EVALUATION OF METHODS OF PROCESSING CHAYA LEAF MEAL (CLM) IN TERMS OF CHEMICAL COMPOSITION AND ON PERFORMANCE AND PHYSIOLOGICAL PARAMETERS OF CHICKS

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Received 12 September, 1988; accepted 20 September, 1989.

ABSTRACT

Four processing methods, air drying, oven (mechanical) drying, fermentation and parboiling of chaya leaves, were evaluated for their effect on the chemical composition of the resulting dry leaves. They were evaluated further in terms of performance and some physiological parameters using 450 day-old cockerels. There were no significant ($P > 0.05$) differences in chemical composition of the chaya leaf meal due to method of processing with the exception of the hydrogen cyanide content which were significantly ($P < 0.05$) higher in the air dried and fermented meals. The feeding of diets incorporating 50g/kg feed of the variously processed chaya leaf meal did not significantly ($P > 0.05$) affect final body weight gain, feed consumption, feed conversion efficiency, water intake and mortality of chicks, as compared to a chaya-free (control) diet. Treatment differences in blood cellular elements of chicks were not significant ($P > 0.05$). Histological observations on the liver of chaya-fed birds indicated no morphological or gross issue changes.

Key words: Chaya leaf meal, processing, chemical composition, performance, chicks.

INTRODUCTION

The Chaya plant (*Cnidoscolus* spp.) is an outstanding source of essential nutrients (National Academy of Sciences, 1975; Martin and Ruberte, 1978) but it has the major disadvantage that it contains hydrogen cyanide, similar to the type found in cassava (Martin and Ruberte, 1978) and also some limited amounts of calcium oxalate (Essuman, 1986).

Cyanide inhIbits many metallo-enzymes by forming stable complexes with them (Dixon and Webb, 1965). The toxicity of cyanide depends primarily upon its potency as a respiratory poison, its site of action being the cytochrome oxidase system of aerobic organisms with which it forms a highly stable complex, thereby producing death by cellular anoxia (Bourodoux et al., 1980).

By far the most common effect of oxalates is to cause kidney damage owing to blocking of the tubules by crystals of calcium oxalate (Clarke and Clarke, 1979). This does not necessarily cause death, but the kidney damage remains and subsequent ingestion of oxalate-containing feedingstuffs may have fatal results. Oxalates may also lead to the breakdown of red blood cells. In certain circumstances oxalate may crystalize out in brain tissues and cause symptoms of paralysis and other disorders of the central nervous system (Clarke and Clarke, 1979).

Because of its cyanide and oxalate contents and possible toxic effects, chaya leaves must be processed before it be can incorporated into poultry feed formulations, especially in areas where conventional feed ingredients are either scarce or expensive. This points to the need for identifying simple procedures for preparing chaya to be used in feeds.

The objective of this study, therefore, is to evaluate four simple methods of processing - air (shade) drying, oven (mechanical) drying, fermentation and parboiling 0 in terms of chemical composition of CLM and the performance and physiological parameters of chicks fed diets incorporating the variously processed ingredient.

MATERIALS AND METHODS

Chaya leaf processsing

Freshly harvested chaya leaves were divided into four lots, each lot receiving one of the four different processing methods.

Air drying: Treatment consisted of spreading out the leaves in the open but protected from direct sunlight for 7 days at ambient temperatures ranging from 22 to 27°C. Leaves were turned over periodically to ensure proper drying.

Oven (mechanical) drying: The second lot was subjected to dry heat for 96 hours in an electric oven (Oven 300 plus Series, manufactured by Gallenkamp, Leicestershire, England) at a temperature of 42°C. The leaves were turned over every 24 hours to ensure thorough drying.

