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Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorpjn@gmail.com

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The Nutritive Value of *Zornia glochidiata* as a Non-conventional Feedstuff in Rabbit in Sokoto, Nigeria

E.A. Ogunsan[1], G.I. Dogo[1], B.L. Aliero[2], W.A. Hassan[3], F.M. Tambuwal[3], N.I. Ogo[1] and J. Jatau[1]
[1]National Veterinary Research Institute, Vom, Plateau State, Nigeria
[2]Faculty of Science, [3]Faculty of Agriculture,
Usmanu Danfodiyo University, Sokoto State, Nigeria

Abstract: An experiment was conducted to determine the effect of including *Zornia glochidiata* (ZG) in the diet of rabbit at 0 (control), 10, 20 and 30%. The results showed that increasing the level of supplementation of ZG beyond 10% decreased feed intake and subsequently live weight gain. Dry matter digestibility also followed a similar trend. Least cost of feed per kilogram live weight gain occurred at the 10% inclusion level of ZG. Although blood parameters differed significantly between treatments, they were mostly within acceptable physiological limits, suggesting no adverse effects in feeding ZG to the animals.

Key words: *Zornia* sp., fibre, digestibility, diet

INTRODUCTION

The genus *Zornia* which belongs to the family papilionaceae comprises of annual or perennial legumes with digitate leaves which are paired, lanceolate with acute apex. The flowers are in terminal or auxiliary spikes while the bracts are paired and they enclose the flowers (Breman and Diarra, 1989). It occurs throughout Africa and the rainy season affords it ample opportunity to thrive successfully on the Sokoto plains of Nigeria (Malami, 2005). Villaquiran and Lascano (1986) reported that *Z. brssiliensis* has lower protein and digestible nutrients compared to *Centresema macrocarpum*. The authors thought that this is associated with digestive disturbances caused by the alkaloids it contains, concluding that this legume may not be suitable as a forage plant. *Z. glochdiata* displays a high degree of defoliation during the dry season but has complete soil coverage three weeks after planting during the wet season (Goncalves *et al.*, 1986). Ciotti (1986) contended that majority of the *Zornia* species establish faster than most other forage grasses and are more adaptable as forage crops. Lenne (1981) reported that even though promising pasture legumes such as *Desmodium gyroides* and *D. leterocarpon* could be severely damaged by root-knot nematode called *Meloidogyne Javanica*, *Z. glochidiata* is not affected. This attribute places *Zornia* species in a better position to compete favourably well with other potential legumes as forage crops for animal feeding.

Rabbit nutrition is the most important external factor that affects modern rabbit meat production (Portsmouth, 1987). The rabbit is a non-ruminant herbivore with an enlarged caecum (Hintz *et al.*, 1978). The consumption of a special type of faecal pellets either taken directly from the anus or eaten from the hutch floor is described as coprophagy and coprophagy plays a dominant role in the digestive physiology of the rabbit (Hintz *et al.*, 1978; Lang, 1981). Coprophagy enhances digestibility of food nutrients, notably amino acids and enables the rabbit to profit from vitamin synthesis (particularly the B complex vitamins), which occurs in the large intestine (Portsmouth, 1987). Although the rabbits eliminate both soft (night) and hard (day) faeces, the soft feaces may constitute as much as one-third of the total faeces (Kulwich *et al.*, 1953) and is usually subjected to coprophagy (Pickard and Stevens, 1972). Ladokun and Egbunike (1998) reported that special attention needs to be given to the type of feed provided for rabbits as this must meet the requirements for energy, protein, vitamins, minerals and other micronutrients necessary for normal growth and development. As a rule, the higher the fibre content of rabbit ration, the more difficult it is to digest, leading to excretion of more indigestible material (Lang, 1981). Thus, high fibre levels in the ration of rabbits promote longer retention of the digesta in the gut (Hoover and Heitman, 1972). Heckmann and Mehver (1970) reported best performance in terms of health, growth and feed conversion when the diet contained 8-9% crude fibre and that increasing the fibre level to 13-14% caused a decrease of 12% in feed conversion efficiency, with no improvement in health.

MATERIALS AND METHODS

Experiment diet: *Zornia glochidiata* (ZG) was obtained from the Livestock Improvement and Breeding Centre, Dogondaji in Sokoto State. The plant specimens were

Corresponding Author: E.A. Ogunsan, National Veterinary Research Institute, P.O. Box 203, Vom, Plateau State, Nigeria

collected when they were young, fresh and green. After cutting, they were air dried on concrete floor in a well ventilated room for 6 days during which they were turned over twice daily. On the seventh day, they were sun-dried for three days and thereafter pounded using local mortar and stored in jute sacs. Random samples of the prepared plant were taken and analyzed for proximate components. Other feed ingredients used to formulate experimental diet include wheat offal, yellow maize, groundnut cake, blood meal, bone meal, trace minerals and common salt. They were obtained from Sokoto central market and used to prepare diet containing 0(control) (without ZG), 10, 20 and 30% inclusion levels of *Zornia glochidiata*.

