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THE EFFECT OF DIETS INCORPORATING *MUCUNA (Mucuna pruriens)* SEED MEAL ON THE PERFORMANCE OF LAYING HENS AND BROILERS

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SUMMARY

The effect of incorporating *Mucuna* (*Mucuna pruriens*) seed meal on the performance of laying hens and broilers was investigated. In the first experiment, one hundred 18-week old black Nera birds were randomly allocated on body weight basis to 4 experimental diets. In diets 1, 2, and 3, 40% soybean meal was replaced with autoclaved (AMSM), raw (MSM) and roasted (RMSM) *Mucuna* seed meal, respectively. As soybean meal contained 15% of the diets in the control diet (Diet 4), the level of *Mucuna* seed meal in the diets was 6%. Each dietary treatment had 25 birds distributed to 5 replicates of 5 birds. The feed consumption of laying hens fed the raw *Mucuna* seed diet was reduced ($P<0.05$) while the feed consumption of birds on the control, AMSM and RMSM *Mucuna* seed treatments was similar. None of the *Mucuna* diets had effect on egg size as the egg weights, lengths and widths were similar across all the treatments. Egg yolk index did not significantly change by feeding any form of *Mucuna* diet. There were no meat or blood spots in the eggs.

In the second experiment, 160 day-old broiler chicks were randomly allocated to four dietary treatments in a completely randomized design. The diets were formulated in a way that roasted *Mucuna* seed meal (RMSM) replaced soybean meal in a conventional broiler diet by 0, 33.3, 66.7 and 100% at both the starter and finisher phases. The final levels of RMSM in the diets were therefore 0, 6, 12 and 18% at the starter phase and 0, 5, 10 and 15% at the finisher phase. For broilers, 12 and 18% RMSM reduced ($P<0.05$) body weight gain and feed consumption at the starter and finisher phases. None of the levels of RMSM affected efficiency of feed utilization, or weights of gizzards and hearts. Addition of 6% RMSM had no effect on the organ weights but weights of air sacs, small and large intestine and caeca were reduced while those of liver and spleen were increased at 12 and 18% RMSM. The 18% RMSM resulted in various degenerative syndromes in the organs of the birds.

Results of the studies suggest (i) that 6% processed *Mucuna* seed meal in the diets of layers had no adverse effect on egg qualities and (ii) broilers raised on diets containing 6% RMSM performed as well as those fed on sole soybean meal diet. Levels higher than 6% caused a reduced performance of the birds because the antinutritional factors in *Mucuna* disrupted the digestive tract and organs.

Key words: *Mucuna* seed meal, laying hens, broilers, growth.

INTRODUCTION

In addition to its agronomic potential as a cover crop and for replenishing soil fertility, *Mucuna* is high in protein with a range of 25-36% (Tables 1-2). Although it is fairly comparable to soybean in terms of amino acid and mineral contents, it is relatively higher in crude fiber (7-9% vs. 5-6%). It contains some anti-nutritional factors (Table 2), with L-3,4-dihydroxy-phenylalanine (L-Dopa) and lectins being prominent among them. Processing often serves to reduce these antinutrients. Ravindran and Ravindran (1988) stated that *Mucuna*'s nutritive value as a livestock feed ingredient can further be improved by soaking, germination and heat treatment which inactivate, reduce or completely destroy its antinutritional components (Ologhobo, 1980; Aletor and Aladetimi, 1989; Agunbiade and Longe, 1996). When processed, the seeds could therefore replace soybean meal in mixed diets for poultry. Del Carmen *et al.* (1999) reported that inclusion of 10% dry-roasted velvet beans in broiler diet resulted in better growth of the birds than raw velvet beans.

The entry of productive and nutritious new feeds such as *Mucuna* into the feed resource base of poultry farmers could significantly enhance poultry production. For example, in southwestern Nigeria, where about 80% of the country's poultry farms are located, utilization of *Mucuna* could help reduce cost of animal feed by replacing the more expensive soybean meal or groundnut cake.

The present work investigated the effect of replacing soybean meal with processed seeds of *Mucuna pruriens* on the performance of laying hens and broilers. The seeds used for these studies were of the black variety. They were obtained from the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria. *Mucuna's* effect on egg quality indices and performance of broilers from starter to finisher phases was the subject of these studies.

Table 1. Essential amino acid content of soybean meal and *Mucuna* seed meal (as % crude protein).

