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Utilisation of Mucuna Beans (*Mucuna pruriens* (L.) DC ssp. *deeringianum* (Bart) Hanelt) to Feed Growing Broilers

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Abstract

Performance of broilers fed on diets containing mucuna beans (MB) (*Mucuna pruriens* (L.) DC ssp. *deeringianum* (Bart) Hanelt) with different treatments were studied in three experiments. First experiment: three sorghum diets using 0 and 280g/kg of MB raw or soaked were evaluated. Second experiment: three sorghum diets using 0 and 280g/kg of MB raw or boiled were evaluated. Third experiment: six maize diets: maize only, three diets containing 280g/kg of MB raw, soaked or boiled, one containing soybean and a balanced diet (control) were evaluated. Experiment one: the birds fed on the 0g MB/kg showed a higher live weight gain (LWG) and a lower feed:gain ratio (FG) ($p < 0.01$) than birds fed on the MB diets. There were no differences for any of the variables studied between the birds fed on the MB diets. Experiment two: the birds fed on the 0g MB/kg performed better ($p < 0.01$) than birds fed on the MB diets. However, birds fed on the boiled MB diet had a higher LWG and a lower FG ($p < 0.01$) than birds fed on the raw and soaked MB diet. Experiment three: the birds fed on the control diet obtained a higher LWG ($p < 0.01$) than birds fed on the remainder treatments. The birds fed on the raw MB diet had a lower FG ($p < 0.01$) than birds on the remainder treatments. However, birds fed on the boiled MB had a higher LWG and feed intake than birds fed on raw and soaked MB diets and only maize diet ($p < 0.01$), but, lower ($p < 0.01$) in comparison to birds fed on the soybean diet. The birds on the raw and soaked MB diets performed worst ($p < 0.01$), even in comparison to birds fed on only maize ($p < 0.01$). The results from these experiments indicated that inclusion of 280g MB/kg in the diet affected adversely the poultry performance. However, utilisation of MB boiled improved the broilers performance compared to birds fed on the raw and soaked MB diets.

Keywords: broilers, mucuna, performance, raw, soaked, boiled, Mucuna pruriens ssp. deeringianum

1 Introduction

The most popular agricultural system practiced by indigenous people in southeast of Mexico and many countries in Latino America is the agroecology system called "milpa".

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This is a small scale production system where agriculture practices and livestock production are harmonized. In this system some animals such as poultry (chicken, turkey and ducks) and pigs are kept in the backyard. The animals are fed with products and by-products from the agriculture such as maize and forages (Rejón *et al.*, 1996). The animals are used as a source of protein and to save money that could easily be tapped into when cash is needed (Rejón *et al.*, 1996; Wieman and Leal, 1998). In such production system some legumes are used, such as the mucuna (*Mucuna pruriens* (L.) DC ssp. *deeringianum* (Bart) Hanelt).

The mucuna bean (MB) is used as a green manure in the milpa to improve soil fertility and to increase the maize yield. However, the beans from mucuna some times do not have any practical use in the production system (Anderson *et al.*, 2001). Recently, some efforts to use the MB in animal feeding have been done. Trejo *et al.* (1999b) and Trejo and Belmar (2000) reported a better acceptance of mucuna by chicks than other legumes. As many legume seeds, MB have antinutritional factors (ANFs) that reduces its utilisation in animal feeding. Protease inhibitors and phenols for example L-dopa has been found in MB. Some treatments to reduce the ANFs in MB have been used, such as heating (autoclaving and dry roasted) and soaking. Some of these treatments have had success to improve the performance of chickens fed MB (Olaboro *et al.*, 1991; Trejo *et al.*, 1999a; Del Carmen *et al.*, 1999). But no study is available to reflect the interaction of the MB treatment and the improvement of diet quality of small scale farming systems. The aim of this study was therefore to evaluate the response of growing broilers fed on high and low quality diets containing MB raw, soaked or boiled, with respect to feed intake, weight gain and feed conversion.

