Effect of duration of cooking *mucuna utilis* seed on proximate analysis, levels of antinutritional factors and performance of broiler chickens.

C.D. Tuleun¹ and J.P. Patrick²

¹ Department Of Animal Nutrition, University of Agriculture, Makurdi, Nigeria.

² Department Of Animal Production, University of Agriculture Makurdi, Nigeria.

Abstract.

The effect of cooking regime on the proximate composition, gross energy and anti-nutritional factors (trypsin inhibitor, phytic acid, hydrogen cyanide, tannin, oxalates and saponins) of *Mucuna utilis* seeds was investigated. Two experiments were conducted with 120 seven-day old broilers of equal average initial weight to evaluate the effect of cooking mucuna seeds at 100°C for 20, 40 and 60 minutes on performance. Results showed that duration of cooking did not have any significant ($P>0.05$) effect on the dry matter, crude fibre and gross energy. However, the crude protein, ether extract and nitrogen free extract significantly ($P<0.05$) decreased. The anti-nutrients; tannins, trypsin inhibitory activity, hydrogen cyanide, total oxalates significantly ($P<0.05$) reduced with increase in duration of cooking. Feed intake, weight gain, feed conversion efficiency, protein intake and utilization were significantly ($P<0.05$) improved with increase in cooking time. It was concluded that raw *Mucuna utilis* seeds contain high levels of anti-nutritional factors and may be unsuitable as feed ingredient but cooking reduced the antinutritive substances in the raw seeds.

Keywords: *Mucuna utilis* seeds; cooking; proximate content; antinutrients; performance.

Introduction

The development of alternative plant protein feedstuffs in broilers diets will continue to receive attention in Nigeria as long as the conventional protein resources like soybean meal, groundnut cake and fish meal continue to be scarce and expensive. These feedstuffs are costly because they are competed for by humans and other industrial users. It has become imperative therefore to turn attention to the exploitation of other novel legumes, particularly those indigenous to the tropics.

One of such legumes is *Mucuna utilis*. It is commonly known as velvet bean in Nigeria, and is a highly productive black seeded tropical

legume that is little known and utilized as human and animal feed. The crude protein content of the ripe seed ranges from 24 -32% on dry matter basis and the protein has relatively good amino acid profile (Ravindran and Ravindran, 1988; Udedibie and Carlinin, 1998, Emenalom and Udedibie, 1998). Though *M.Utilis* is high in protein, but the wider use of this legume, has been limited by the presence of anti-nutritional factors like trypsin inhibitors, haemagglutins, phytates, hydrogen cyanide and tannins (Iyayi and Egherevba, 1998, Olaboro *et al.*, 1991, Siddhuraju *et al.*, 1996, Udedibie and Carlinin, 1998). The presence of these factors has been associated with growth depression and other

undesirable physiological and biochemical alterations (Aletor and Aladetimi, 1989, Iyayi and Taiwo, 2003). Heat treatment has been reported to improve nutrient utilization of legumes by animals (Ologhobo *et al.*, 1993; Kaankuka *et al.*, 1996; Emiola *et al.*, 2003). The objective of this study therefore was to determine the efficacy of soaking overnight and cooking for different time regime on the nutritive value of *Mucuna utilis* bean compared with the nutritive value of the raw bean on broiler chickens.

Materials and Methods.

Source and preparation of the seed: *Mucuna utilis* seeds were purchased from International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria. The seeds were divided into four portions. One portion was processed raw while the three portions were subjected to heat treatment by cooking in water (100°C) for 20, 40 and 60 minutes respectively. After this, the water was drained, the seeds were thinly spread out on a concrete floor to dry. The dried seeds were ground in hammer mill.

Proximate analysis: Samples of raw, water soaked and cooked *Mucuna* seed meals were analyzed for their proximate composition (AOAC, 1995). Nitrogen free extract (NFE) was determined by difference. The gross energy of the samples were assayed using the adiabatic oxygen bomb calorimetry technique.