Table 1: PERCENTAGE COMPOSITION OF EXPERIMENTAL DIETS

	Dietary treatments				
Ingredient	Control	Air	Oven	Fermented	Parbolied
Maize	60.0	60.0	60.0	60.0	60.0
Fishmeal	6.0	9.0	9.0	9.0	9.0
Chaya leaf meal	-	5.0	5.0	5.0	5.0
Soybean meal	4.0	4.0	4.0	4.0	4.0
Wheat bran	17.0	9.0	9.0	9.0	9.0
Brewer's spent grains	6.0	6.0	6.0	6.0	6.0
Dried brewer's yeast	4.0	4.0	4.0	4.0	4.0
Salt	0.5	0.5	0.5	0.5	0.5
Oyster shell	2.0	2.0	2.0	2.0	2.0
Vitamin-trace mineral premix	0.5	0.5	0.5	0.5	0.5
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Total	100	100	100	100	100
Chemical composition					
Crude protein (%)	21.17	21.01	21.03	21.04	21.03
Ether extract (%)	2.42	4.31	4.25	4.24	4.23
Crude fibre (%)	3.40	3.92	3.94	3.92	3.93
Ash (%)	12.50	10.24	10.63	10.45	10.82
Nitrogen free extract	59.51	61.52	61.15	61.34	60.99
Cystine (%)	0.64	0.65	0.65	0.65	0.65
Methionine (%)	0.69	0.72	0.70	0.72	0.71
Lysine (%)	1.11	1.21	1.20	1.22	1.18
Metabolizable energy (MJ/kg)	11.83	11.63	11.48	11.56	11.50

Fermentation: The apparatus consisted of a 200-litre water tank. Leaves were soaked in the tank for 24 hours after which they were removed and air dried for 7 days at ambient teperatures which ranged from 22 to 27°C.

Parboiling: Fresh chaya leaves were placed in a 100-litre water tank and boiled for 1 minute at a temperature of 100°C. The partially boiled leaves were later air dried for 7 days.

Each processed lot was ground and stored in polythene sacks until used in formulations.

Chemical analyses

Proximate analysis (dry matter, crude protein, ash, ether extract, crude fibre and nitrogen-free extract) of CLM from each treatment and experimental diets was carried out according to methods outlined by Association of Official Analytical Chemists (1980). Hydrogen cyanide concentration in leaves from each treatment was determined according to the method of Vogels (1983), while calcium oxalate contents were determined to methods of Association of Official Analytical Chemists (1980).

Experimental birds

Four hundred and fifty day-old cockerels (AF Bosbek strain) were weight-sorted and randomly divided into 5 triplicate groups of 30 chicks per replicate in a completely randomised design. Each replicate lot was placed and brooded in a battery brooder measuring approximately 0.36m

x 0.34m, a floor space of 0.004m^2 per chick. Each group of 90 chicks received one of the 5 experimental diets for a period of 4 weeks.

Experimental diets

A control diet and 4 treatment diets (produced by adding 50g/kg of the 4 processed CLMs to the control) were formulated as shown in Table 1. Feed and water were provided ad libitum throughout the experimental period.

Parameters measured

Feed consumption, body weight changes and feed conversion efficiency were determined on a weekly basis. Records of water intake and mortality of chicks were also kept.

Haematological studies

Blood samples were drawn from the wing vein of 4-week-old selected birds from different diets and the following parameters were obtained: haemoglobin content by the cyanmethaemoglobin method, hematocrit (packed cell volume by the micro- hematocrit method (Dacie and Lewis, 1975) and the leucocyte count using the Nat's methyl violet diluent (Nat and Herrick, 1952).

Histological studies

Liver of selected birds from different diets were removed, weighed and expressed as percentof liveweight. Liver sections were cut at 6 microns before staining with haematoxylin and eosin (Humason, 1967) and examined microscopically for any abnormalities in the cells.

Statistical analysis

The data obtained were subjected to analysis of variance technique as outlined by Steel and Torrie (1980).

RESULTS AND DISCUSSION

The chemical composition of the various chaya leaf meal is given in Table 2. With the exception of the hydrogen cyanide contents which were significantly ($P < 0.05$) lower for oven-dried and parboiled chaya leaves, all other chemical components determined were not significantly ($p < 0.05$) affected by the method of processing. The levels of hydrogen cyaanide were 2.21g/kg for air dried, 1.19g/kg for oven dried, 2.69g/kg for fermented and 1.70g/kg for the parboiled CLM.

