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Evaluation of Different Heat Processing Methods on the Nutritive Value of *Mucuna pruriens* (Velvet Bean) Seed Meals for Broilers

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Abstract: *Mucuna pruriens* like most tropical legumes contain anti-nutritional factors, which limit its use as livestock feed ingredient. Proximate analysis and two performance studies using finisher broilers were carried out to determine the nutritive value of raw, toasted, cooked and, soak and cooked *Mucuna (*SACM). *M pruriens* seeds were ground raw, ground and toasted, and cooked prior to drying and midling in Experiment 1 and soaked in water for 48 hours prior to cooking for one hour before drying and milling in Experiment 2. Toasting increased the crude protein of the raw seed by 6.5% but decreased the ether extract by 22.9%. Cooking and soaking prior to cooking decreased the values for crude protein and ether extract by 5.3 and 6.5%, and 13.7 and 20.6%, respectively. In Experiment 1, 100gkg^{-1} raw, toasted, cooked and 200gkg^{-1} SACM were substituted into nutritionally balanced rations fed 28 to 56d of age. *Mucuna* seed meals caused progressive reductions in growth; at 56d of age broilers fed 100gkg^{-1} raw, toasted, cooked and 200gkg^{-1} cooked *Mucuna* grew 61.8, 67.2, 80.4 and 63.7% of control, respectively. Feed intake declined significantly with 100gkg^{-1} toasted and 200gkg^{-1} cooked MSM respectively. Feed to gain ratio decreased significantly ($P<0.05$) with 100gkg^{-1} raw, toasted and 200gkg^{-1} cooked *Mucuna,* respectively. The heart, liver, kidney and gizzard weights relative to body weights were significantly ($P<0.05$) affected by the diets. In Experiment 2, 200gkg^{-1} and 300gkg^{-1} dietary levels of Nigerian and Brazilian SACM were fed 28 to 56d respectively. With 300gkg^{-1} broilers grew significantly ($P<0.05$) slower than the control and 200gkg diet groups but feed intakes were unchanged. Inclusion of 200gkg^{-1} of the meals, allowed better growth than 300gkg^{-1} and by 56d of age growth were significantly ($P<0.05$) depressed relative to control. At 200 and 300gkg^{-1} both Nigerian and Brazilian SACM promoted much better growth and efficiency than the raw *Mucuna* in Experiment 1 but values were significantly lower than those of controls. With 200gkg^{-1} broilers grew to 87.2 and 89.2% of controls respectively, a marked improvement over cooked *Mucuna* in Experiment 1. However, cooking, and soak and cook methods of detoxification slightly improved the nutritive value of *Mucuna* at 100 and 200gkg^{-1}, respectively. Thus indicating partial or incomplete detoxification of the seeds. Further detoxification studies to ascertain the best processing method for improved feeding value of the seed is therefore needed. Increasing the cooking time and cooking in alkaline or acid solution may be helpful in the regard.

Key words: *Mucuna* seed, cooked, toasted, soak and cook, broilers

Introduction

M pruriens is a tropical legume that is little known and used in human food or animal feed in Nigeria. Generally, *Mucuna* like most tropical legumes has become a low status product and has been neglected for a long time in all respects, from research to production and nutrition. The seed can be said to be under-utilized as little has been done to facilitate its production, processing and marketing or use. There is however, a trend towards the exploitation of under utilized tropical legumes for incorporation into animal feed resources in the developing countries. This in a way will reduce feed costs as these legumes face little or no competition between human and animals for them as food or feed like the conventional protein supplements, notably soybean (*Glycine max*) and ground nut (*Arachis hypogea*).

M pruriens commonly known as velvet bean in Nigeria, Australia, South Africa, Brazil and U.S.A, Pica in Venezuela and Bengal bean in India (Skerman, 1977) is a highly productivity-black-seeded tropical legume that is valuable only as green manure/cover crop in many tropical countries. The presence of anti-nutritional factors in the raw seeds has limited their use in non-ruminant animals. *M pruriens* has been reported to contain trypsin inhibitors, phytates, cyanogenic glycosides, tannins and L-3,4 dihydroxyphenyalanine (L-Dopa) (Ravindran and Ravindran, 1988; Mary Josephine and Janardhanan, 1992; Vijayakumari, 1994, Udedibie and Carlini, 1998). However, the concentrations of toxic and anti-nutritional factors in plants are known to be influenced greatly by climatic and ecological conditions. A study by Udedibie and Carlini (1998) has shown that Brazilian *M pruriens* lack haemagglutinating activity (i.e. no lectins) contrary to the report that Indian variety contains lectins (Siddhuraju *et al*., 1996). Siddhuraju *et*

