Der Tropenlandwirt, Zeitschrift für die Landwirtschaft in den Tropen und Subtropen
95. Jahrgang. Oktober 1994, S. 197 - 205

Supplement effects of low- and high-cyanide cassava peels on the performance, nutrient digestibility, and serum metabolites of growing pigs

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30 growing pigs were randomly offered diets containing 0, 203, or 419 mg HCN/kg in order to investigate the effects of low and high cyanide concentrations in cassava peels on the performance, nutrient digestibility, serum protein (total), albumin, urea, glutamic pyruvate transaminase, and glutamic oxaloacetate transaminase. The weight gain, feed intake, feed utilization, and protein efficiency ratio were not significantly affected (P0.>05) by the dietary cyanide level, altough these parameters were lower in animals consuming the high-cyanide diet. While the serum total protein and albumin were not significantly different (P<0.05) between animals on the low- and high-cyanide diets, the serum urea was significantly (P) increased with increasing dietary cyanide level. Serum glutamic pyruvate transaminase (SGPT) and serum glutamic oxaloacetate transaminase (SGOT) did not react significantly (P>0.05) to increased dietary cyanide levels.

1 Introduction

In nature cyanide and its precursors are ubiquitos. In both man and animals the ingestion of cyanide is principally from cyanophoric plants containing cyanogenic glycosides (ERMANS et al. 1972). Cassava is one of the dietary foodstuffs which contain moderate to high levels of cyanogenic glycosides. Generally, among the cyanophoric sources maximum yields of cyanide can be as high as 100-300 mg/100g tissue (MONTGOMERY 1969), so that the amount of cyanide ingested

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from these sources can be substantial when compared with the lethal dose range of 0.5-3.5 mg/kg body weight (ERMANS et al. 1972). Cassava peel, which is the major repository of cyanide in the plant, is increasingly being used as an animal feed in the tropics either fresh or dried. The peels from the sweet and bitter varieties in Nigeria have been shown to contain up to 265 mg and 322 mg/kg, respectively, on average in sundried form (TEWE 1983). Earlier reports have shown the implication of the cynogenic glucosides of cassava in neurological and endocrinological anomalies (OSUNTOKUN and MONEKOSSO 1969, EKPECHI et al. 1966, DELANGE 1974) and in endemic goitre and cretinism (DELANGE et al. 1983) in human populations. The markedly high levels of cyanide in the cassava varieties currently used for animal and human consumption necessitate an elucidation of other effects of the cyanide content of cassava (peel). This study was therefore set up to investigate the effects of the peels containing low- and high-cyanide on the performance, nutrient digestibility, and serum metabolites using growing pigs as experimental animals.

2 Material and methods

Cassava peels were obtained from the Agronomy Department of the University of Ibadan, Nigeria. Two sets of 5 varieties, each with low levels of cyanide (range 196-210 mg/kg) and high levels of cyanide (range 410-427 mg/kg), were used after sundrying. The peels were milled before being incorporated in the diets at 40% level supplementation for maize. 30 weanling pigs of Landrace X Large White breed were allocated to the 3 experimental diets (Table 1) on the basis of weight and sex with 10 animals (5 males + 5 females) per treatment. The diets were isonitrogenous and isocaloric and contained 0,203, and 419 mgHCN/kg diet. The animals were fed and given water ad libitum and records of body weight and feed intake were taken weekly. Blood samples were taken at commencement of the study for baseline analysis and thereafter weekly. The study lasted for 72 days. Digestibility trials were carried out with another 12 weanling pigs which were housed in metabolic cages and randomly allocated to the 3 diets with 4 animals (2 males + 2 females) per treatment. Collection of urine and feaces was done daily, and the urine was treated with tetraoxosulphate (VI) acid to prevent loss of nitrogen. The study lasted for 14 days.