Table 2: CHEMICAL COMPOSITION OF VARIOUSLY-PROCESSED CHAYA LEAF MEALS (g/kg DRY MATTER)[1]

	Processing method				
Component	Air dried	Oven dried	Fermentation	Parboiling	(±SEM)
Dry matter	901.8	890.7	907.2	897.2	1.82
Crude protein	302.7	300.8	305.5	304.6	3.84
Ether extract	39.0	36.0	33.9	33.0	1.44
Ash	81.0	82.0	82.5	81.5	1.80
Crude fibre	101.7	105.7	102.5	102.1	1.17
N- free extract	475.6	475.5	475.6	478.9	1.22
Hydrogen cyanide	2.21^a	1.19^b	2.69^a	1.70^b	0.04
Calcium oxalate	2.40	2.60	2.10	2.80	0.15

[1] All data are the mean + SE of three determinations. * Means within a row showing different superscripts are significantly different (P.05)

Table 3: PERFORMANCE, BLOOD PARAMETERS AND LIVER WEIGHTS OF CHICKS FED DIETS CONTAINING DIFFERENT PROCESSED CHAYA LEAVES

	Diets					
Parameter	Control	Air dried	Oven dried	Fermented	Parboiled	(±SE)
Initial body weight (g)	39.73	39.33	39.73	39.33	39.00	0.88
Weight gain (g/bird/d)	6.17	6.15	6.39	6.62	6.72	1.78
Feed intake (g/bird/d)	20.18	18.49	19.02	19.91	91.58	1.08
Feed:gain	3.27	3.01	2.98	3.01	2.91	0.43
Water intake ($ml/bird^{-d}$)	40.46	38.14	38.22	40.16	39.04	2.10
Mortality (%)	7.73	6.63	5.50	5.50	6.60	1.06
Haemoglobin (g/100cc)	9.50	9.20	9.00	9.10	9.10	0.54
Hematocrit (%)	29.80	29.70	30.30	29.80	29.70	1.08
Leucocutes ($10^3/mm^3$)	32.20	32.70	32.10	32.00	32.50	0.18
Liver weights (%)	9.41	9.59	10.03	10.19	9.65	0.66

The average daily weight gain, as shown in Table 3, indicated no significant ($P > 0.05$) treatment differences. Birds fed on various chaya leaf meal diets, with the exception of those on air dried chaya diet, recorded higher daily weight gains than those on the control diet. Previous work on chaya showed significant ($P < 0.01$) reduction in weight gains with increasing levels of CLM in chicken rations but there was no significant difference between birds fed diets which contained 45g chaya per kg diet and those on haya-free diets (Kess *et al.*, 1987).

Feed intake was not significantly ($P > 0.05$) affected by the inclusing of different processed chaya leaves. The highest feed intake was however, recorded by birds fed on chaya-free diet (control).

Similarly, the feed:gain ratios were not significantly ($P > 0.05$) influenced by the incorporation of the variously processed CLM in the diets. The feed:gain ratios observed were 3.27, 3.01, 2.98, 3.01 and 2.91 for diets containing no chaya, air dried, oven dried, fermented and parboiled CLM, respectively. Even though there were no significant ($P > 0.05$) treatment effects, it is worth noting that chicks fed different CLM-containing diets were slightly more efficient in converting feed to gain.

Daily water intake was not significantly ($P > 0.05$) affected by the various dietary treatments. Diazbolio (1974) reported that chaya has a diuretic effect on humans. It was therefore expected that the water consumption would increase by feeding of diets incorporating the variously processed CLM. This was however, not observed under the present study. The results however, indicate a positive correlation between feed intake and the amount of water drank as shown in Table 3. The amount of water drank by birds gave a correlation coefficient of 0.97 when linearly regressed against food intake.

There were no health-related problems nor deaths during the experiment that could be attributed to the various dietary treatments. The mortality figures were 7.73%, 6.63%, 5.50%, 5.50% and 6.60% for the control, air dried, oven dried, fermented and parboiled chaya-containing diets, respectively even though the air dried and fermented CLM-containing diets contained statistically ($P < 0.05$) higher HCN contents than the other diets. This might imply that the levels or amounts of HCN taken by the birds were not beyond the tolerance level. Bondi and Alumot (1987) reported that the level of HCN lethal to living organisms is in the range of several milligrams/kg body weight and death occurs within a few seconds. Detoxification of small amounts

appears to occur in the liver via enzymatic oxidation by sulphur donors (hydrogen sulphide or thiosulphate) to yield thiocyanate. The thiocyanate produced is excreted in the urine (Bondi and Alumot, 1987).