2 Materials and Methods

The experiments were carried out at the Facultad de Medicina Veterinaria y Zootecnia in Yucatan, Mexico. This site has a tropical climate with an annual average temperature of 27.7°C and an annual precipitation of 800 mm (Gobierno del Estado de Yucatán, 1983).

2.1 Animals

Ninetysix male broilers were used in experiment one. Sixty broilers (30 male and 30 females) were used in experiment two and one hundred and ninety two broilers (96 females and 96 males) were used in experiment three. All broilers were from a commercial line Hubbard

2.2 General management

The broilers were from one day hatch when arrived. At arrival the chicken were kept in brooder rings during fifteen days. The first five days the chickens were kept in a heater and received soluble vitamins and minerals in the water. At age seven days there were vaccinated against Newcastle. During this period they were fed with a commercial diet (22% crude protein and 13 MJ ME/ kg). At the age of fifteen days the chickens were weighed and assigned to their respective treatments.

During the experiments the chickens were caged in pairs. In the second and third experiments a female and a male were accommodate in each cage. The cages were 40 by 40 centimetres. Each cage had a feeder and a drinker.

2.3 Treatments to mucuna beans

Raw: The MB were milled with a sieve of 3 millimetres and then included in the diets.

Soaked: The MB were broken in five to eight pieces in a meal with a sieve of half an inch. Then, the MB were soaked in water during 24 hours in a water-MB ratio of 1:2 (kg/kg) After that, the MB were dried in an oven at 60°C. Finally, the MB were milled with a sieve of 3 millimetres.

Boiled: The MB were broken as in soaked treatment and then boiled during thirty minutes at 100°C in a water-MB ratio of 1:2 (kg/kg). Then, the MB were dried in an oven at 60°C. afterwards, the MB were milled with a sieve of 3 millimetres.

2.4 Experimental diets

Experiment one: Three sorghum-based diets were used. Two diets included 280 g/kg of MB raw or soaked and a diet based in sorghum and soyabean meal (control) (table 1). All the diets were balanced to the same concentrations of energy and protein according to National Research Council (1994).

Experiment two: Three isonitrogenous and isoenergetic sorghum-based diets were used, two diets included 280 g/kg of MB raw or boiled and one with out MB an based in soybean meal and sorghum as control diet (table 2). The diets were balanced according to National Research Council (1994).

Experiment three: This experiment was carried out with maize only as the control, reflecting the feeding conditions for poultry in rural backyards in the southeast of Mexico, where maize usually represents the main or only component of the diet Rejón *et al.* (1996). The diets were: maize only, three diets included 280 g/kg of MB raw, soaked or boiled and one included soybean meal (maize + SBM) this with the objective to match the same amounts of nutrients of the diets with MB. There was also, a balanced diet based in maize and soybean meal according to National Research Council (1994) as a control diet (table 3). These diets with MB varied in energy, nitrogen and aminoacid concentration, compared to the diet only maize and balanced diet.

2.5 Experimental procedure

Food intake was calculated as the difference between feed offered and feed refusal by cage, from which a value for the mean food intake per chicken per day was derived. The live weight gain was calculated on an individual chicken basis using the initial weight and final weight per cage, from which individual chicken weight was estimated. Using average daily food intake and live weight gain per chicken , feed:gain ratio was calculated. The duration of the each experiment was fifteen days.

Table 1: Diets used in experiment one

Ingredients (g/kg)	*Diets*		
	Control	*Raw MB*	*Soaked MB*
Soybean meal	338	215	215
Sorghum	595	418	418
Soybean oil	30	50	50
Mucuna beans	0	280	280
Methionine	1	2	2
Calcium	14	13	3
Dicalcium phosphate*	15	17	17
Salt	3	3	3
Mineral premix†	1	1	1
Vitamin premix‡	1	1	1
Salinomycin	1	1	1
Flavomycin premix§	1	1	1
Composition (%)			
Crude Protein	20.0	20.0	20.0
ME (MJ/kg)	13.0	13.0	13.0
Crude Fibre	3.6	4.6	5.0
Lysine	1.1	1.1	1.1
Methionine+cystine	0.7	0.7	0.7
Calcium	0.9	1.0	1.0
Total phosphorus	0.7	0.6	0.6

* Concentration : P 21%, Ca 18%.