Amino acid	Soybean meal	*Mucuna seed* meal
Arginine	7.20	5.80
Glycine	4.10	2.85
Histidine	2.50	2.03
Isoleucine	4.30	4.72
Leucine	7.60	7.09
Lysine	5.60	6.22
Methionine	1.10	1.50
Phenylalanine	4.80	4.23
Threonine	3.80	4.08
Tryptophan	1.60	1.44
Valine	4.40	5.21

Source: Ravindran and Ravindran (1988)

Table 2. Chemical composition of *Mucuna* seed meal.

Parameter	Content
Proximate composition (g kg^{-1} DM)	
Crude protein	354
Crude fibre	77
Ether extract	32
Ash	36
Nitrogen free extract	479
Major minerals (g kg^{-1} DM)	
Potassium	14
Calcium	10
Magnesium	19
Phosphorus	8
Trace minerals (mg kg^{-1} DM)	
Zinc	13
Manganese	27
Iron	129
Copper	25
Anti-nutritional factors (mg kg^{-1} DM)	
Hydrocyanic acid (HCN)	82
Tannins	21
Phytic acid	21

Source: Iyayi and Egharevba (1998).

MATERIALS AND METHODS

Experiment 1. Effect of processed *Mucuna* seed meal on egg qualities of laying hens

One hundred 18-week old black Nera birds (White Leghorn x Plymouth Rock) were randomly allocated on the basis of body weight to 4 experimental diets, three of which contained *Mucuna* seed meal: 1. raw *Mucuna* seed meal (MSM), 2. roasted *Mucuna* seed meal (RMSM), 3. autoclaved *Mucuna* seed meal (AMSM), and 4. no *Mucuna* seed meal (Control) (as summarized in Table 3). The AMSM was produced by

wet heating the seeds in an autoclave at 120°C for 18 minutes. The RMSM was produced by roasting the seeds with sand over fire until the shiny seed coat became dull (approximately 40 min). The processed and raw *Mucuna* beans were then milled using a laboratory hammer mill. Samples were taken for analysis of nutritional composition in the analytical laboratory of the Department of Animal Science, University of Ibadan, using the procedure of AOAC (1984). *Mucuna* seed meal replaced 40% of the soybean meal in the diets, corresponding to 6% of the diet since the level of soybean meal in the control was 15% (Table 3). Each dietary treatment had twenty-five birds, which were divided into 5 replicates of 5 birds in a completely randomized design. All the birds were housed in clean steel cages and subjected to standard routine management. At 50% lay, the birds were put on their respective diets and thereafter egg collection and assessment were carried out for 30 weeks. The egg quality indices used to measure the performance of laying hens on the *Mucuna* diets are described in Table 4. Data collected were subjected to statistical analysis of variance (ANOVA) using the technique of Steele and Torrie (1980) and differences between paired means were tested with Duncan multiple range test.

Table 3. Composition of experimental diets for laying hens in Experiment 1.

Ingredient	*Mucuna* diet	Control
	g kg^{-1}	
Maize	300	300
Wheat bran	150	150
Mucuna seed meal	60	-
Soybean meal	90	150
Groundnut cake	130	130
Fish meal	20	20
Oyster shell	75	75
Bone meal	23	23
Blood meal	30	30
Cassava flour	120	120
Salt	1	1
Vit-min premix*	1	1
TOTAL	1000	1000

*Vit-Min Premix (Agricare-Mix, Pfizer Production Plc, Lagos, Nigeria) contained per 1000 g: Vitamin A, 12,000,000 IU; Vitamin D3 2, 000, 000 IU; Vitamin E 7,000 IU; Vitamin B2 4,000 mg; Nicotinic acid 15,000 mg; Calcium d-pentothenate 8,000 mg; Biotin 40 mg; Vitamin B12 10 mg; Mn 20,000 mg; Fe 50,000 mg; Zn 100,000 mg; Cu 10,000 mg; Iodine 750 mg; Co 3000 mg.

Experiment 2. Graded levels of processed *Mucuna* seed meal in broiler diet

One hundred and sixty broiler chicks were allocated into four dietary groups on body weight basis in a completely randomized design. Each dietary treatment had 40 birds divided into 4 replicates of 10 birds each. The diets were isoenergetic and isoproteic. Roasted *Mucuna* seed meal (RMSM) was prepared as described above. The diets were formulated in a way that the roasted *Mucuna* seed meal (RMSM) replaced the 180 g kg^{-1} (18%) soybean meal (SBM) in a conventional broiler diet at 0, 33.3, 66.7 and 100% levels, corresponding to 0, 6, 12 and 18% levels of RMSM in the diet at the starter phase. At the finisher phase, 150 g kg^{-1} (15%) soybean meal was also replaced at 0, 33.3, 66.7 and 100%, corresponding to 0, 5, 10, and 15% levels of RMSM, respectively (Table 5). The study lasted for 8 weeks. At the end of the first 4 weeks (starter phase), the finisher diets with their slightly different RMSM levels were initiated. Records of feed consumption were taken daily and used to compute weekly feed intake while body weight gain was taken weekly. The relationship between observed parameters and RMSM level was assessed by linear regression analysis. Chi-square was used to analyze data on organ lesions.