al. (1996) and Udedibie and Carlini (1998) also reported the effect of heart treatments on some of the anti-nutritional factors present in the seed. The Nigeria *M pruriens* seeds have however, attracted little attention as a potential source of protein and energy in non-ruminant animal feeds. A preliminary study by Afolabi *et al*. (1985) showed that even though the seeds were high in crude protein, they were toxic to broilers when fed raw. Olaboro *et al*. (1991) also reported depressed growth rate in broilers fed raw Mucuna.

However, in Sri-Lanka *M pruriens* seeds are soaked overnight, subjected to long cooking until they are soft and used in various local food preparations (Jayaweera, 1981). This paper reports the results of studies carried out to determine the effect of dietary inclusion of heat-treated *M pruriens* seeds on the performance of finisher broilers.

Materials and Methods

Source of seed: The *M pruriens* seeds used for the studies were obtained from Nigeria and Brazil. The Nigerian seeds were harvested from the wild around villages in Ikeduru Local Government Area of Imo State. The Brazilian seeds were brought into Nigeria and multiplied in the Teaching and Research Farm of Federal University of Technology, Owerri, Nigeria.

Seed processing: Raw seeds of *M pruriens* from Nigeria were ground using 2mm screen. Part of the meal was stored raw [raw *Mucuna* seed meal (RMSM)]. The other part was toasted to produce toasted *Mucuna* seed meal (TMSM). This involved spreading it thinly in a pan and placing the pan in the oven (120 ^{o}C). It was stirred from time to time to maintain uniform heating. The heating (toasting) was considered adequate when the meal changed from whitish to light brown and become crispy to the touch. The process lasted for 20-25 minutes. Another batch of the seeds were cooked at 96 ^{o}C for 60 minutes, sun dried and ground to produce cooked Mucuna seed meal (CMSM).

In another processing, Nigeria and Brazilian *M pruriens* seeds were soaked in water for 48 hours before cooking, respectively. The cooked seeds were then dried in the sun and ground as above to produce Nigerian soak and cook *Mucuna* (NSACM) and Brazilian soak and cook *Mucuna* (BSACM) respectively.

Proximate composition: Samples of the raw, toasted cooked and soak and cook meals were analyzed for their proximate compositions (crude protein, crude fibre, ether extract and total ash) according to AOAC (1995). Carbohydrates (nitrogen-free extract) were obtained by difference. The energy value of the samples were estimated (in kg) by multiplying the percentage crude protein, crude fat and carbohydrates by the factors 16.7,37.7 and 16.7, respectively (Table 1).

Experimental diets

Experiment 1: Five experiment diets were formulated such that diet 1 (the control) contained no Mucuna seed meal. Diet 2 contained 100gkg^{-1} RMSM, diet 3 contained 100gkg^{-1} CMSM, diet 4 contained 200gkg^{-1} CMSM while diet 5 contained 100gkg^{-1} TMSM, respectively. Ingredient composition of the diets is shown in Table 2.

Experiment 2: Five experiment diets were again formulated such that diet 1 (the control) contained no *Mucuna* seed meal. Diets 2 and 3 contained 200 and 300gkg^{-1} NSACM whereas diets 4 and 5 contained 200 and 300gkg^{-1} BSACM respectively. Ingredient composition of the diets is shown in Table 3.

Experimental birds and design

Experiment 1: One-day old broiler chicks of Anak breed were raised for the experiment. The broilers were given *ad libitum* access to water and commercial broiler starter feed (Guinea feed Nigeria Ltd.). At 28d of age the broilers were weighed and 200 broilers with weight range of 670 to 680 were selected and grouped according to body weights into 5 groups of 40 broilers. Within each group, broilers were allocated to one of 4 pen (measuring 4m long x 2m wide) to each 10-broiler chicks/pen so that overall mean weights and weight ranges were similar within groups. Each diet was fed as mash throughout the experimental period. Feed and water were available *ad libitum*. The experimental diets were fed for a period of 35d. Feed intakes (pen basis) were taken daily while individual broiler weights were measured on d 28, 35, 42, 49, 56 and upon completion of the experiment.