Experimental animals: Six to eight weeks old weaned rabbits of Nigerian ecotypes weighing between 550 and 590 g were used in the experiment. A total of 117 male rabbits were divided into groups of nine animals. Nine animals were assigned to each dietary treatment. The animals in each treatment were divided into three groups of 3 animals each-thus giving three replicates per treatment. The animals were housed in metabolism cages and each treatment was fed the experimental diet for an initial seven days adjustment period, which was followed by an experimental period of 56 days. 200 g of diet was provided daily and water was given *ad libitum*. Daily feed and water intake were measured. The experimental animals were weighed weekly.

Digestibility trial: Four weeks from the commencement of the experiment, a digestibility trial was introduced which lasted for ten days. During this trial, daily feed intake and faecal output were measured. 100 g of faecal samples were obtained from each animal and put in clean polythene bags and transferred into a refrigerator. At the expiration of the 10 days digestion trial, the faecal samples were analyzed for proximate composition using the methods described by AOAC (1990).

Blood analysis: Whole blood samples were collected through the jugular vein of the experimental animals on the day they were put into the metabolism cages and thereafter, samples were collected fortnightly. Haemoglobin was analyzed using dippelfarstab haemoglobinometer; total protein by biuret method; bilirubin, Serum Glutamicaxaloacetic Transaminase (SGOT) and Serum Glutamic-pyruvic Transaminase (SGPT) were assessed using Corning colorimeter. Alkaline phosphatase, urea and creatinine were determined using diacetyl monoxine extraction procedure (Tietz, 1987); sodium and potassium were analyzed on Seac Fp 20 flame photometer while bicarbonate ion was determined by the tetrimetric method.

Table 1: Gross composition (%) of experimental diets

	Treatments (% inclusion levels of ZG)			
Ingredients	1(0)	2(10)	3(20)	4(30)
Wheat offal	56.55	50.55	43.35	31.25
Groundnut cake	8.76	8.45	6.65	6.75
Blood meal	2.95	2.45	3.75	4.05
Yellow maize	27.74	24.15	22.25	23.95
Zornia glochidiata	0.00	10.00	20.00	30.00
Bone meal	2.65	2.65	2.65	2.65
Vitamins*	0.01	0.01	0.01	0.01
Trace minerals**	1.33	1.33	1.33	1.33
Total	100.00	100.00	100.00	100.00

*Vitamin A: 15,000,000 I.U; D3: 4,4000 I.U: E1:, 350 mg, K 4,350 mg, B2 4,350 mg B6: 2,350 mg: B12: 11.350 mg: C: 1,000 mg. **Magnesium: 1,400 mg/kg; Iron: 1,5000 mg/kg; Copper 400 mg/kg; Phosphorus: 1%

RESULTS

Gross and chemical composition of experimental diet: The gross and chemical composition of the experimental diets are shown on Tables 1 and 2 respectively. ZG contained 15% CP, 38% CF, 36% NFE and 7.5% ash. Increasing the level of ZG in the diet (from 0 to 30%) led to increase in CF and ash contents. The protein contents in the diets were however similar (Table 2).

Feed intake and live weight gain: Feed intake was higher for animals fed the 10% ZG diet (80 g/d) followed by those fed the control diet (73 g/d). Protein intake and protein efficiency ratio followed a similar pattern. Weight gain also followed a similar pattern with the highest value recorded for animals on the 10% ZG diet, (18.2 g/d). Rabbits fed the 20 and 30% ZG diets had the least weight gain (7.9 and 7.8 g/d respectively).

The control diet is the most expensive (Naira 26/kg) (Naira 150 ≅ 1$). Cost of feed declined progressively from Naira 26/kg to Naira 20/kg with increasing levels of ZG. Cost of feed consumed and cost of feed per kg live weight gain followed a similar pattern (Table 3).

Nutrients digestibility: Digestibility values for DM, CF, NFE and P were higher ($p<0.05$) for the 10% ZG diet (Table 4). CP digestibility decreased with increasing levels of ZG, while crude fat digestibility increased with increasing levels of ZG in the diets.

Blood chemistry: Haemoglobin concentration in the 10% ZG diet was higher than that recorded for the 30% diet, while total bilirubin was higher for treatment 3, followed by treatments 2, 1 and 4 in that order. Total protein, albumin and urea levels were however higher for the control diet. Including ZG in the diets increased SGOT levels. SGPT rose from 4 IU/L for the control diet to 7.5 IU/L for the 10% diet and them declined to 3 IU/L for the 30% inclusion level of ZG ($p<0.05$). ALP and creatinine levels also followed a similar pattern. Levels of Na^+, Cl^- and HCO_3^- did not differ significantly between the treatments.