Table 4. Importance of and procedure followed to measure the egg quality indices in Experiment 1.

Index	Importance	Procedure
Egg weight	Indicates the mass of the egg.	Direct weighing.
Egg length	Indicates the oblong nature of the egg.	Direct measurement using veiner caliper.
Egg width	Indicates the broadness of the egg.	Measurement with a ruler of a loop placed round the egg at its broadest point.
Yolk weight	Indicates the mass of the yolk.	Yolk is extracted into a preweighed yolk separator. The yolk and separator are weighed and the yolk weight is estimated by difference.
Yolk height	Indicates firmness of the yolk.	A thin glass rod is inserted into the center of the yolk and the height estimated using a ruler.
Yolk length	Indicates the extent to which yolk spreads when the egg is broken.	The length from one extreme to the other is estimated with a veiner caliper.
Yolk color	Indicates the intensity of color, which is partly related to the carotene level in the diet.	The color intensity is matched with a range of colors numbered from 1 to 15 on the La Roche color fan.
Yolk index	Indicates firmness, with high index meaning the yolk is firm and low index that it spreads easily.	Ratio of yolk height to yolk length.

Table 5. Dietary composition of experimental starter and finisher broiler diets at the various levels of replacing soybean with *Mucuna* (0, 33.3, 66.7, and 100%) in Experiment 2.

	Starter diets				Finisher diets			
	0%	33.3%	66.7%	100%	0%	33.3%	66.7%	100%
Ingredients (g kg^{-1})								
Maize	460	460	460	460	400	400	400	400
Cassava	50	50	50	50	-	-	-	-
Wheat bran	100	100	100	100	250	250	250	250
Maize bran	-	-	-	-	80	80	80	80
Brewer's dried grains	60	60	60	60	-	-	-	-
Groundnut meal	110	110	110	110	70	70	70	70
Soybean meal	180	120	60	-	150	100	50	-
Mucuna seed meal	-	60	120	180	-	50	100	150
Fish meal	25	25	25	25	22.5	22.5	22.5	22.5
Bone meal	60	60	60	60	15.5	15.5	15.5	15.5
Oyster shell	5.0	5.0	5.0	5.0	8.0	8.0	8.0	8.0
Salt	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Vit-Min Premix*	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
TOTAL	1000	1000	1000	1000	1000	1000	1000	1000
Nutrient composition (g kg^{-1})								
Protein	219	213	210	217	202	212	210	212
Crude fibre	72.20	71.30	69.00	67.00	50.58	50.00	49.00	48.00
ME MJ kg^{-1}	11.43	11.44	11.41	11.43	11.43	11.42	11.43	11.44

*Vit-Min Premix (Agricare-Mix, Pfizer Production Plc, Lagos, Nigeria) contained: Vitamin A, 12,000,000 IU; Vitamin D3 2, 000, 000 IU; Vitamin E 7,000 IU; Vitamin B2 4,000 mg; Nicotinic acid 15,000 mg; Calcium d-pentothenate 8,000 mg; Biotin 40 mg; Vitamin B12 10 mg; Mn 20,000 mg; Fe 50,000 mg; Zn 100,000 mg; Cu 10,000 mg; Iodine 750 mg; Co 3000 mg.

RESULTS AND DISCUSSION

Effect of processed *Mucuna* seed meal on egg qualities of layers

Laying hens fed the raw *Mucuna* seed diet had reduced (P<0.05) feed consumption (Table 6). The feed consumption of birds on the control, autoclaved and roasted *Mucuna* seed treatments was similar. There were no effects of *Mucuna* on egg size based on egg weights, lengths and widths, which were not significantly different from control (p>0.05). Similarly, yolk index was not significantly altered by feeding any form of *Mucuna* including raw beans. There were no meat or blood spots in the eggs.

Results demonstrate that feeding raw *Mucuna* results in reduced feed intake, which on the long run should affect egg weight and size. *Mucuna*'s antinutritional factors, i.e., lectins, L-Dopa, tannins, and phytic acid, may cause reduced feed intake as a result of the need for them to be detoxified which in turn confers nutritional stress on the birds. Leon *et al.* (1991) and Ologhobo *et al.* (1993) fed jack beans (*Canavalia ensiformis*) to broilers and reported marked chronic effect of the antinutritional factors in the jack beans seeds on the anatomy of the digestive tract of the birds.