At the end of the growth trial, two birds per replicate (i.e. 8 bird per treatment) were randomly selected, fasted for 18 hours, individually weighed, slaughtered and eviscerated. The weights of their liver, kidney, heart and gizzard were taken and expressed as percentages of live weights.

Experiment 2: Two hundred young broiler chicks of Anak breed at 28d of age were selected such that they weighed on the average 660±2.0g. The birds were grouped into 5 groups of 40 birds. Within each group birds were allocated, to one of 4 pens (measuring 4m long x 2 m wide) to each 10-birds per pen so that overall mean weights and weight ranges were similar within each group. Pens were randomly allocated to diets within groups. Each diet was fed as mash throughout the experiment. Feed and water were available *ad libitum*. The experimental diets were fed for a period of 35d. Feed intakes (pen basis) were taken daily while individual weights were measured on d 28, 35, 42, 49, 56 and upon completion of the experiment.

Table 1: Proximate Composition of Raw, Cooked, Toasted, and Soaked and Cooked *Mucuna* Seed Meals

	Different Samples of *Mucuna* bean				
Nutrients gkg^{-1}Dm	RMSM[1]	CMSM[2]	TMSM[3]	NSACM[4]	BSACM
Crude protein	303.3	287.2	322.9	283.6	279.6
Crude fibre	72.6	82.6	88.5	83.4	87.8
Ether extract	69.5	60.0	53.6	55.2	74.3
Ash	57.3	46.9	44.9	45.9	46.2
Nitrogen free extract	497.3	523.3	490.1	511.9	4.59
Energy content (kj kg^{-1}DM)	15990.2	15797.3	15597.8	16119.9	16022.5

[1]RMSM: Raw *Mucuna* seed meal. [2]CMSM: Cooked *Mucuna* seed meal. [3]TMSM: Toasted *Mucuna* seed meal
[4]NSACM: Nigeria soaked and cooked *Mucuna.* [5]BSACM: Brazilian soaked and cooked Mucuna.

Table 2: Ingredient and Proximate Composition of the Experiment Diets

Ingredient (gkg^{-1})	Control	RMSM[1]	CMSM[2]	CMSM	TMSM[3]
	(0.00)	(100.0)	(100.0)	(200.0)	(100.0)
Maize	550.0	500.0	500.0	450.0	500.0
Mucuna bean	--	100.0	100.0	200.0	100.0
Soybean meal	150.0	100.0	100.0	50.0	100.0
Spent grain	75.0	75.0	75.0	75.0	75.0
Wheat offal	70.0	70.0	70.0	70.0	70.0
Palm kernel cake	70.0	70.0	70.0	70.0	70.0
Bone meal	35.0	35.0	35.0	35.0	35.0
Blood meal	20.0	20.0	20.0	20.0	20.0
Fish meal	20.0	20.0	20.0	20.0	20.0
L-lysine	2.5	2.5	2.5	2.5	2.5
L-methionine	2.5	2.5	2.5	2.5	2.5
Vit/TM premix[4]	2.5	2.5	2.5	2.5	2.5
Salt	2.5	2.5	2.5	2.5	2.5
Total	1000.0	1000.0	1000.0	1000.0	1000.0
Calculated Chemical Composition (%DM)					
Crude protein	195.4	195.3	195.5	195.5	195.5
Crude fibre	48.7	48.8	49.0	50.5	48.9
Ether extract	51.8	45.7	42.7	52.0	43.9
Calcium	13.1	12.7	13.0	13.3	13.2
Phosphorus	7.1	6.8	6.7	6.8	6.9
ME (MJ/Kg)	12.82	12.58	12.55	12.60	12.50

[1]Provided the following per kg diet. Vit .A. 10.00iu, Vit .D_3 200iu, Vit. E. 30mg Vit. K. 4mg, Ribofl. 5mg, Pantothenic acid 13mg, Niacin 30mg, Choline Chloride, 5mg, Vit. B_{12} 0.2mg, Folic acid 4mg, Mn 80mg, Zn, 50mg, Iodine, 1.0mg, C0,0.2 mg, Iron, 25mg.