The blood cellular elements in the chicks, which were all within the ranges provided by Coffin (1967), revealed no significant (P 0.05) differences among treatment means. The reported normal ranges by Coffin (1967) are: haemoglobin 8 - 13g/100c,c; hematocrit 35.8% and leucocytes 20 - 40 x 10^3/mm^3.

No significant differences were observed in the treatment means for liver weights expressed as percent of the liveweight. Generally, slightly higher liver weights were observed in chicks fed diets containing variously-processed CLM. The slightly higher liver weights in chicks fed on chaya-containing diets might probably be due to a toxic factor present in this material, however, no clear trend could be established between the concentration of HCN in the diet and the liver wi = eights. The relative liver weights of birds gave a correlation coefficient of 0.60 when linearly regressed against the concentration of HCN in the diets.

In general the histological characteristics of the livers of chicks on the control diet were similar to those of chicks fed on the various CLM diets. Under the conditions of this study no toxic effects in terms of gross morphological changes in the liver were observed.

It is apparent that processed CLM could be incorporated at a concentration of 50g/kg diet in chicks diet without any deleterious effects.

ACKNOWLEDGEMENT

The authors are grateful to Messers S. S. Yambillah and Gyedu-Baah Apanin for technical assistance and Ms. Gladys A. Ndzibah for secretarial assistance.

REFERENCES

ASSOCIATION OF OFFICIAL ANALYTICAL CHEMISTS 1980. *Official Methods of Analysis*, 13th edn. Association of Official Analytical Chemists, Washington, DC.

BONDI, A. and ALUMOT, E. 1987. Anti-nutritive factors in animal feedstuffs and their effects on livestock. *Prog. Food and Nutr. Sci.*, 11:115-151.

BOURDOUX, P., MAFUTA, A., HANSON, A. and ERMANS, A. M. 1980 Cassava toxicity: the role of linamarin. In: Role of Cassava in the Etiology of Endemic Goitre and Cretinism. Ermans, A. M; Mbulamako, N. M; Delange, F; Ahluwalia, R. (Eds). IDRC 136e, Ottawa, Canada, pp. 15-27.

CLARKE, E.G.C. and CLARKE, M. L. 1979. Oxalic acid. In: *Veterinary Toxicology* ELBS (edn). Balliere Tindall, London, Great Britain, pp 257-260.

COFFIN, D. L. 1967. Normal ranges of blood cellular elements in chickens. In: *Manual of Veterinary Clinical Pathology.* 3rd edn. Comstock Publ. Assoc. New York, pp. 156-157.

DACIE, J. V. and LEWIS, S. M. 1975. *Practical Haematology.* 5th edn. Churchill Livingstone, Edinburgh.

DIAZ-BOLIO, J. 1974. *La Chaya - Planta Maravillosa.* Area Maya, Merida, Mexico, pp 48.

DIXON, M. and WEBB, E. C. 1965. *Enzymes,* 2nd edn. Longmans sGreen and Co., London.

ESSUMAN, R. L. 1986. Further studies on the nutritive value of chaya plant BSc. (Biochemistry) Thesis. University of Science and Technology, Kumasi, Ghana.

HUMASON, G. L. 1967. *Animal Tissue Techniques.* 2nd edn. Freeman, San Francisco, pp. 142.

KESE, A. G., DONKOH, A., ATUAHENE, C. C. and POKU-PREMPEH, Y. 1989. Utilization of chaya (Cnidoscolus aconitifolius (Mill.) Johnston) leaf meal in chicks diets. *Nigerian J. Anim. Prod.* 16:

NAT, M. P. and HERRICK, C. A. 1952. A new blood diluent for counting the erythrocytes and leucocytes of the chicken. *Poult. Sci.*, 31: 735-738.

NATIONAL ACADEMY OF SCIENCES 1975. Vegetables - Chaya. In: *Underexploited Tropical Plants with Promising Economic Value.* National of Academy of Sciences, Washington, DC, pp. 45-48.

STEEL, R.G.D. and TORRIE, J. H. 1980. *Principles and Procedures of Statistics, A Biometrical Approach.* 2nd edn. McGraw-Hill Book Co., New York, 633 pp.

VOGELS, A. I. 1983. *Textbook of Quantitative Inorganic Analysis.* 4th edn. Passet, J., Denney, R. C., Jeffrey, G.H. and Madham, J. (reviewers). Longman Press, London, pp. 494.