Table 2: Chemical composition (%DM) of the experimental diets

		Treatments (% inclusion levels of *Z. glochidiata*)			
Item	*Z. glochidiata*	1(0)	2(10)	3(20)	4(30)
Dry matter	97.08	92.39	91.83	92.70	92.40
Crude protein	14.99	18.00	17.60	18.08	18.10
Crude fibre	38.24	6.78	9.88	12.88	15.56
Crude fat (EE)	1.73	4.82	3.73	4.10	4.52
NFE	36.39	65.10	63.30	59.96	56.71
Total ash	7.47	4.59	4.90	5.00	5.11
Calcium	0.85	0.12	0.20	0.26	0.32
Phosphorus	0.19	0.12	0.56	0.68	0.76
ME 1kcal/kg	2626.80	2412.30	2410.90	2450.30	2563.40

Table 3: Performance characteristics of rabbits fed graded levels of *Zornia glochidiata*

	Treatments (% inclusion levels of ZG)			
Parameter	1(0)	2(10)	3(20)	4(30)
Initial weight (g)	580.00±5.5	577.00±3.6	560.00±6.5	590.00±5.5
Final weight (g)	1462.10±6.3	1597.00±6.7	1002.50±4.7	1024.20±5.6
Final weight gain (g)	882.10^{b}	1020.00^{a}	442.50^{c}	434.20^{d}
Daily weight gain (g)	15.80^{b}	18.20^{a}	7.90^{c}	7.80^{c}
Daily feed intake (g)	73.90^{b}	80.10^{a}	62.40^{c}	62.00^{c}
Daily protein intake (g)	13.30^{b}	14.40^{a}	11.20^{c}	11.20^{c}
Feed conversion ratio	4.70^{c}	4.40^{d}	7.90^{b}	8.10^{a}
Protein efficiency ratio	1.20^{b}	1.30^{a}	0.70^{c}	0.70^{c}
Cost of feed (N/kg)	25.97	23.79	21.48	20.12
Cost of feed consumed (N/day)	1.92^{a}	1.90^{a}	1.34^{b}	1.27^{c}
Cost of feed/kg live weight gain (N)	121.25^{b}	104.39^{c}	169.62^{a}	162.82^{a}

Means on the same row with different superscripts (a, b, c, d) are significantly different ($p<0.05$)

Table 4: Nutrients digestibility of rabbit fed graded levels of *Zornia glochidiata*

	Treatments (% inclusion levels of *Z. glochidiata*)			
Parameter	1(0)	2(10)	3(20)	4(30)
Dry Matter (DM)	68.88^{c}	83.93^{a}	69.52^{b}	63.95^{d}
Crude Protein (CP)	80.27^{a}	79.52^{a}	77.17^{b}	70.98^{c}
Crude Fibre (CF)	53.61^{d}	82.59^{a}	59.78^{b}	56.39^{c}
Crude Fat (EE)	45.22^{d}	49.71^{c}	78.05^{b}	84.32^{a}
Nitrogen Free Extract (NFE)	80.84^{b}	89.56^{a}	75.07^{c}	71.83^{d}
Total Ash (TA)	70.56^{ab}	72.35^{a}	63.81^{b}	27.82^{c}
Calcium (CA)	73.28^{a}	73.16^{a}	68.38^{b}	43.75^{c}
Phosphorus (P)	63.69^{b}	67.40^{a}	33.19^{c}	32.01^{d}

Table 5: Blood chemistry of rabbits fed graded levels of *Zornia glochidiata*

	Treatments (% inclusion levels of ZG)			
Parameter	1(0)	2(10)	3(20)	4(30)
Haemoglobin (g/100 ml blood)	11.4^{a}	10.2^{c}	12.0^{a}	9.8^{c}
Total bilirubin (mg/100 ml)	0.4^{c}	0.5^{b}	0.7^{a}	0.1^{d}
Conjugate bilirubin (mg/100 ml)	0.4^{a}	0.3^{b}	0.3^{b}	0.3^{b}
Total protein (g/dl)	7.7^{a}	6.7^{d}	7.1^{c}	7.5^{b}
Albumin (g/d)	4.7^{a}	3.8^{d}	4.1^{c}	4.6^{b}
SGOT (IU/L)	3.5^{b}	7.0^{a}	6.5^{c}	6.4^{c}
SGPT (IU/L)	4.0^{b}	7.5^{a}	4.0^{b}	3.0^{c}
ALP (KingAmstrong unit KAU)	82.8^{b}	110.4^{a}	55.2^{c}	50.8^{d}
Urea (mg/100 ml blood)	6.2^{a}	4.7^{d}	4.9^{c}	5.1^{b}
Creatinine (mg/100 ml blood)	1.5^{d}	2.2^{a}	1.8^{b}	1.6^{c}
Na^+ (mmol/L)	137.0	146.0	142.0	140.0
K^+ (mmol/L)	5.6^{d}	6.8^{c}	7.0^{b}	7.2^{a}
Cl^- (mmol/L)	99.0	108.0	105.0	104.0
HCO_3^- (mmol/L)	22.0	20.0	22.0	22.0