Data analysis: Data generated in the two experiments were subjected to one-way analysis of variance (Steel and Torrie, 1960) and significant differences between treatment means were determined using fishers least significant difference (LSD) test (Snedecor and Cochran, 1967)

Results and Discussion

Proximate composition of Mucuna seed meals: The data on the proximate composition of the raw cooked, toasted and, soak and cook *M. pruriens* seeds are presented in Table 1. The crude protein value of 303.3gkg^{-1} for the raw seeds is in agreement with values in literature. Raw *M pruriens* seed from India has been reported to contain 314.0gkg^{-1} crude protein (Siddhuraju *et al.,* 1996), from Sri-Lanka 240-313.0gkg^{-1} (Ravindran and Ravindran, 1988) and from Brazil 321.5gkg^{-1} (Udedibie and Carlini, 1998). Cooking and, soaking prior to cooking reduced the crude protein contents of the raw Nigerian and Brazilian seeds by 5.3 and 6.5% respectively. The reduction in crude protein content is in agreement with earlier reports on jack bean (Udedibie *et al.,* 1994) and could possibly be due to damage on the nitrogenous compounds during cooking. The crude protein was slightly enhanced by toasting (6.5%) which in reverse order significantly depressed the ether extract content by 22.9% possibly due the driving off of lipid-related compounds.

Table 3: Ingredient and proximate composition of the experimental diets

Ingredients (gkg^{-1})	Control	NSCM[1]	NSCM[2]	BSCM[3]	BSCM
	0.00	200.0	300.0	200.0	300.0
Maize	600.0	500.0	450.0	500.0	450.0
NSCM	-----	200.0	300.0	-----	-----
BSCM	-----	------	------	200.0	300.0
Soybean Meal	200.0	100.0	50.0	100.0	50.0
Spent grain	50.0	50.0	50.0	50.0	50.0
Wheat offal	45.0	45.0	45.0	45.0	45.0
Palm kernel cake	20.0	20.0	20.0	20.0	20.0
Fish meal	20.0	20.0	20.0	20.0	20.0
Blood meal	20.0	20.0	20.0	20.0	20.0
Bone meal	35.0	35.0	35.0	35.0	35.0
L-lysine	2.5	2.5	2.5	2.5	2.5
L-methonine	2.5	2.5	2.5	2.5	2.5
Vit/Tm premix[3]	2.5	2.5	2.5	2.5	2.5
Salt	2.5	2.5	2.5	2.5	2.5
Total	1000.0	1000.00	1000.0	1000.0	1000.0
Calculated Chemical Composition (%DM).					
Crude protein	195.0	199.3	198.3	198.6	197.2
Crude fibre	42.5	52.6	53.1	52.6	53.0
Ether extract	40.5	44.8	45.5	45.1	45.6
Calcium	12.5	12.5	12.5	12.5	12.5
Phosphorus	9.6	9.4	9.2	9.2	9.2
ME (MJ kg^{-1})	12.82	12.60	12.80	12.60	12.80

[1]NSCM: Nigerian Soak and Cook meal. [2]BSCM: Brazilian Soak and Cook meal.

[3]Provided the following per kg diet. Vit. A. 10,000iu, Vit. D_3, 200iu, Vit.E. 30mg, Vit.K, 4mg, Ribofl, 5mg, Pantothenic acid, 13mg, Niacin, 30mg, Choline Chloride, Vit. B_{12}, 0.2mg, Folic acid, 4mg, Mn, 80mg, iodine, 1.0mg, 10.2mg, Iron 25mg.