The methods of the Association of Official Analytical Chemists (AOAC 1980) were used to analyse the samples. The cyanide content of the diets was analysed by the automated enzymic assay of RAO and HAHN (1984). Serum total protein was estimated by the biuret method of WEICHELBAUM (1964). Serum urea determination was by the diacetylmonozine method of FAWCETT and SCOTT (1960) as modified by KAPLAN and SZABO (1979). Estimation of serum glutamic oxaloacetate transaminase (SGOT) and serum glutamic pyruvate transaminase (SGPT) was

made by the method of REITMAN and FRANKEL (1957). The results were analysed by the analysis of variance (ANOVA) technique of COCHRAN and COX (1957). The difference between paired means was assessed by the least significance difference (LSD) method.

Table 1: Gross composition of experimental diets

Ingredients (%)	Dietary treatments		
	1	11	111
Yellow maize	67.00	18.50	18.50
Cassava peel	—	40.00	40.00
Groundnutmeal	11.72	20.00	20.00
Fishmeal	4.39	4.50	4.50
Bloodmeal	4.39	4.50	4.50
Brewer's grain	7.50	—	—
Palm oil	2.50	10.00	10.00
Bonemeal	1.50	1.50	1.50
Min-Vit-Premix[1]	0.50	0.50	0.50
Salt	0.50	0.50	0.50
Total	100.00	100.00	100.00
Analysed protein (%)	19.79	20.42	20.42
Analysed ME (kcal/gm)	3.13	3.12	3.12
Analysed HCN (mg/kg)	0.00	203.00	419.00

1 1-Min-Vit-Premix provides: Zoodry VM 501 Vitamin and trace mineral premix contents/kg: Vit A 12,000,000 I. U., Vit D_3 2,000,000 I. U., Vit E 7,000 I. U., Vit B_2 4,000 mg, Nicotinic acid 15,000 mg, Calcium d-pentothenate 8,000 mg, Vit H (Biotin) 40 mg, Vit B_{12} 10 mg, Mn 20,000 mg, Fe 50,000 mg, Zn 100,000 mg, Cu 10,000 mg, Iodine 750 mg, Co 300 mg.

3 Results

The results of the daily weight gain, feed intake, feed utilization, and protein efficiency ratio are presented in Table 2. The coefficient of correlation between dietary cyanide and daily weight gain, feed intake, and feed utilization are presented in Table 3. The daily weight gain, feed intake, feed utilization, and protein efficiency ratio were not significantly affected ($P>0.05$) by increases in the dietary cyanide level. Dietary cyanide (X) was highly and negatively correlated with daily weight gain (Y1:r=-0.81), feed intake (Y2:r=-0.78), and feed utilization (Y3:r=-0.71).

Results of nutrient digestibility are shown in Table 4. Only the ether extract increased significantly with an increase in dietary cyanide. Results of serum metabolites are presented in Table 5. Serum total protein, albumin, SGOT, and SGPT

Table 2: Performance of pigs on experimental diets

Parameters	Dietary treatments			
	1	11	111	SE
Initial body weight (kg)	17.10	16.89	15.80	±0.90
Final body weight (kg)	54.30	51.45	49.88	±1.20
Daily weight gain (kg)	0.52	0.48	0.47	±0.06
Daily feed intake (kg)	1.64	1.42	1.38	±0.08
Efficiency of feed utilization	3.15	2.95	2.94	±0.09
Protein efficiency ratio	1.57	1.60	1.59	±0.07

Table 3: Correlation coefficient between dietary cyanide and some performance parameters

Dietary cyanide (mg/100kg) (X)	Daily weight gain (Y_1)	Daily feed intake (Y_2)	Feed utilization (Y_3)
203	0.48	1.42	2.95
419	0.47	1.38	2.94
r	-0.81	-0.78	-0.71

Table 4: Nutrient digestibility and energy utilization of pigs on experiental diets

Parameters (%)	Dietary treatments			
	1	11	111	SE
Crude protein	64.39	63.08	62.67	±1.20
Crude fibre	68.41	62.07	53.77	±1.28
Ether extract	57.44a	89.86b	89.88b	±3.21
Nitrogen-free extract	97.59	92.40	94.41	±3.88
Total digestible nutrient	81.76	79.96	76.25	±1.32
Organic matter	86.64	83.96	80.92	±2.96
Digestible energy	78.39	79.86	80.92	±2.87
Metabolizable energy	75.25	73.65	77.68	±1.56

Values without common superscript in the same horizontal row are significantly different (P)

were not significantly (P>0.05) affected by increases in dietary cyanide, but serum urea was significantly (P<0.05) increased with increases in dietary cyanide.