† Concentration of minerals/kg of premix: Mg 15g, Mn 20g, Fe 18g, Cu 4g, Zn 60g, Se 0.042g, I 0.005g, Co 0.060g, Na 9g.

‡ Concentration of vitamins/kg of premix: Vit. A: 1,800,000 UI, Vit. D_3: 640,000 UI, Vit. E: 400 UI, Vit. K: 160 mg, riboflavine: 1400mg, pantothenic acid: 600mg, niacine: 8000mg, piridoxine: 200mg, choline: 120,000mg, Vit. B_{12} 4.4mg.

§ Concentration of Flavomycin: 4%.

2.6 Experimental design and statistical analysis

A randomised design was used in the three experiments. There were sixteen repetitions per treatment in experiment one and three, and ten repetitions per treatment in experiment two. The experimental unit was the cage. The means of the different treatments in each experiment were compared to using the Duncan test. Data obtained was analysed using ANOVA procedure of SAS Institute (1990).

Table 2: Diets used in experiment one

Ingredients (g/kg)	*Diets*		
	Control	*Raw MB*	*Boiled MB*
Soybean meal	345	216	216
Sorghum	560	391	391
Soybean oil	58	74	74
Mucuna beans	0	280	280
Methionine	1	2	2
Calcium	14	12	12
Dicalcium phosphate*	15	18	18
Salt	3	3	3
Mineral premix†	1	1	1
Vitamin premix‡	1	1	1
Salinomycin	1	1	1
Flavomycin premix§	1	1	1
Composition (%)			
Crude protein	20.0	20.0	20.0
ME (MJ/kg)	13.6	13.6	13.6
Crude fibre	4.0	4.0	4.0
Lysine 1.1	1.1	1.1	
Methionine + Cystine	0.7	0.7	0.7
Calcium	0.9	0.9	0.9
Total phosphorus	0.7	0.7	0.7

* Concentration : P 21%, Ca 18%.

† Concentration of minerals/kg of premix: Mg 15g, Mn 20g, Fe 18g, Cu 4g, Zn 60g, Se 0.042g, I 0.005g, Co 0.060g, Na 9g.

‡ Concentration of vitamins/kg of premix: Vit. A: 1,800,000 UI, Vit. D_3: 640,000 UI, Vit. E: 400 UI, Vit. K: 160 mg, riboflavine: 1400mg, pantothenic acid: 600mg, niacine: 8000mg, piridoxine: 200mg, choline: 120,000mg, Vit. B_{12} 4.4mg.

§ Concentration of Flavomycin: 4%.

3 Results

3.1 Experiment one

As is shown in table 4, the feed intake in this experiment was similar between the treatments ($p > 0.01$). However, live weight gain was higher in birds fed on the control diet ($p < 0.01$) than in birds fed on diets with MB. Inversely, feed:gain ratio was lower in birds fed on the control diet ($p < 0.01$) in comparison to birds fed on diets with MB (table 4).