Table 4: Performance of finisher broilers fed raw, cooked and toasted *Mucuna* seed meals

Parameters	Dietary levels (gkg^{-1})					
	Control	RMSM	CMSM	CMSM	TMSM	SEM
	0.0	100.0	100.0	200.0	100.0	
Initial body wt. (gm)	680.0	680.0	680.0	680.0	680.0	0.00
Final body wt. (gm)	2300.0^{a}	1682.2^{c}	1981.0^{b}	1711.2^{c}	1770.1^{bc}	115.1
Growth rate (g/d)	46.3^{a}	28.6^{c}	37.2^{b}	29.5^{c}	31.1^{bc}	3.30
Feed intake (g/d)	89.0^{a}	89.4^{a}	82.1^{a}	63.3^{b}	73.6^{b}	4.20
Feed to gain ratio	1.92^{c}	3.13^{a}	2.21^{bc}	2.32^{b}	2.37^{b}	0.20
Mortality (%)	0.00^{b}	0.00^{b}	5.00^{b}	0.00^{b}	0.00^{b}	1.00
Internal organs (%of body wt.)						
Heart	0.45^{c}	0.54^{ab}	0.51^{b}	0.56^{a}	0.54^{ac}	0.02
Liver	1.81^{b}	2.07^{a}	2.07^{a}	2.06^{a}	1.85^{b}	0.07
Kidney	0.25^{a}	0.17^{b}	0.25^{a}	0.19^{b}	0.17^{b}	0.02
Gizzard	4.31^{b}	5.06^{a}	4.57^{b}	5.01^{a}	5.18^{a}	0.17

abc, means within a row with different superscripts are significantly different (P<0.05).

Performance of the experimental birds

Experiment 1: The data on the performance of the experimental birds are presented in table 4. *Mucuna* sees meal diets significantly (P<0.05) depressed growth rate of broilers when compared with the control diet group. Broilers fed $100gkg^{-1}$ RMSM, TMSM, CMSM and $200gkg^{-1}$ CMSM diets grew 61.8, 67.2, 80.4 and 63.7% of control, respectively. Feed intake was significantly (P<0.05) reduced at $200gkg^{-1}$ CMSM and $100gkg^{-1}$ TMSM dietary inclusion levels, respectively. The feed to gain ratio of birds fed $100gkg^{-1}$ CMSM diet compared statistically with the control but differed significantly (P<0.05) from that of birds fed $100gkg^{-1}$ RMSM diet. Birds fed $100kg^{-1}$ RMSM diet had the poorest growth and feed

Table 5: Performance of finisher broilers fed processed Nigerian and Brazilian Mucuna seed meal

Parameters	Dietary levels (gkg^{-1})					
	Control	NSCM	NSCM	BSCM	BSCM	SEM
	0.00	200.0	300.0	200.0	300.0	
Initial body wt. (g)	662.1	662.1	662.1	662.1	662.1	0.00
Final body wt. (g)	1889.2^{a}	1733.2^{b}	1605.8^{c}	1763.1^{b}	1613.6^{c}	52.4
Growth rate (g/d)	35.1^{a}	30.6^{b}	25.1^{c}	31.5^{b}	27.2^{c}	1.74
Feed intake (g/d)	166.4^{a}	151.1^{b}	161.4^{a}	144.4^{b}	170.0^{a}	4.75
Feed to gain ratio	4.74^{b}	4.94^{b}	6.43^{a}	4.58^{b}	6.25^{a}	0.39
Mortality (%)	0.00	0.00	0.00	0.00	0.00	0.00

abc, means within a row with different superscripts are significantly different (P<0.05).

to gain ratio relative to the control and other *Mucuna* bean diet groups. The heart weights were significantly (P<0.05) incresed among the Mucuna bean diet groups. The liver, kidney, and gizzard of birds' fed $100gkg^{-1}$ CMSM diet compared statistically with the control group but differed significantly from the other *Mucuna* diet groups.

Dietary raw *Mucuna* seed meal have been reported to reduce growth rate of broiler chicks and egg production in laying hens (Afolabi *et al*., 1985; Olaboro *et al*., 1991) which is confirmed by the result of this study. The result also indicates that toasting is an inefficient method of improving the nutritive value of the seed for broilers as had earlier been observed with jack bean (Bressani and Sosa, 1990; Udedibie *et al*., 1994) and *Mucuna* bean. However, cooking slightly improved the nutritive value of the seed by allowing better performance of broilers at a dietary inclusion of $100gkg^{-1}$ CMSM than at $100gkg^{-1}$ TMSM. It could be that cooking was more effective in detoxifying the seeds than toasting.