Table 5: Serum metabolites in pigs on experimental diets

Parameters	Dietary treatments			
	1	11	111	SE
Total protein (g/100ml)	7.91	7.69	7.40	±1.01
Albumin (g/100ml)	4.29	4.45	4.48	±0.62
Urea (g/100ml)	42.51a	50.41b	55.53c	±3.52
Glutamate pyruvate transaminase (I.U./L)	23.71	22.32	20.56	±1.87
Glutamate oxaloacetate transaminase (I.U./L)	22.69	21.37	21.14	±1.63

Values without common superscript in the same horizontal row are significantly different (P)

4 Discussion

Performance and nutrient digestibility

The results of the present study showed that the incorporation of cassava peels containing up to 419 mgHCN/kg diet did not have any deleterious effects on the performance of the animals. Though MANER (1973) and FETUGA (1972) have reported depressed performance of pigs reared on cassava-based diets. OTCHERE et al. (1980) and LARSEN and AMANING-KWARTENG (1980) have reported the beneficial effects of feeding cassava to pigs. Similar studies conducted by GOMEZ (1983) with rats showed that body growth and feed consumption were similar for both high-cyanide and low-cyanide containing varieties. Feeding trials by SANTOS (1983) with broilers also showed that least-cost diets with varying levels of cassava meal from either low- or high-cyanide content varieties produced similar results. The results of this study are also in agreement with earlier reports of JOB (1975) that a diet based on cassava meal produced from a high-cyanide content variety was consumed non-significantly less than a diet based on cassava meal produced from a low-cyanide content variety. The difference in feed intake is thus reflected in difference in average daily weight gain. The high cyanide content could impact a bitter taste on the diets thereby reducing the feed intake of animals on these diets. Though the sulphur-amino acids could also be used to detoxify the cyanide to thiocyanate, sparing only a little for body growth, up to a level of 419 mgHCN/kg, the animals did not have a significantly impaired performance. Another factor for the non-significant difference in the performance of the animals was the non-significant difference in the digestibility of the nutrients.

The crude fibre digestibility was similar in all treatments because its level of 6.50-8.58 in the diets is acceptable to pigs. The higher values for ether extract for animals on diets 2 and 3 are due to the higher levels of palm oil in these diets, which was added primarily to reduce the dustiness of the cassava peel-based diets.

Serum metabolities

The non-significant difference for the serum protein and albumin in this trial is an indication of the comparable quality of the protein in the experimental diets. Values were however lower ($P>0.05$) for the cassava peel-based diets because animals on these diets had to draw on the body protein for detoxification of the cyanide. The results of serum urea concentration are in agreement with the findings of KUMPTA and HARPER (1961). These authors reported that under the condition of amino acid imbalance, like in protein deficiency or in the presence of toxic agents, degradation of the amino acids occurs with a consequent increase in the serum urea level. The higher values ($P<0.05$) of urea of animals on the cassava diets was therefore due to the constant depletion of the sulphur-amino acids for detoxification over the trial period. Over this period an imbalanced amino acid state was created in the animals with a resultant increased catabolism of the amino acids (HARPER 1971) and a consequent increase in the serum urea levels.

The serum GPT and GOT activities did not show any significant changes. Since the diets were comparable in protein levels, they were practically isonitrogenous. The activities of the enzymes respond to differences in the quantity and quality of dietary protein (SCHIMKE 1962, WIRTGHEN and BERGNER 1969). That the serum GPT and GOT did not significantly differ in this trial was therefore as a result of the isonitrogenous nature of the diets. The results also corroborate the fact that the dietary cyanide level in this trial did not have any serious effect on organs like liver and heart where the enzymes are found in high concentrations. It is only in cases of serious hepatic necrosis or myocardial infarction as - confirmed by the work of ALETOR (1983) - that the leakage of the enzymes into the blood stream occurs.