Graded levels of processed *Mucuna* seed meal in broiler diet

Body weight gain and feed consumption of birds on the 12 and 18% roasted *Mucuna* seed meal (RMSM) diet were reduced (P<0.05) at both starter and finisher phases (Table 7). No level of *Mucuna* had any significant effect on efficiency of feed utilization.

No dietary level of RMSM had any effect on the weight of the gizzards and heart at the end of the experiment (Table 8). The addition of 6% RMSM had no effect on any of the other organ weights. However, the weights of air sacs, small and large intestine, and caeca were reduced and the weights of liver and spleen were increased at the two higher levels (12 and 18%) of RMSM.

Pulmonary congestion, oedema, enteritis, villous collapse and cardiac muscle degeneration were all present in the birds on the 18% RMSM diet (Table 9). Birds on the 12 and 18% RMSM diets and above had increased (P<0.05) fatty degeneration, hepatic necrosis, cellular infiltration, mild portal fibrosis, splenic lymphoid necrosis, macrophage proliferation and lympho phagocytosis.

Table 6. Egg quality indices of laying hens fed *Mucuna* seed meal diets

Parameter	MSM	RMSM	AMSM	Control	SEx
Weekly feed intake (kg)	5.39[b]	5.98[a]	6.10[a]	6.13[a]	±0.92
Egg weight (g)	52.51	52.79	54.53	55.97	±3.23
Egg length (cm)	5.59	5.76	5.89	5.77	±0.90
Egg width (cm)	4.42	4.53	4.24	4.28	±0.80
Yolk weight (g)	14.69	15.40	15.07	14.14	±1.09
Yolk length (cm)	3.71	3.64	3.67	3.59	±0.08
Yolk height (cm)	1.59	1.59	1.63	1.57	±0.04
Yolk color	1	1	1	1	-
Shell thickness (cm)	0.58	0.50	0.58	0.50	±0.02
Yolk index	0.43	0.44	0.47	0.44	±0.01

MSM = Raw *Mucuna* seed meal, RMSM = Roasted *Mucuna* seed meal, AMSM = Autoclaved *Mucuna* seed meal, Control = No *Mucuna* seed meal

The results demonstrate that feeding broilers with levels of RMSM higher than 6% to finisher phase at 8 weeks can produce lesions in some organs. The consumption of diets with levels of RMSM higher than 6% led to reduced feed consumption. A moderate to severe anaemia (low red blood cells), leucopaenia (low white blood cells) and splenic damage observed in the birds at the 18% RMSM level are possible reasons for the lower feed intake which resulted in low weight gains. Analysis of the processed RMSM showed that it contained 21 g kg^{-1} tannin, 82 g kg^{-1} hydrocyanic acid, and 21 g kg^{-1} phytic acid. Tannin could have induced poor performance of the birds as earlier reported by Mitjavila *et al.* (1977) and D'Mello and Devendra (1995). Earlier findings of Griffith (1991) of the adverse effects of feeding tannins in poultry diets support this view.

Table 7. Performance of broilers with diets at various levels of replacing soybean meal with roasted *Mucuna* meal.

Parameter	Starter phase (0-4 weeks)				Finisher phase(5-8 weeks)				Exp. period (0-8 weeks)				SE_X	Linear	Regression Equation
	0	33.3%	66.7%	100%	0%	33.3%	66.7%	100%	0%	33.3%	66.7%	100%			
Initial weight (g)	47.0	46.5	46.5	46.5	-	-	-	-	-	-	-	-			
Final weight (g)	-	-	-	-	1300 ^{a}	1235 ^{b}	1128 ^{c}	1039 ^{d}	-	-	-	-	±60	**	y=1122.83-7.4x
Feed intake (g wk^{-1})	438^{a}	435^{a}	429^{b}	434^{b}	473 ^{a}	409 ^{b}	377^{c}	370c	455 ^{a}	422 ^{a}	403 ^{b}	402 ^{b}	±16	*	-----
Weight gain (g wk^{-1})	142 ^{a}	146 ^{a}	138 ^{b}	134 ^{b}	171 ^{a}	151 ^{b}	132^{c}	114^{d}	157 ^{a}	149 ^{a}	135 ^{b}	124^{c}	±17	*	y=132-7.0x
Efficiency of feed utilization	0.33 ^{a}	0.34 ^{a}	0.32 ^{a}	0.31 ^{a}	0.36 ^{a}	0.37 ^{a}	0.35 ^{a}	0.31 ^{a}	0.34 ^{a}	0.36 ^{a}	0.33 ^{a}	0.31 ^{a}	±0.02	*	y=0.32+0.06x

Note: values on the same row with different superscripts within the same phase are different (P<0.05).
NS - Not significant; * = (P<0.05); ** = (P<0.01).