Table 3: Diets used in experiment one

Ingredients (g/kg)	*Diets*					
	Maize	*Maize + raw MB*	*Maize + soaked MB*	*Maize + boiled MB*	*Maize + soybean meal*	*balanced*
Soybean meal	0	0	0	0	132	338
Maize	992	712	712	712	858	598
Mucuna beans	0	280	280	280	0	0
Soybean oil	0	0	0	0	0	46
Methionine	0	0	0	0	0	1
Calcium	1	1	1	1	1	3
Dicalcium phosphate*	0	0	0	0	0	7
Salt	3	3	3	3	3	3
Mineral premix†	1	1	1	1	1	1
Vitamin premix‡	1	1	1	1	1	1
Salynomycin	1	1	1	1	1	1
Flavomycin premix§	1	1	1	1	1	1
Composition (%)						
Crude protein	8.8	13.3	13.3	13.3	13.4	20.0
ME (MJ/kg)	13.1	13.0	13.0	13.0	13.5	13.6
Crude fibre	2.6	3.2	3.2	3.2	3.1	3.9
Lysine	0.3	0.6	0.6	0.6	0.6	1.1
Methionine+cystine	0.4	0.4	0.4	0.4	0.5	0.7
Calcium	0.3	0.3	0.3	0.3	0.3	0.9
Total phosphorus	0.2	0.2	0.2	0.2	0.3	0.7

* Concentration : P 21%, Ca 18%.

† Concentration of minerals/kg of premix: Mg 15g, Mn 20g, Fe 18g, Cu 4g, Zn 60g, Se 0.042g, I 0.005g, Co 0.060g, Na 9g.

‡ Concentration of vitamins/kg of premix: Vit. A: 1,800,000 UI, Vit. D_3: 640,000 UI, Vit. E: 400 UI, Vit. K: 160 mg, riboflavine: 1400mg, pantothenic acid: 600mg, niacine: 8000mg, piridoxine: 200mg, choline: 120,000mg, Vit. B_{12} 4.4mg.

§ Concentration of Flavomycin: 4%.

3.2 Experiment two

In this experiment the feed intake was higher in birds fed on the control diet ($p < 0.01$) than in birds fed on diets with MB. Similarly, live weight gain was higher in birds fed on the control diet ($p < 0.01$) in comparison to birds fed on diets with MB. Also, live weight gain was higher in chickens fed on boiled MB than birds fed on raw MB. Feed gain ratio was lower in chickens fed on the control diet ($p < 0.01$) in comparison to chickens fed on diets with MB. However, feed gain ratio was lower in chickens fed on boiled MB ($p < 0.01$) than chickens fed on raw MB (table 5).

Table 4: Performance of growing broilers fed on raw and soaked mucuna bean diets in experiment one.

	Treatments[1]			*SE* ±
	Control	*Raw MB*	*Soaked MB*	
Initial weight (g)	421.5	420.8	419.5	4.77
Live weight gain (g /day)	59.4^a	42.9^b	44.5^b	1.31
Feed intake (g/day)	105.7	105.3	105.8	2.50
Feed:gain ratio	1.79^a	2.47^b	2.40^b	0.04

[1] values with different letters differ statistically significant ($p < 0.01$)

Table 5: Performance of growing broilers fed on raw and boiled mucuna bean diets in experiment two.

	Treatments[1]			*SE* ±
	Control	*Raw MB*	*Boiled MB*	
Initial weight (g)	319.0	319.2	317.8	8.58
Live weight gain (g/day)	51.6^a	19.3^b	26.8^c	1.52
Feed intake (g/day)	79.7^a	51.3^b	52.8^b	2.42
Feed:gain ratio	1.55^a	2.81^b	1.99^c	0.11

[1] values with different letters differ statistically significant ($p < 0.01$)

3.3 Experiment three

The highest weight gain was observed in broilers fed on the balanced diet ($p < 0.01$) followed by broilers fed on the maize + soybean meal (SBM) and maize + boiled MB, respectively. The lower live weight gain was observed in chickens fed on the raw and soaked MB diets ($p < 0.01$) in comparison to the birds in the remainder diets, even in comparison to the birds fed only maize (table 6). A higher feed intake was found in birds fed on the maize + SBM diet ($p < 0.01$), followed by birds fed on the control diet ($p < 0.01$) than in birds fed on the boiled MB diet ($p < 0.01$). However, bird fed on the boiled MB diet had a higher feed intake than birds fed on the raw and soaked MB diets. Birds fed on the raw and soaked MB diets had a lower feed intake ($p < 0.01$) in comparison to birds fed only maize (table 6).