E. A. IYAYI: Begleiteffekte niedriger und hoher Zyanidkonzentrationen von Maniokschalen für Entwicklung, Nährstoffverdaulichkeit und Serummetaboliten wachsender Schweine

30 wachsenden Schweinen wurden Futterrationen mit 0, 203 oder 419 mg HCN/kg OS nach zufälliger Auswahl verabreicht, um die Wirkungen niedriger und hoher Zyanidkonzentration von Maniokschalen auf Entwicklung, Nährstoffverdaulichkeit, Serumprotein (insgesamt), Albumin, Harnstoff, Glutaminpyruvattransaminase und Glutaminoxalazetattransaminase zu untersuchen. Lebendmassezunahme, Futteraufnahme, Futternutzung und Proteinwirkungsgrad wurden durch das Zya-

nidniveau nicht signifikant (P0,05) beeinträchtigt, obwohl diese Parameter bei den Tieren mit dem Hochzyanidfutter schlechter ausfielen. Während Gesamtserumprotein und Albumin beim Vergleich von Tieren mit gering- und hochgradig zyanidhaltiger Fütterung sich nicht signifikant unterschieden (P0,05), war der Serumharnstoff mit ansteigendem Zyanidgehalt im Futter signifiant (P,05) erhöht . Serumglutaminpyruvattransaminase (SGPT) und Serumglutaminoxalazetattransaminase (SGOT) reagieren nicht signifikant (P0,05) auf steigenden Zyanidgehalt im Futter.

E. A. Iyayi: Effets concomitants d'une concentration de cyanure basse et haute d'écorces de manioc pour le développement, la digestibilité des substances nutritives et les métabolites sériques de porcins croissants

Ont été administrées à 30 porcins croissants des rations de fourrage avec 0, 203 ou 419 mg HCN/kg OS, suivant un choix aléatoire, pour étudier les effets d'une concentration de cyanure basse et haute d'écorces de manioc sur le développement, la digestibilité des substances nutritives, la protéine sérique (au total), l'albumine, l'urée, les transaminases pyruvique glutamique et oxalacétique glutamique. L'augmentation de la masse vive, l'absorption du fourrage, l'utilisation du fourrage et le degré d'effet protéique n'ont pas été entravés de façon significative par le taux de cyanure (P>0,05), bienque ses paramètres étaient moins bons chez les animaux qui recevaient un fourrage à cyanure concentré. Alors que la protéine sérique totale et l'albumine, en comparaison avec les animaux recevant un fourrage à cyanure peu et hautement concentré ne se distinguaient pas remarquablement (P>0,05), l'urée serique était significativement élevée selon l'augmentation de la teneur en cyanure du fourrage (P<0,05). Les transaminases pyruvique de sérum glutamique (SGPT) et oxalacétique de sérum glutamique (SGOT) n'ont pas réagi de facon significative (P>0,05) à une augmentation de la teneur en cyanure du fourrage.

E. A. Iyayi: Efectos complementarios de baja y alta concentración de cianuro en la corteza de yuca para el desarrollo, la digestibilidad de nutrientes y metabolitos de suero en cerdos en crecimiento

30 cerdos en crecimiento fueron alimentadas con raciones con 0, 203 o 419 mg HCN/kg MS elegidas al azar, para investigar los efectos de bajas y altas concentraciones de cianuro en la corteza de yuca en cuanto a desarrollo, digestibilidad de nutrientes proteina del suero (total), albumina, urea, glutamina-pyruvato-transaminasa y glutamina-oxalacetato-transaminasa. El aumento de peso, el consumo de forraje, la metabolizatión del forraje y el grado de efectividad de las proteinas no fueron inhibidos en forma significante (P0,05) por la concentración de cianuro, a

pesar que, estos parámetros mostraron valores deficientes en los animales que consumieron forraje con alto contenido de cianuro. La proteina del suero total y la albúmina, al comparar animales alimentados con forraje con alta y baja concentración de cianuro, no mostraron diferencias significantes (P0,05). La urea del suero, por su parte, aumentó en forma significante (P,05) en la medida que se elevó el contenido de cianuro en el forraje. La glutamina-pyruvato-transaminasa del suero (SGPT) y la glutamina-oxalacetato-transaminasa del suero (SGOT) no reaccionaron en forma significante (P0,05) ante un aumento del contenido de cianuro en el forraje.

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