Table 8. Weight of cut parts and organs of birds at the end of the finisher phase (as proportion of live weight) with diets at various levels of replacing soybean meal with roasted *Mucuna* meal.

Dietary treatments	0%	33.3%	66.7%	100%	SE_X	Linear	Regression equation
Parameters							
Eviscerated weight	700	700	669	627	±66	**	Y= 670-12.56X
Organs							
Gizzard	47.79 [a]	46.79 [a]	40.70 [a]	39.78 [a]	±2.9	NS	----
Liver	20.50[a]	21.97[a]	28.65[b]	35.71[c]	±1.7	**	Y= 19.7-0.78X
Heart	4.18 [a]	3.70 [a]	3.33 [a]	3.75 [a]	±0.7	NS	----
Air sacs	4.93[a]	4.63 [a]	3.15 [b]	3.10 [b]	±0.8	**	Y= 4.31-0.214X
Small intestine	28.87 [a]	27.13 [a]	25.70 [b]	25.09 [b]	±2.2	*	Y= 141.1-0.19X
Large intestine	5.12 [a]	5.06 [a]	3.72 [b]	3.90 [b]	±1.0	*	Y= 4.95-0.47X
Caeca	6.38 [a]	6.08 [a]	5.32 [b]	5.23 [b]	±1.1	**	Y= 33.8+0.47X
Soleen	1.92 [a]	2.95 [a]	4.84 [b]	5.75 [c]	±1.2	**	Y= 1.87-0.03X

Note: values with same superscript on same row are different (P<0.05).
NS = Not significant; * = (P<0.05); ** = (P<0.01).

Table 9. Results of chi-square analyses of data on organ lesions at the end of finisher phase with diets at various levels of replacing soybean meal with roasted *Mucuna* meal.

	Dietary treatment levels of MBM			
Organ lesions	0	33.3%	66.7%	100%
Pulmonary congestion and oedema	NS	NS	NS	***
Enteritis and villous collapse	NS	NS	NS	***
Cardiac muscle degeneration	NS	NS	NS	***
Fatty degeneration, hepatic necrosis, cellular infiltration and mild portal fibrosis	NS	NS	**	***
Splenic lymphoid necrosis, macrophage proliferation and lympho phagocytosis	NS	NS	**	***
Renal congestion, tubular nephrosis, protein and urate casts in tubules	NS	*	***	***

NS = Not significant; * = (P<0.05); ** = (P<0.01), ***=(P<0.001).

Other antinutritional factors, i.e., L-Dopa and lectins possibly exerted deleterious effects on the birds fed with RMSM as reported by Afolabi *et al.* (1985), Ravindran and Ravindran (1988), and Carew *et al*. (2002). Grant (1991) reported that lectins exert their deleterious antinutritional effects via reduced nutrient absorption following extensive structural and functional disruption of the intestinal villi. These antinutritional factors possibly caused a shedding of the outer membrane of the gastrointestinal tract and decreased villus length, with consequent reduction in the surface area for absorption in the small intestine. The reduced weight of the small and large intestines with increased level of RMSM may indicate such phenomena. The report of Lorenzson and Olsen (1982) supports this view. Nevertheless, other agents in *Mucuna* such as phytic acid, hydrocyanic acid (HCN) and the high fiber level could also have been responsible for the observed effects. HCN has been reported to induce weight loss in animals (Iyayi, 1994) because its detoxification requires the use of sulfur amino acids. The requirement of amino acids for this process further reduces the amount available for muscle mass formation. The enlargement of liver and spleen is possibly due to their damage by the antinutritional factors and the infiltration of fluid into their cells.

CONCLUSION

Results of the study showed that (i) laying hens ate normally with diets containing autoclaved or roasted

Mucuna compared to raw *Mucuna* seeds, (ii) if processed *Mucuna* was included at 6% level of diet, it produced as good egg quality as a diet solely based on soybean meal and (iii) processed *Mucuna* seeds are a promising plant protein source to replace soybean meal in feeding broilers. Inclusion level of 6% of RMSM in diets seems optimum for producing broilers from the starter to finishing phase. More than 6% RMSM causes deleterious effects.

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