Means on the same row with different superscripts (a, b, c, d) are significantly different ($p<0.05$). SGOT = Serum Glutamic-oxaloacetic Transaminase, SGPT = Serum Glutamic Pyruvic Transminase, ALP = Alkaline Phosphatase, HCO_3^- = Bicarbonate ion

DISCUSSION

The reduced performance with the high levels of ZG in the diets could be due to the increase in the level of fibre (CF) which rose from 7% in the control diet to 16% in the 30% ZG diet. Heckmann and Mehuer (1970) reported best performance in terms of health, growth and feed conversion in rabbits when the diet contained 8-9% crude fibre. The crude fibre content in the 30% diets in this study is well over what rabbit would tolerate for Heckmann and Mehuer (1970) were of the opinion that increasing the fibre level to 13-14% caused a decrease of 12% in feed conversion efficiency, with no improvement in health. In the same vein, a level of 2-14% crude fibre has been recommended for all-purpose rabbits (Gaman *et al.*, 1970; Maff, 1978). Similar response was observed by Joktham *et al.* (2003), Shiawoya and Adams (2004) who reported that the high crude fibre in mango *(Mangifera indica)* leaves might have accounted for the lower feed intake in rabbit while Aduku *et al.* (1989), Agunbiade *et al.* (2003) observed that *Mangifera indica* is poorly accepted by rabbits. Nworgu *et al.* (2001) however in a performance experiment discovered that feeding a mixture of mango leaf meals and concentrates enhanced feed intake in rabbits. This they attributed to the addition of concentrate in the feeding regimen. Palatability of feed plays an important role in determining the quantity of feed rabbit takes as explained by Villaquiran and Lascano (1986) who reported that ZG has bitter taste which is associated with the alkaloids it contains. This could have contributed to the lower feed intake of the diets containing higher levels of ZG, with the consequent lower performance. Furthermore, Villaquiran and Lascano (1986) have reported that *Zornia* species are low in protein and digestible nutrients contents. The DM digestibility of 84% was best at 10% inclusion level of ZG and decreased to 64% at 30% level. The trend is similar to the observations made by Adejinmi *et al.* (2003) when they fed fermented and unfermented cocoa pod husk to rabbits. Results of this study however tend to indicate that the possible effects of anti-nutritional factors (alkaloids) became evident only when the inclusion level went beyond 10%, because the best performance was recorded at the 10% level.

In this study, crude fat digestibility was found to increase as the level of ZG in the diets increased (Table 4). Clarke *et al.* (1977) however reported that there is no evidence that rabbits require fat in their diets, except as a source of essential fatty acids and to facilitate supply and absorption of soluble vitamins. According to Lang (1981), conventional feedstuffs containing 2-4% fat appear to meet the requirements of rabbits. Digestibilities of DM, CP and CF were better ($p<0.05$) for the 10% ZG diet compared to those of the other treatments (except for CP with the control diet). This further explains the better performance of animals fed the 10% ZG diet.

Cost of feed decreased with increasing levels of ZG in the diets. However, cost of feed per Kg live weight gain was lowest for the 10% ZG diet followed by the control diet (Table 3), with the least values recorded for the 20 and 30% diets ($p<0.05$). These results therefore show that it is more economical to raise rabbits on the 10% ZG diet compared to the other treatments.

As for blood chemistry, most of the parameters measured differed significantly except for Na^+, Cl^- and HCO_3^-. Significant differences were observed in Total Protein (TP) levels (6.7-7.7g/dl). It has been observed that continuous ingestion of diet containing high levels of CP, could lead to increase in feed protein catabolism in the liver, giving rise to urea formation (Benjamin, 1970; Kirk *et al.*, 1990). It is therefore adduced that the increases in TP and indeed urea are physiological and would not cause liver damage. Alkaline phosphatase which was highest at the 10% level decreased progressively towards the 30% level. A similar trend was observed for the creatinine, where the value of 1.6 mg% at the 30% diet approached that of the control at 1.5 mg%, suggesting that the decreases were only transient and the animals may not experience liver or kidney dysfunction. The levels of sodium, chloride and bicarbonate ions were not affected in this trial, suggesting that there was a steady state in the electrolyte balance of the experimental animals.

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