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RESPONSE OF SOME METABOLIC AND BIOCHEMICAL INDICES IN RABBITS FED VARYING LEVELS OF DIETARY CYANIDE

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ABSTRACT

Twenty four growing rabbits were used to assess the response of serum metabolites, performance, nutrient digestibility, and carcass characteristics of rabbits to varying dietary cyanide levels. The animals were randomly allocated to four experimental, isocaloric and isoproteinous diets containing 0mg, 250mg, 500mg and 750mg dietary cyanide levels corresponding to diets 1, 2, 3 and 4 respectively. Animals on diets 2, 3, and 4 had significantly ($P<0.05$) reduced digestibility of dry matter and nutrients. Daily body weight gain, daily water intake and feed efficiency significantly ($P<0.05$) reduced as the cyanide level increased. The serum metabolites, glucose, cholesterol, serum glutamate oxalotransaminase (SGOT), serum glutamate pyruvate transaminase (SGPT) and urinary cyanide were not significantly affected ($P>0.05$). The slaughter weight, and weights of the head and lungs of the rabbits on the cyanide diets were significantly lower ($P<0.05$) than those on the control diet. The results showed that dietary cyanide had negative impact on nutrient digestibility, growth performance and some carcass characteristics.

INTRODUCTION

Over the decades cassava has been assuming an important status in Nigeria both as feed for animals and food for man. Recently, data according to Ikwell (1999) put Nigeria as the current world leading producer of cassava with 33 million metric tonnes per year with possible increase in production expected over the years ahead. The astronomical rise in prices of other energy staples for human consumption in the country has resulted in a significant shift to cassava consumption. Food insecurity due to a general decline in the economy has led to short cuts in the processing of cassava for human consumption. Under these conditions, cassava products with high cyanide contents more than the recommended levels (Banea, 1993; Oke, 1994) can be deleterious. Cassava roots on traumatization releases cyanide from the glucosides linamarin and lotaustralin. Cyanide of dietary origin has been implicated in the aetiology of various disease conditions (Tylleskar *et al,* 1992; Banea, 1993 and Rosling, 1994). Some abnormalities that border on pathological changes as well as metabolic integrity of the organism under repeated intakes of cassava with high cyanide content do occur. These biochemical changes which may be due to either the direct effects of hydro cyanic acid or its product of bio transformation have been demonstrated to draw on various nutrients such as protein in the human or animal metabolic pool for the accomplishment of the processes which they undergo (Maner and Gomez, 1973).

This study was set up to investigate the effect of consumption of diets with graded levels of cyanide on rabbit performance, nutrient digestibility serum metabolites and carcass quality. The aim was to estimate the optimum level of cyanide permissible using rabbits as experimental animals

MATERIALS AND METHODS

Twenty-four growing rabbits (12 males and 12 females) of New Zealand white strain and of average weight of 770 g were randomly allocated to four experimental diets after balancing for body weight. The diets were isocaloric and isoproteinous with varying dietary cyanide levels of 0, 250, 500 and 750mg cyanide levels per kg feed (Table 1).

Table 1. Gross composition of experimental diets

Feed stuffs	Diet 1	Diet 2	Diet 3	Diet 4
Maize	35.00	35.00	35.00	35.00
Fish meal	2.60	2.60	2.60	2.60
GNC	19.00	19.00	19.00	19.00
Corn bran	20.00	20.00	20.00	20.00
Rice bran	21.40	21.40	21.40	21.40
Min/Vitmix a	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25
Bone meal	1.50	1.50	1.50	1.50
Total	100.00	100.00	100.00	100.00
Potassium cyanide	0.00			
Cyanide (mg)	0.00	250.00	500.00	750.00

a = Mineral vitamin premix supplied per kg diet: Vit A 10,000 IU, Vit D1,000 IU, Vit E 10 mg, Vit B 1.6mg, Vit B2 3.2mg, Vit B62.4 mg, Vit B 12 8mg, Folic acid 0.6mg, Pathothenic acid 14.4 mg, Choline chloride 80mg; Mg 0.25g; Mn 120mg; Fe 48mg; Cu 0.4mg and Se 100mg. GNC =Groundnut cake

Table 2. Chemical composition (g/kg) of experimental diets.