The high feed intake value of the group on $100gkg^{-1}$ RMSM diet contrary to expectation was some how difficult to explain. Birds taking raw Mucuna seed meal diet may have experienced energy deficiency problem, hence the high feed intake since birds eat to meet their energy requirements. This probably may have given rise to the significantly (P<0.05) poor feed to gain ratio of the group. It is however, difficult to determine the factors responsible for the reduced feed intake but improved growth rate of the birds on CMSM diets. It is speculated that the action of moist heat on the bean may have reduced the inhibitory activities of the anti-nutritional factors especially, the heat-labile factors. Hence the slightly improved feed utilization and growth of birds fed heat-treated *M pruriens* seed meal diets.

The 5.0% mortality (2 birds) obtained from the group on $100gkg^{-1}$ CMSM diet was difficult to be blamed on Mucuna seeds in view of the fact that the other three Mucuna diet groups were mortality free. However, Berhe (2001) reported that the L-Dopa content of *M pruriens* could be poisonous if eaten in quantities above 1.500mg. If that is the case, the presence of L-Dopa and other unidentified heat-stable anti-nutritional factors in *M pruriens* seeds may have contributed to the decrease in performance and variations in the internal organ weights of birds fed heat treated *Mucuna* seed meal diets.

Experiment 2: The data on the performance of experimental birds are summarized in table 5. At $200gkg^{-1}$ dietary inclusion levels of both Nigerian and Brazilian *M pruriens* seed meals, the feed intake and growth rates of the birds were significantly (P<0.05) lower than the control. Birds on $200gkg^{-1}$ of Nigerian and Brazilian *Mucuna* seed grew 87.2 and 89.3% whereas those on $300gkg^{-1}$ grew 71.5 and 77.5 of the control respectively. Interestingly feed intake of the birds at $300gkg^{-1}$ dietary inclusion levels of both types of seed meals compared favourably with the control but their growth rates remained significantly (P<0.05) lower than the control and $200gkg^{-1}$ *Mucuna* diet groups respectively. Birds on $300gkg^{-1}$ diets had a significantly (P<0.05) poor feed to gain ratios relative to the control and $200gkg^{-1}$ diet groups. There was no mortality in any of the treatment groups during the trial.

M pruriens seed from India (Siddhuraju *et al*., 1996) has been reported to exhibit haemagglutinating activity (i.e. they contain lectins) contrary to reports by Udedibie and Carlini (1998) that Brazilian *M pruriens* seeds lack haemagglutinating activity. The similarity in the performance of birds fed the same dietary levels of Nigerian and Brazilian *Mucuna* seeds may mean chemical similarity of the seeds. The improved feed intake but depressed growth rate of the birds on 300 gkg^{-1} *Mucuna seed* diet could again be attributed to the presence of L-Dopa and other unidentified anti-nutritional factors in the seeds, which increased with increasing quantity of the processed meals in the diets. Thus depressing the performance of birds at high dietary inclusion levels of both seed meals. However, birds fed $200gkg^{-1}$ of soaked and cooked Nigerian or Brazilian *Mucuna* seeds meals recorded marked improvement over birds fed CMSM in experiment 1. This shows that soaking the seed in water prior to cooking

was more effective in improving the nutritive value than cooking alone. Soaking prior to cooking may have opened up more surface area for heat penetration. This tends to agree with the report of Bender (1970) that the denaturation of hear-labile inhibitors by thermal processing is function of temperature, duration of heating, particle size and moisture content. It can be speculated therefore that the low performance of the birds fed *Mucuna* seed meal diets was most probably due to inadequate treatment of the seeds. Jayaweera (1981) reported that *M pruriens* are soaked overnight and subjected to long cooking until they are soft which probably could be longer than the one hour of cooking used in this study.

Conclusion: We believe that raw *Mucuna* seeds are toxic to birds. The results of these trials have shown that for *Mucuna* seeds to be render valuable and acceptable as non ruminant animal feed ingredient moist heat treatments are the option of choice for processing it. An overall result on the feeding value of raw and processed seeds of *M pruriens* suggests that though cooking and soaking prior to cooking improved the nutritive value of the seed at $100gkg^{-1}$ and $200gkg^{-1}$ diet respectively, they performance were not comparable to the controls.
However, there is still need for further research on its detoxification considering the high crude protein content of the seeds which is a nutritional factor indicative of its high potential as protein supplement in poultry diets. Further research on increased cooking time or cooking in alkaline or acid solutions may be helpful in improving the feeding value of the seeds.

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