in.

Air humidity was kept at 60 to 65 % in the early growing period by spraying water on the floor. Lamps were installed at a height of 2.2 meters above the floor. The water supply was through drinkers, one for each hen and the food supply was a feeder per hen. The experimental design included five experimental groups of 10 laying hens each. The dietary treatments were as follows: Control (10 laying hens); L_6 (Leucaena, 6 g/day (10 laying hens)); L_8 (Leucaena, 8.0 g/day (10 laying hens)); 3) L_{10} (Leucaena, 10 g/day (10 laying hens)); and 4) L_{12} (Leucaena,, 12 g/day (10 laying hens)), in addition, five levels of Banana flour: Control (10 laying hens); 25% (10 laying hens); 50%, (10 laying hens); 75% (10 laying hens) and 100% (10 laying hens) were assessed.

Chemical composition and chemical analyses of experimental diets

Chemical composition and chemical analyses of experimental diets of Leucaena and banana flour were determined using the standard AOAC (2000) procedures to determine dry matter (DM), organic matter (OM), ether extract (EE), crude fiber (CF), and crude protein (CP) content. Neutral detergent fiber (NDF) and acid detergent fiber (ADF) as sequential method were performed according to Van Soest *et al.* (1991). Tables 1, 2 and 3 show the composition and chemical analyses of experimental diets containing different levels of *Leucaena leucocephala* and Banana flour.

Table 1 – Composition and chemical analyses of experimental diets containing different levels of *Leucaena leucocephala*.

Treatments	Ingredients (%)			
Leaf meal	6	8	10	12
Sorghum	57.34	56.00	54.46	52.22
Soya bean meal	15.45	15.12	14.56	12.69
$CaCO_3$	8.75	8.10	7.8	7.46
Canola meal	5.00	5.00	5.00	5.00
Corn stover	3.00	3.00	3.00	3.00
Soya oil	1.92	2.29	2.5	3.48
Di-Cal-phosphate	1.56	1.46	1.38	2.3
Lysine	0.18	0.27	0.38	0.80
Methionine	0.21	0.17	0.33	0.46
NaCl	0.30	0.30	0.30	0.30
Mycosorb	0.10	0.10	0.10	0.10
Funginat	0.05	0.05	0.05	0.05
Choline chloride	0.05	0.05	0.05	0.05
Vita. and Min. premix[a]	0.08	0.08	0.08	0.08
Anti-oxidant	0.01	0.01	0.01	0.01
Total	100.00	100.00	100.00	100.00
Chemical analysis (calculated as % on DM basis)				
Dry matter (%)	87.25	89.56	90.34	90.44
Gross energy (kcal/kg)	15.68	16.24	15.46	17.15
Crude protein (%)	19.60	19.76	20.10	20.46
ADF (%)	8.4	9.10	9.34	9.88
NDF (%)	54.45	58.20	59.38	61.22
Calcium (%)	3.12	3.44	4.22	4.66
Phosphorus (%)	0.56	0.52	0.45	0.36
Ash (%)	12.80	12.42	11.78	11.33

[a]Content kg-1 of diet: Manganese, 62 mg; iodine, 1 mg; iron, 53 mg, copper, 5 mg; zinc, 54 mg; selenium, 0.2 mg; vitamin A, 8000 UI; vitamin D, 2500 UI; vitamin E, 8 UI; vitamin K, 2 mg; vitamin B12, 0.001 mg; riboflavin, 5.3 mg; pantothenate of calcium, 12 mg; niacin, 33 mg; choline, 500 mg; folic acid, 0.5 mg; thiamine, 1 mg; pyridoxine, 2.1 mg; biotin, 0.04 mg.

Performance parameters

Feed intake (g/day), Body weight (g/day) and Weight gain (Final weight - Initial weight) were determined weekly.

Leucaena preparation

Leucaena was prepared according to protocol described by Abou-Elezz *et al.* (2011). Leucaena fresh leaves were collected from trees growing at Port-au-Prince, under the tropical conditions of Haiti. The branches were cut from trees; leaves were separated from branches, spread out, and dried under shade for a period of 2 days. Afterwards, they were dried in ovens (70 °C) for 2 days. The dried leaves were crushed with a hammer mill to make the Leucaena, which were incorporated to the experimental diets.

Banana flour preparation

The bananas were produced and collected by the State University farm, they were chopped into pieces to facilitate drying. The fragments of the bananas were dried in an oven at a temperature of 60 °C for 2 days. Additionally, they were ground and transformed into flour. Table 2 shows the composition of Banana flour of diets for laying hens.

Table 2 – Composition and chemical analyses of the experimental of diets for laying hens.

Ingredients	0%	25%	50%	75%	100%
Banana flour	0	26.5	35.05	40.56	54.08
Hominy	54.08	27.58	19.03	13.52	0
Soy	40.45	40.45	40.45	40.55	40.45
Methionine	0.08	0.08	0.08	0.08	0.08
Zinc-bacitracin	0.05	0.05	0.05	0.05	0.05
Fat	1	1	1	1	1
Limestone	3.34	3.34	3.34	3.34	3.34
NaCl	0.25	0.25	0.25	0.25	0.25
Vitamin-mineral	0.25	0.25	0.25	0.25	0.25
Mycotoxin	0.5	0.5	0.5	0.5	0.5
Total	100	100	100	100	100

Table 3 – Composition and chemical analyses of Banana flour.