Anti-nutritional factors analysis: Tannin was determined by the folin-Denis method (AOAC, 1990). Phytic acid was determined by the colorimetric method of Stewart (1974). A 2.5g amount of sample was extracted for 3 hour with 100ml of 0.2 M HCl. The phytic acid was isolated from the acidified extract recovered, digested and estimated as phytate phosphorus. Trypsin inhibitory activity was determined following method of Kakade *et al* (1974) using benzoyl – DL- arginine – P – nitro anilide (BAPNA) as the substrate and expressing the results as trypsin

units inhibited (TUI) per milligram of dry sample. Hydrocyanic acid was determined by modified alkaline titration method (AOAC, 1980). Titration of distillate was carried out with 0.02M sodium thiosulphate using 1ml iodine and a drop of starch as the indicator. Total oxalate content was determined by the procedure of Abaga *et al* (1968).

Experimental diets: Four experimental diets were formulated for starter and finisher birds such that diet 1 contained 20% raw mucuna bean (RMB), diet 2 contained 20% soaked and cooked *Mucuna* bean seeds for 20 min (SC20), diet 3 contained 20% soaked and cooked *Mucuna* bean seeds for 40 min (SC40), and diet 4 contained 20% soaked and cooked *Mucuna* bean for 60 min (SC60), (Tables 1 and 2).

A total of 120 seven –day old broiler chicks of Anak® strain were used in this study. They were balanced for weight and randomly divided into four groups of 30 chicks per group in a completely randomized design. Each group was further sub - divided into three replicates of 10 birds each. Feed and water were provided *ad libitum* and light provided for 24h throughout the four weeks brooding period. Feed intake and the body weight of chicks were recorded on 7, 14, 21, 28 and 35 days for the starter phase and 35, 42, 49 and 56 days for finisher phase of the trial.

Statistical analysis: Data collected were subjected to Analysis of Variance. Differences between the treatment means were separated using Duncan's New Multiple Range Test. All statistical procedures were according to the methods of Steel and Torrie (1980).

Results

The analyzed chemical composition of the raw and soaked and cooked mucuna seeds is presented in Table 3. Duration of cooking did not have any significant ($P>0.05$) effect on the

Table 1. Gross composition of broiler starter diets (%).

Ingredients	1	2	3	4
Maize	42.81	41.80	42.01	41.30
Full -fat Soyabean	33.29	34.30	34.09	34.80
Mucuna seed meal	20.00	20.00	20.00	20.00
Bone meal	3.00	3.00	3.00	3.00
Salt	0.50	0.50	0.50	0.50
DL- methionine	0.15	0.15	0.15	0.15
Premixes*	0.25	0.25	0.25	0.25
Calculated analysis				
Crude protein (%)	22.00	22.00	22.00	22.00
Crude fibre (%)	3.93	4.18	4.15	4.23
Available phosphorus (%)	0.79	0.83	0.80	0.83
Calcium (%)	1.23	1.24	1.23	1.24
Methionine (%)	0.45	0.45	0.45	0.45
Lysine (%)	1.21	1.24	1.21	1.22
ME (Kcal/Kg)	3006	3024	3002	3026

*Each Kg feed contained: Vitamins A, 5000 I.U., Vitamin D₃ 1,000,000 I.U., Vitamin E, 15,000mg, Vitamin B₁, 1,200mg; Vitamin B₂, 400mg; Biotin, 32 mg; Vitamin B₁₂, 10mg; Folic acid, 400mg; 120,000mg; manganese, 40,000mg; Iron, 20,000mg; Zinc 18,000mg; Copper, 800mg; Iodine, 620mg; cobalt 40mg.

dry matter and crude fibre. However, as the cooking time increased, there was a significant ($P<0.05$) decrease in crude protein, ether extract, and nitrogen free extract and increase in ash content of the soaked and cooked mucuna seed. The gross energy of the raw and soaked and cooked mucuna seeds were similar. The levels of anti-nutritional factors as influenced by the duration of cooking are presented in Table 4. There was a significant ($P<0.05$) reduction in hydro-cyanide (HCN) content with increase in the duration of cooking of mucuna seeds. The raw mucuna seeds had the highest concentration (33.46mg/kg DM of samples). There was a 4.2, 13.2 and 10.9% destruction of HCN within 20, 40 and 60 minutes of cooking respectively. The destruction of about 28 and 30% tannin in mucuna seed was achieved during the first 20 and 60 minutes of cooking respectively. Duration

of cooking did not have any significant effect on phytic acid content. There was a significant decrease ($P<0.05$) in trypsin inhibitor activity with increase in duration of cooking of mucuna seeds. The raw mucuna seed had the highest value of 33.59 (TUI/mg). A rapid destruction of trypsin activity with approximately 31, 39 and 47% of activity achieved within 20, 40 and 60 minutes respectively. The destruction of oxalates in mucuna seeds followed the same trend as the trypsin inhibitor activity. There were however, no definite effect of the duration of cooking on the saponin content of mucuna seeds.