	Diets			
	1	2	3	4
Crude protein	18.80	18.76	17.90	18.53
Crude fiber	5.80	5.90	5.82	5.81
Ether extract	5.17	5.17	5.97	5.99
Ash	4.67	5.75	4.54	4.35
NFE	65.00	64.42	65.77	65.26

The animals were randomly assigned to the four test diets with six rabbits per treatment. Each rabbit served as a replicate. The animals were housed and fed individually and water given *ad libitum* . Records of body weight, feed consumption and daily water intake were recorded weekly for 60 days. On the eighth week, urine and faecal droppings were collected for the next seven days for nutrient digestibility estimation. The droppings were then dried, ground and analysed for dry matter (DM), crude protein (CP), crude fibre (CF) and ether extract (EE), as for the experimental diets using AOAC (1990) methods. A small volume out of the 10% urine kept was analysed for urinary cyanide, which served as inverse of thiocyanate.

At the end of the experimental period, two rabbits from each treatment group were randomly selected, weighed and slaughtered to evaluate their carcasses. Blood was collected by jugular venepuncture from the animals into heparinized bottles. Blood samples per animal for analysis were in triplicates. Serum metabolites were analysed according to the technique of Trinder (1988) and Boehringer (1980).

Data were subjected to analysis of variance (ANOVA) and regression using the general linear model (GLM) of SAS (1997). The significance between means was separated using Duncan 's Multiple range test (Steele and Torrie, 1960).

RESULTS AND DISCUSSION

The influence of varying dietary cyanide levels on performance of rabbits is shown in Table 2. Presence of cyanide in the diet caused depression in the dry matter intake, daily water intake, daily weight gain and feed efficiency (P<0.05). A unit increase in dietary cyanide level brought about reduction in growth rate by 0.08g, daily dry matter intake by 0.01 and feed efficiency by 0.0001g and increment in feed gain ratio or efficiency of feed utilization by 0.0001g.

This showed negative correlation between cyanide level and the growth parameters. This is in consonance with the report of Omole (1992), Esonu and Udebibe (1993) and Agunbiade et al (2001) who found depression in feed intake and body weight when cassava peel meal completely replaced maize in rabbit diet. The significantly reduced water intake induced by increased dietary cyanide levels was a possible reason for this since water intake and feed consumption are related. Moreover, increase in dietary cyanide levels caused a significant reduction (P<0.05) in the live weight, slaughter weight, eviscerated weight, and the weights of head and lungs of the rabbit.

A unit increase in cyanide concentration in the diet caused 0.40g reductions in the live weight, 0.40g in slaughter weight, 0.24g in eviscerated weight, and 0.02g in weight of the head and 0.004 g in weight of the lungs. Reduction in weight of the lungs due to increased cyanide levels could result in decreased oxygen uptake and utilization-a condition often encountered in under high cyanide load in the system. Under this condition, efficient utilization of feed declines as indeed indicated by the significant reduction in the digestibility of the nutrients (Table 6). This depression increased as cyanide concentration increased up to 750mg. Our results are contrary to those of Agunbiade *et al* (1999) that carcass characteristics and gut dimension were not significantly affected by dietary treatments even with 100% cassava peel meal. Cyanide being a natural toxin always requires sulphur for its detoxification in the animal's body.

The source of this body sulphur is usually the sulphur containing amino acids such as methionine and lysine. The use of these amino acids for this purpose makes them unavailable for protein synthesis in the animal.

Table 3. Performance Characteristics of Weaner Rabbits Fed Varying Dietary Cyanide Levels.