Banana flour	Nutrients content (dry matter)					
	DM	CP	EE	CF	ADF	NDF
0%	94.98	24.37	2.80	15.60	22.00	60.00
25%	97.99	27.47	3.00	14.40	47.00	64.00
50%	96.74	26.11	3.60	12.80	46.00	63.00
75%	95.78	22.57	2.00	11.80	43.00	86.00
100%	96.64	23.31	1.40	10.40	49.00	87.00

DM dry matter, CP crude protein, EE ether extract, CF crude fiber, ADF acid detergent fiber, NDF neutral detergent fiber.

Statistical analysis

The data were expressed as mean values ± standard deviation (SD) and were analyzed by analysis of variance using a one-way ANOVA procedure based on a completely randomized design. The GraphPad Prisma® version 6.0 statistical software (GraphPad Software, San Diego CA) was also used to analyze the data. The analysis of differences between the average values of the treatment groups were compared by application of Tukey's tests. The level of significance was set at $p<0.05$.

RESULTS

Chemical composition

Data for chemical analysis of *Leucaena leucocephala* and *Musa cavendishii* are illustrated in Tables 1 and 3.

Growth Performances

No differences ($p<0.05$) between the Control and the groups of treatments on Body weight were observed during the first 30 days. Regarding, weight gain, statistically significant differences ($p<0.05$) were observed between the Control (3.01 ± 0.75) and of the treatments L_8 (0.45 ± 0.15 g), L_{10} (0.34 ± 0.17 g), and L_{12} (0.60 ± 0.07 g) on the 10th day. In addition, on day 20, statistically significant differences ($p<0.05$) were observed between the Control (4.23 ± 2.08 g) and the L_{10} (0.25 ± 1.13 g). On the 30th day, statistically significant differences ($p<0.05$) were observed between the Control (2.23 ± 1.65 g) and the treatments L_6 (0.20 ± 0.07 g), L_8 (0.05 ± 0.03 g) L_{10} (0.08 ± 0.03 g) and L_{12} (0.05 ± 0.03 g), respectively (Table 4).

There was no significant difference in Weight gain during the days 15, 20 and 25 between the Control and the levels 25, 50 75 and 100% respectively, while on the 30th day statistically significant differences ($p<0.05$) were observed between the Control (21.67 ± 0.6 g) and the 25% (4.87 ± 0.02 g) and 75% (9.67 ± 0.2 g). For feed intake, statistically significant differences were observed on the 15th day at level 100% (17.92 ± 1.47 g) comparing with the Control (25.40 ± 2.01 g). However, on day 20, the feed intake was increased significantly between the Control (11.34 ± 0.9 g) and the level 100% (2.45 ± 0.90 g).

There was no significant difference during day 25, whereas for day 30 statistically significant differences were observed between the Control (9.81 ± 1.02 g) and the levels 25% (1.72 ± 1.78 g) and 75% (4.16 ± 2.2 g), respectively). The results revealed that the highest feed intake values were observed for the level 25% (30.84 ± 2.01g) on day 15, 50% (16.30 ± 2.9 g) on day 20, 100% (11.81 ± 2.8 g) on day 25, and the Control (9.81 ± 1.02 g) on day 30 (Table 5).

Table 4 – Effect of dietary treatments on body weight and weight gain of laying hens*.

	Dietary treatments of *Leucaena leucocephala*				
Variable	Control	L_6	L_8	L_{10}	L_{12}
Body weight (g)					
Day 0 to 1	1598.34 ± 34.76[a]	1410.60 ± 86.86[a]	1413.20 ± 86.44[a]	1494.80 ± 211.44[a]	1592.00 ± 2.00[a]
Days 10 to 20	1609.07 ± 25.33[a]	1425.40 ± 87.06[a]	1416.40 ± 86.82[a]	1497.20 ± 210.66[a]	1596.20 ± 2.01[a]
Days 20 to 30	1617.67 ± 46.78[a]	1443.00 ± 89.90[a]	1425.20 ± 87.54[a]	1499.00 ± 210.28[a]	1607.40 ± 1.77[a]
Days 0 to 30	1611.09 ± 28.33[a]	1444.40 ± 90.16[a]	1425.60 ± 87.35[a]	1499.60 ± 210.30[a]	1607.80 ± 1.77[a]
Weight gain (g)					
Day 10	3.01 ± 0.75[ab]	2.11 ± 1.15[a]	0.45 ± 0.15[a]	0.34 ± 0.17[a]	0.60 ± 0.07[a]
Day 20	4.23 ± 2.08[ab]	2.51 ± 0.53[a]	1.25 ± 0.18[ab]	0.25 ± 1.13[b]	1.59 ± 0.19[ab]
Day 30	2.23 ± 1.65[ab]	0.20 ± 0.07[a]	0.05 ± 0.03[a]	0.08 ± 0.03[a]	0.05 ± 0.03[a]

Control; L_6 (Leucaena, 6 g/day); L_8 (Leucaena, 8 g/day); L_{10} (Leucaena, 10 g/day) and L_{12} (Leucaena, 12 g/day).