Impact of soaked and cooked mucuna seed meal on the performance of broiler chicks is shown in Table 5. At starter phase, the diets containing mucuna seed that had been soaked and cooked for 60 minutes were consumed more than the raw

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Table 2. Gross composition of broiler finisher diet (%).

Ingredients	1	2	3	4
Maize	49.93	48.92	48.13	48.55
Soyabean	26.17	27.18	26.97	27.55
Mucuna seed meal	20.00	20.00	20.00	20.00
Bone meal	3.00	3.00	3.00	3.00
Salt	0.50	0.50	0.50	0.50
DL- methionine	0.15	0.15	0.15	0.15
Premixes*	0.25	0.25	0.25	0.25
Calculated analysis				
Crude protein (%)	20.00	20.00	20.00	20.00
Crude fibre (%)	3.77	4.01	3.97	4.06
Available phosphorus (%)	0.76	0.79	0.77	0.80
Calcium (%)	1.21	1.21	1.21	1.21
Methionine (%)	0.42	0.43	0.43	0.43
Lysine (%)	1.05	1.06	1.06	1.06
ME (Kcal/Kg)	3015	3034	3012	3036

*Each kg of feed contained nutrients as in Table 1.

Table 3. Proximate analysis and Gross energy content of mucuna seed meal prepared from raw and cooked mucuna utilis seeds (%DM).

Duration of cooking (minutes).	0	20	40	60	SEM
Dry matter	89.70	89.55	90.19	89.31	0.90
Crude protein	29.37 ^a	27.95 ^b	28.27 ^{ab}	27.93 ^b	0.87
Crude fibre	5.53	6.63	6.61	6.87	0.45
Ether Extract	5.90 ^a	4.53 ^b	4.08 ^{bc}	3.17 ^c	0.43
Ash	4.43 ^c	6.68 ^b	8.78 ^a	7.76 ^{ab}	0.47
NFE	44.47 ^a	43.76 ^a	42.45 ^b	43.75 ^a	0.85
Gross energy (Kcal/g)	3.49	3.65	3.47	3.67	0.30

^{abc} Means on the same row with different superscripts are significantly (P<0.05) different.

SEM = Standard error of means

NFE = Nitrogen free extract

Table 4: Levels of anti-nutritional factors of mucuna seed meal prepared from raw and cooked mucuna utilis seeds.

Duration of cooking (minutes).	0	20	40	60	SEM
HCN(mg/kgDM)	33.46 ^a	32.04 ^{ab}	29.02 ^c	29.81 ^b	1.00
Destruction of HCN (%)	-	4.20	13.20	10.90	-
Tannin (%)	1.41 ^a	1.01 ^b	1.16 ^b	0.99 ^b	0.08
Destruction of Tannin (%)	-	28.30	17.70	29.70	-
Phytic acid (g/kg DM)	1.56	1.49	1.53	1.52	0.42
Destruction of Phytic acid (%)	-	4.40	1.90	2.50	-
TIA (TUI/mg)	33.59 ^a	23.03 ^b	20.40 ^{bc}	17.77 ^c	1.16
Destruction (%)	-	31.40	39.20	47.00	-
Oxalates (g/kg DM)	1.95 ^a	1.90 ^a	1.59 ^{ab}	1.38 ^b	0.12
Destruction (%)	-	2.50	18.40	29.20	-
Saponins (%)	0.11 ^b	0.87 ^a	0.10 ^b	0.94 ^a	1.29

^{abc} Means on the same row with different superscripts are significantly ($P<0.05$) different.