Parameter	DIETARY CYANIDE LEVELS				Regression equation	Inference
0mg	250mg	500mg	750mg			
Initial live weight (g)	769.17	779.17	777.50	766.67		
Final live weight (g)	1630.00	1425.00	1371.67	1329.17		
Daily feed intake (g DM)	68.08 ± 1.29a	60.33 ± 1.38c	58.12 ± 0.38c	54.56 ± 1.21b	Y=15.19151-0.00842X	* *
Daily water intake (ml)	266.97 ± 20.15a	232.41 ± 14.04c	232.52 ± 21.31c	201.69 ± 23.88b	Y=66.49849-0.01678X	*
Daily weight gain (g)	16.64 ± 1.43a	11.53 ± 0.81b	10.46 ± 0.93b	9.74 ± 0.42b	Y=262.19962-0.0773X	* *
Feed efficiency	0.25 ± 0.02a	0.19 ± 0.01b	0.18 ± 0.02b	0.18 ± 0.01b	Y=0.22849-0.00008X	* *
Feed conversion ratio	4.85 ± 0.49	5.32 ± 0.27	5.77 ± 50.00	5.63 ±0.17	Y=4.99189+0.00109X	NS
Urinary cyanide	25.88 ± 1.13	39.38 ± 2.98	30.38 ± 5.16	34.88 ± 7.37	Y=29.9250+0.00720X	NS

a, b, c (means in the same row having different superscript are significantly different

**(P< 0.05 ; ** (P<0.01 NS (Not significant*

Table 4. Serum metabolites of rabbits fed varying levels of dietary cyanide

Parameter	DIETARY CYANIDE LEVELS	Regression equation	Inference

0mg	250mg	500mg	750mg			
Glucose	102.33 ± 21.83	135.00 ± 29.63	109.33 ± 27.82	91.00 ± 18.00	Y=120.17105-0.02126X	NS
Cholesterol	74.33 ± 7.75	106.75 ± 28.13	53.67 ± 2.73	104.00 ± 15.00	Y=83.40789+0.00453X	NS
SGOT	74.67 ± 14.50	105 ± 24.49	111.67 ± 22.98	85.00 ±1.00	Y=88.82895+0.02126X	NS
SGPT	102.67 ± 26.26	72.75 ± 8.25	133.00 ± 41.07	67.50 ± 55.50	Y=96.17105-0.00526X	NS

NS (Not significant)

Table 5. Carcass characteristics of rabbits fed varying levels of dietary cyanide

Parameter	DIETARY CYANIDE LEVELS				Regression equation	Inference
0mg	250mg	500mg	750mg			
Live weight (g)	1650.00 ± 100.00 a	1500.00 ± 0.00c	1375.00 ± 25.00b	1355.00 ± 5.00b	Y=1621.5000-0.4040X	*
Slaughter weight (g)	1600.00 ± 100.00 a	1425.00 ± 25.00c	1315.00 ± 35.00b	1305.00 ± 5.00b	Y=1560.5000-0.3980X	*
Carcass weight (g)	1335.00 ± 195.00	1075.00 ± 25.00	1000.00 ± 45.00	975.00 ± 45.00	Y=1269.5000-0.4620X	N. S.
Eviscerated weight(g)	840.00 ± 80.00 a	737.50 ± 12.50c	6600 ±10.00 b	670.00 ± 20.00b	Y=815.0000-0.2350X	* *
Fresh pelt weight (g)	159.45 ±11.45	143.73 ± 8.67	126.50 ± 6.60	123.55 ± 10.55	Y=157.0470-0.0500X	N. S.
Hind and fore limbs weight (g)	32.70 ± 2.10	36.27 ± 0.77	32.75 ± 2.25	33.25 ± 4.25	Y=34.0210-0.0008X	N. S.
Head (g)	146.95 ± 1.35 a	151.00 ± 0.50a	131.60 ± 0.60b	134.15 ± 3.15b	Y=149.5950-0.0231X	* *
Intestine weight (g)	290.. 00 ± 40.00	237.50 ± 12.50	250.00 ± 0.00	275.00 ± 15.00	Y=268.0000-0.0130X	N. S.
Liver weight (g)	48.35 ± 10.55	45.94 ± 5.86	40.40 ± 0.40	40.65 ± 0.45	Y=48.1310-0.0115X	N. S.
Kidney's weight (g)	9.45 ± 0.05	9.86 ± 0.26	9.80 ± 0.30	9.40 ± 0.20	Y=9.6570-0.0001X	N. S.
Heart weight (g)	3.90 ± 0.40	3.75 ± 0.65	2.95 ± 0.05	3.45 ± 0.75	Y=3.8330-0.0009X	N. S.
Brain weight (g)	7.65	7.86	7.80	8.00	Y=7.6790-0.0004X	N. S.