[a,b]Different letters in the same row and column indicate significant difference in the Tukey's test. (p<0.05).

*Each group consisted of 10 Laying hens.

Table 5 – Effect of dietary treatments on weight gain and effectiveness of laying hens*

	Dietary treatments of Banana flour				
Variable	Control	25%	50%	75%	100%
Weight gain (g)					
Day 15	19.09 ± 1.17[a]	34.67 ± 0.6[a]	38.31 ± 1.2[a]	38.50 ± 0.87[a]	25.44 ± 1.2[b]
Day 20	17.18 ± 1.06[a]	32.83 ± 1.2[a]	34.02 ± 0.65[a]	26.50 ± 1.02[a]	26.06 ± 2.3[a]
Day 25	21.18 ± 2.23[a]	23.50 ± 0.3[a]	20.89 ±1.06[a]	25.17 ± 0.48[a]	24.65 ± 0.55[a]
Day 30	21.67 ± 0.6[ab]	4.87 ± 0.02[a]	16.24 ± 0.9[a]	9.67 ± 0.2[a]	16.56 ± 0.60[a]
Feed intake (g)					
Day 15	25.40 ± 2.01[ab]	30.84 ± 2.01[a]	26.46 ± 4.4[a]	23.24 ± 2.35[a]	17.92 ± 1.47[b]
Day 20	11.34 ± 0.9[ab]	17.55 ± 4.3[ab]	16.30 ± 2.9[ab]	11.57 ± 2.2[b]	2.45 ± 0.90[ab]
Day 25	10.79 ± 1.1[ab]	10.55 ± 2.5[a]	9.25 ± 2.01[a]	10.07 ± 3.01[a]	11.81 ± 2.8[a]
Day 30	9.81 ± 1.02[b]	1.72 ± 1.78[a]	7.13 ± 1.1[a]	4.16 ± 2.2[a]	7.93 ± 2.7[a]

[a,b]Different letters in the same row and column indicate significant difference in the Tukey's test. (p<0.05).

*Each group consisted of 10 Laying hens.

DISCUSSION

In the present study, at the end of the production cycle, body weight, Weight gain and Feed intake were similar between the treatments and levels compared with the Control. These results are in agreement with similar total feed intake, final body weight observed by Atawodi *et al.* (2008) in laying hens. Numerous investigations have been reported that the inclusion of *L. leucocephala* has effects in the diets regarding the performance of laying hens (Nunes de Oliveira *et al.,* 2014). Nuhu (2010) and Abou-Elezz *et al.* (2011) have reported that the variations in the nutrients composition of Leucaena could be attributed to various factors such as plants age, climatic conditions, agronomic practices as well as methods of processing and analysis. The results of this research showed that the Leucaena plays an important role in the diet of laying hens. A study realized by Lu *et al.* (2016) has shown that leucaena could improve dietary of the animals. Although in our study, the feed intake at day 30 for the level of 25% (1.72g) was lower compared with the Control (9.81g). The nutrition of the animals is very important, it directly influences egg quality and the economic income in the poultry industry. Few researchers have used Banana flour in laying hen diets.

As shown in Table 4, the weight of laying hens increased after days 15 and 25 (38.50 and 25.17 g) in response to 75% of Banana flour, whereas, for day 30, the weight increased to 100% (16.56 g). The increased feed intake of banana flour suggested that it does not contain anti-nutrients that reduce the feed intake of laying hens. Another study realized by Adeniji *et al.* (2007) found that banana contained low levels of anti-nutrients such as tannins, phytates and oxalates. The results of this experiment clearly showed that Banana flour can be used up to 100% in the diet of laying hens. Currently, there are few studies on the use of Banana flour in the diet of laying hens. The present study suggested that the Leucaena and Banana flour could be used to improve the performance of laying hens. Utilization of Leucaena and Banana flour can reduce the budget for feed in poultry sector. Future researches need to try

the use of Leucaena and Banana flour in other animals of poultry sector. Finally, the use of these flours can be used as a partial substitute for the protein specially in laying hens

CONCLUSIONS

This study has demonstrated that the feed intake of laying hens varies between the different levels. Due to the high price of protein ingredient, Leucaena and Banana flour can be useful as a good alternative of animal feed, as they are low cost production. Therefore, Leucaena and Banana flour may be an alternative food resource to implement sustainable laying hen's production in tropical countries as Haiti, it can be included to growing laying hen' s diets. In addition, Leucaena and Banana flour are an effective way to enhance nutrition for the laying hens. Based on the results, it can be concluded that Leucaena leucocephala and Banana flour can be used as protein in the diets of laying hens. Therefore, the data in our study may provide the basis for future research.

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