TIA = Trypsin inhibitor activity

TUI = Trypsin Units inhibited

SEM = Standard error of means

and the cooked for 20 and 40 minutes respectively. Significantly better weight gains were achieved as the duration of cooking increased. *Mucuna* cooked for 40 and 60 minutes had significantly ($P<0.05$) better feed conversion ratio in the birds than those on the raw mucuna seed diet. Protein intake of broilers fed 60 minutes cooked seed meal diet was significantly higher ($P<0.05$), while the raw diet was similar to that of the 20 and 40 minutes cooked mucuna seed meal diets. Protein efficiency ratio significantly improved as the duration of cooking increased. The dietary inclusion of mucuna seeds cooked at different time regime reduced feed cost per kilogram weight gain. The feed cost saving (%) were 21.3, 28.5 and 24.5% for soaked and cooked for 20, 40 and 60 minutes respectively.

Table 6 summarized the results of the effect of duration of cooking mucuna seed meal on the performance of finished broiler chickens. Increasing the duration of cooking resulted in significantly ($P<0.05$) higher daily weight gain, daily feed intake, daily protein intake and protein efficiency ratio. The feed cost/kg gain decreased with increase in the duration of cooking mucuna seed meal in the diets. About 27% feed cost saving was realized in soaked and cooked for 60 minutes diets.

Discussion.

In the chemical analyses, the raw and soaked and cooked mucuna seeds showed that the seeds had relatively high protein content. The crude protein of raw mucuna was similar to values

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Table 5 Effect of duration of cooking Mucuna seed on the performance of starting broiler chicks fed the experimental diets

Treatments	1	2	3	4	
Cooking time (minutes)	0	20	40	60	SEM
Performance criteria					
Initial weight (g/bird)	100.36	100.20	100.44	100.40	2.29
Final weight (kg/bird)	0.79 ^c	0.95 ^{bc}	1.06 ^b	1.10 ^a	0.06
Daily weight gain (g/bird/day)	24.63 ^c	30.35 ^b	34.27 ^a	35.70 ^a	1.29
Daily feed intake (g/bird/day)	63.43 ^b	61.77 ^b	63.35 ^b	70.01 ^a	1.22
Feed conversion ratio	2.58 ^a	2.04 ^{ab}	1.85 ^b	1.96 ^b	0.20
Daily protein intake g/bird/day)	13.95 ^b	13.59 ^b	13.94 ^b	15.40 ^a	0.26
Protein efficiency ratio (PER)	1.77 ^c	2.24 ^{bc}	2.32 ^b	2.46 ^a	0.10
Feed cost (₦/kg)	59.28	58.98	59.04	58.83	-
₦/kg meat produced	152.94	120.32	109.22	115.31	-
Cost reduction (%)	-	21.30	28.50	24.60	-

^{abc} Mean within rows with different superscripts are significantly different (P<0.05)

Table 6: The growth performance of finisher broiler as influenced by duration of cooking mucuna seed.

Treatments	1	2	3	4	
Cooking time (minutes)	0	20	40	60	SEM
Daily weight gain (g/d/bird)	26.32 ^c	34.68 ^b	37.13 ^{ab}	39.79 ^a	0.61
Daily feed intake (g/d/bird)	84.93 ^b	87.53 ^b	93.47 ^a	94.62 ^a	2.09
Feed conversion ratio	3.23 ^a	2.52 ^b	2.52 ^b	2.38 ^b	0.10
Daily protein intake (g/bird/day)	16.99 ^b	17.50 ^b	18.69 ^a	18.93 ^a	0.29
Protein efficiency ratio	1.55 ^b	1.99 ^a	1.99 ^a	2.10 ^a	0.6
Feed cost (₦/kg)	61.24	61.12	61.18	61.01	-
Cost/kg weight gain (₦)	198.39	154.02	154.17	145.20	-
Feed cost saving (%)	-	22.30	22.20	26.80	-

^{abc} Mean within rows with different superscripts are significantly different (P<0.05)