	± 0.35	± 0.74	± 0.40	± 0.20		
Lungs weight (g)	9.70 ± 0.00a	7.01 ± 0.76 b	6.95 ± 0.45b	6.80 ± 0.30b	Y=8.9290-0.0035X	*

a, b, c means in the same row having different superscript are significantly different

** P< 0.05 ** P<0.01 NS Not significant*

Table 6. Apparent nutrient digestibility of rabbits fed varying cyanide level

Parameter	DIETARY CYANIDE LEVELS				Regression equation	Inference
0mg	250mg	500mg	750mg			
Dry matter	74.94 ± 2.0 a	69.99 ± 0.85c	69.34 ±2.65c	67.55 ± 1.29b	Y=73.8303-0.0091X	*
Crude protein	66.26 ± 1.18a	62.48 ± 1.41b	59.43 ± 2.96c	57.66 ± 1.20c	Y=65.7773-0.0115X	*
Crude fibre	48.53 ± 5.83a	35.80 ± 2.77b	33.65 ±3.24c	33.37 ± 3.59 c	Y=44.9853-0.0191X	*
Ether extract	90.66 ± 0.18a	88.03 ± 1.34b	88.46 ± 1.35b	83.07 ± 3.21c	Y=90.9380-0.0089X	*

*a,b,c means on same row have different superscripts are significantly different. * P<0.05*

Highly proteinous feedstuffs such as fishmeal was included to supply part of the sulphur needed for the detoxification of the cyanide; hence no mortality was recorded even at 750mg cyanide inclusion in the diet. This observation is in line with that of Tewe (1981) who reported that 500 ppm hydrogen cyanide in cassava had little effect on health of rat and pigs if fed in diets adequate in protein and iodine. But a dietary deficiency of the sulphur element could have been induced in the animals and this coupled with thermal stress involved in the catabolism of amino acids led to reduction in efficient utilization of the diets with high cyanide. Wooley and Cooley (1956) had reported that detoxification of cyanide to thiocyanate required sulphur from protein synthesis in the animal. This manifested itself in reduced dry matter intake, reduced water consumption and low nutrient digestibility (Table 6) with a consequent reduction in growth rate, feed conversion and in some carcass characteristic as cyanide concentration increased beyond 250 mg. This is in line with Whanger (1972). Also, there was significant reduction in water intake with no significant abnormality on urinary volume. This is contrary to the report of Odeigha (1993) who fed albino rats exclusively with cassava and reported an increase in water and feed consumption and urine volume with a reduction in body weight. The results however are in agreement with the finding of Eshiet *et al* (1980) who reported no significant difference in urinary thiocyanate of rabbits fed various levels of cassava root meal. The results of urinary cyanide (Table 3) indicate the inverse level of thiocyanate that could have been in the urine. Furthermore, the little or no significant change in glucose, cholesterol, SGPT and SGOT as seen in Table 4 is supported by the report of Akanji (1994) and Tylleskar (1994). Results of the work of these authors show that animals need to have good access to supplementary protein-rich food that furnished sulphur amino acids for the detoxification of the cyanide.

Based on the results of this study, diets formulated and food prepared for human consumption should contain not more than 250 mg cyanide per kilogram in diet. But where higher levels of cyanide occur in the diet, the protein supply must be adequate.

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