The feed:gain ratio was extremely high in birds fed on the maize + raw MB diet than in the remainder diets ($p < 0.01$). The soaked and boiled treatment of MB improved

the feed:gain ratio in comparison to birds fed on the raw MB diets ($p < 0.01$). The feed:gain ratio were similar between birds fed on only maize, boiled MB and maize + SBM diets (P¿0.01). The lower feed gain ratio was observed in birds fed on the control diet (table 6).

Table 6: Performance of growing broilers fed on maize based diets with MB in experiment three.

	Treatments[1]						
	Maize	*Maize + raw MB*	*Maize + soaked MB*	*Maize + boiled MB*	*Maize + SBM*	*Balanced*	*SE ±*
Initial weight (g)	409.2	408.4	409.7	408.8	409.4	408.6	7.92
Live weight gain (g/day)	14.2^{d}	0.7^{e}	2.0^{e}	22.5^{c}	46.2^{b}	51.0^{a}	1.52
Feed intake (g/day)	66.5^{d}	40.9f	50.1^{e}	83.7^{c}	110.2^{a}	97.2^{b}	2.79
Feed:gain ratio	4.8^{b}	67.5^{a}	17.5^{b}	3.8^{b}	2.4^{b}	1.9^{b}	4.8

[1] values with different letters differ statistically significant ($p < 0.01$)

4 Discussion

The soaked treatment of MB in experiment one did not improved the productive performance in the broilers. As a result, the birds fed on the soaked MB diet performed similar to broilers fed on the raw MB diet. In contrast by using high inclusion levels (of up to 48%) of MB Trejo *et al.* (1999a) found a better performance in chicks using soaked MB. These researchers reported that soaking treatment of MB is effective in reducing L-dopa. According to Budavari (1989) L-dopa is very soluble in water and oxidize easily in contact with air.

In the second experiment the live weight gain, feed intake and feed:gain ratio of broilers fed on the boiled MB diet improved in comparison to broilers fed on the raw MB diet. These observations are in agreement with results where broilers were fed with MB treated by heat (Olaboro *et al.*, 1991; Del Carmen *et al.*, 1999). The results suggest that some ANFs in MB are susceptible to be eliminated by thermic treatments. According to van der Poel A. F. B. (1989) the thermic treatments are very effective to remove some ANFs such as the protease inhibitors. However, the boiling treatment of MB was not so efficient to improve the performance of the broilers, in comparison to broilers fed on the maize + SBM diet.

In the experiment three the broilers fed on the raw and soaked MB diets performed worse than the broilers fed on the remainder diets, even in comparison to broilers fed on the only maize diet. In this case the soaked treatment also showed its inefficiency to remove ANFs in MB. This results indicated that some ANFs in MB are not soluble in water. Nevertheless, the boiling treatment of MB improved the broilers live weight gain

and feed:gain ratio compared to broilers fed on the raw MB diets and the only maize diet. The performance of birds on boiled MB in experiment three was similar to results obtained in experiment two. The food intake of birds fed on boiled MB was greatest than the only maize diet but the total maize consumed was 10% less than the only maize diet.

Finally, the better performance of broilers fed on the control diet than broilers fed on the remainder diets was due to a well balance of aminoacids.

The results obtained in this research work pointed out that inclusion of MB in the diet reduced the performance of growing broilers in comparison to balanced diets. The soaked treatment of MB was not effective enough to improve the performance of growing broilers in comparison to broilers fed on the raw MB diet even in comparison to birds fed only maize, but boiling treatment of MB increased the live weight gain, feed intake and reduced feed conversion in comparison to the raw and soaked MB and only maize diets. The boiling of MB could increase the productive performance of broilers fed only with maize based diets in peasant systems. This results lead to the conclusion that the main antinutritional factors in MB are thermo labile.

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