(-) Not applicable

reported for mucuna seeds (Emenalom and Udedibie, 1998, Emiola *et al.*, 2003, Iyayi and Taiwo, 2003), but lower than the 35.5% reported by Iyayi and Egherevba (1998). Variations in the reported values in this trial might have been caused by environmental factors, cultivar differences, soil fertility, time of harvesting of the seeds and probably conditions of cooking. Cooking irrespective of time regime tended to reduce crude protein content of mucuna seeds. This observation is in agreement with the findings of Mbajunwa (1995) and Nestares *et al* (1996), who reported a decreased protein content of seeds as a result of cooking and attributed this to the loss of soluble or proteinaceous parts of the seeds into the cooking water. The percentage crude fibre content of soaked and cooked *M. utilis* seeds (6.6%) found in this trial (Table 3) is similar to the value of 6.2% reported by Emiola *et al.* (2003). The low fibre content makes it a desirable component of monogastric animal diet. The decrease in nitrogen – free extract might be due to a higher loss of this fraction during cooking as it is composed mainly of starch, sugar, some water soluble vitamins and lignin. Ether extract content followed similar trend with NFE. This result is in consonance with the reports of Ukachukwu and Obioha (1997) who observed a reduction in fat and ash content of soaking for 48 hours and cooking for 1 hour. The loss might have been due to leaching of some fats into the cooking water or volatilization of fats during boiling.

Percentage tannin content decreased with increase in duration of cooking. Rao and Doesthale (1982) reported that the tannin content of cooked grains was generally significantly lower than that of raw grains, with a reduction of about 28 and 30% in tannin content resulting in the 20 and 60 minutes cooking respectively. Udensi *et al* (2005) also found that boiling for 60 and 90 minutes significantly reduced the tannic

acid content of raw mucuna bean meal. The phytic acid content of raw mucuna seed (1.56g / kg DM) and that of the cooked mucuna seed (1.52g /kg DM) were similar. The fact that duration of cooking did not have any appreciable effect on the phytic acid content is evidence that phytates are stable to heat treatment (Kaankuka *et al.*, 1996).

Raw *mucuna utilis* seed contained 33.46mg kg⁻¹ HCN kg⁻¹ dry matter, this is significantly lower than the values of 109 mg kg⁻¹ and 1750mg kg⁻¹ reported in mango seed kernel and rubber seeds respectively (Ravindran and Sivakanesan, 1996); as well as the values reported in cassava (Oke, 1968) respectively. Boiling generally reduced HCN. Kg⁻¹ in the seeds as shown by the values of hydrocyanic acid in raw and boiled seeds (33.5 vs 32, 29, and 29.8mg,kg⁻¹).

Marked reduction in activity of trypsin inhibitor was observed with an increase in the duration of cooking. The content of trypsin inhibitor was reduced by 47% when the *mucuna* seeds were subjected to cooking for 60 minutes, although there was a reduction in protein solubility due to denaturation as can be observed in the crude protein content of the seeds. However, the beneficial effect of destroying the anti-growth factors outweighed this adverse effect. There were improvements in feed intake, weight gain, feed conversion ratio and efficiency of protein utilization on the groups fed cooked mucuna seed meal when compared to the raw mucuna seed meal at both phases of the trial.

This observation is consistent with the reports of Emenalom and Udedibie (1998) and Emiola *et al.*, (2003) that the nutritive value of the mucuna seed was improved when subjected to cooking. These were attributed to better protein absorption, detoxification of anti-nutritional factors, higher palatability and availability of

amino acids in the diets. According to Siddhuraju *et al* (1996), raw mucuna seed contains trypsin inhibitors, which has been associated with delayed protein digestion by inhibiting trypsin and chemotrypsin activities simultaneously and forming an enzyme – inhibitor complex (Gallaher and Schneeman, 1986) to impair digestibility of crude protein.

The results of the economic of production showed that low nutrient and cheaper – priced feeds were not the most profitable. Feed cost tend to marginally decrease in cooked mucuna seed meal. However, intake of high quality feed is reduced up to 40 minutes cooked mucuna seed meal diet, weight gain is improved and feed efficiency is also improved. These accounted for higher percentage cost reduction recorded for birds fed boiled mucuna seed meal diets.

Conclusion.

Soaking and cooking significantly improved the quality of mucuna protein with respect to protein efficiency ratio (PER). The influence of anti-nutritional (trypsin inhibitor, tannic acid etc) factors in impairing protein quality in raw mucuna diet became obvious as a depressant of PER. However, soaking of Mucuna seeds for 24 hours prior to cooking for 60 min gave an indication of partial detoxification as evidence in percent destruction and better chickens performance. Twenty percent (20%) dietary inclusion of mucuna seed soaked for 24 hours and cooked for 60 minutes gave promising results which were comparable to reported findings on broiler chickens fed conventional feeds.

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