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Tannin, Phytin and Oxalate Contents of Some Wild Under-utilized Crop-seeds in Nigeria

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ABSTRACT

Eighteen wild under-utilized crop-seeds were investigated for their tannin, phytin and oxalate contents. Tannic acid content ranged between 0·11% in Coula edulis *and 1·15% in* Lophira alata. *Phytic acid content varied between 330 mg/100 g dry matter in* Carapa procera *and 1580 mg/100 g dry matter in* Terminalia catappa. *Total oxalate content ranged between 5·34 g/100 g dry matter in* Xylopia aethiopica *and 14·0 mg/100 g dry matter in* Carapa procera. *When soluble oxalate was expressed as a percentage of total oxalate, high values were obtained in* Vitex doniana *(92·21%) and* Xylopia aethiopica *(82·0%).*

The antinutritional effects of these components are discussed in relation to (a) their potentials as feed for livestock and (b) their use as spices, condiments and food supplements by the large rural population in Nigeria.

INTRODUCTION

The presence of inherent toxic factors and other antinutritional components in plants has been given (Liener, 1962; 1964; 1974) as one of the variables affecting the nutritional value of feeds and foods. These factors are present in small quantities in foods and feeds of man and animals (including wildlife and fish) yet are instrumental in their overall nutritive quality.

In several leguminous feeds, no adverse effects of phytins, tannins or oxalates on nutritive values have been reported (Dye, 1956; Tamir & Alumot, 1970; Rostungo, 1972).

The importance of these constituents lies in their ability to chelate and

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bind divalent metals to form complexes. Insoluble oxalate salts are also very detrimental in that their presence in feeds may cause kidney damage and may also produce acute hypocalcaemia in animals (Clearke & Clearke, 1975). Phytic acid has been reported, in addition to its metal-chelating ability, to complex with proteins in legumes, thus affecting their nutritive value (Evans & Bandemer, 1967).

Tannins have been described (Goldstein & Swain, 1963) as phenolic compounds whose degree of hydroxylation and molecular size are sufficient to form complexes with proteins.

This paper is therefore an account of our investigation on the tannic acid, phytic acid and oxalate contents of some wild under-utilized non-leguminous crop-seeds in Nigeria.

Some of these seeds are utilized either by man as spices or condiments or by animals in the wild. Little or no attempt has been made to characterize the nutrient composition of these seeds to optimize their utilization. Recently, the proximate and mineral compositions were reported (Balogun, 1982). It is hoped that the present study will throw more light on the utilization potentials of these hitherto under-utilized crop-seeds.

MATERIALS AND METHODS

Seeds from ripe fruits of eighteen different species used for this study were collected at the seed store of the Forestry Research Institute of Nigeria (FRIN), Ibadan, Nigeria. Information from the herbarium of FRIN revealed that seeds were collected from these wild trees in both the forest and savannah regions of Nigeria.

One kilogram of each seed was collected and taken to the laboratory for analysis. The seeds were then washed with glass-distilled water, drained and oven-dried at 60°C for 6 h. They were then cooled in a desiccator and milled in a laboratory milling machine. Duplicate analyses for tannin, phytic acid and oxalates were carried out on the milled samples of each species.

Tannin was determined as tannic acid by the protein precipitation method of Hagerman & Butler (1978). For the determination of phytic acid, a combination of two methods was used. The extraction and precipitation of phytic acid were performed according to the procedure of Wheeler & Ferrel (1971) and iron in the precipitate was measured by Makower's method (1970). A 4:6 Fe/P atomic ratio was used to calculate phytic acid. Total and soluble oxalates were determined by the method of Dye (1956).

Analyte recovery

The accuracy of the methods for determining tannin and phytic acid was tested by analyzing each of the samples that had been spiked with a known concentration of tannic acid and phytic acid. Using calibration curves, the percentage recoveries for each of tannic acid and phytic acid were determined. The accuracy of methods used was satisfactory as the average recoveries for tannic acid and phytic acid were 63% and 65%, respectively.

Analytical precision

The precision of the methods used (for tannin and phytic acid) was evaluated by five replicate analyses of a *Bixa Orellana* sample. The standard deviations and coefficients of variation were 0·020% and 10·3% for tannin and 0·015% and 9·8% for phytin. To ensure freedom from interferences, the extracts of the samples (where intense coloured extracts were produced) were passed through activated charcoal.

RESULTS

Tannic acid (%) and phytic acid contents, expressed as mg/100 g dry matter, are presented in Table 1. Tannic acid contents, expressed as a percentage of dry weight, ranged between 0·11% in the seed of *Coula edulis* and 1·15% in

TABLE 1
Tannic Acid and Phytic Acid Contents[a] of Some Wild Under-utilized Crop-Seeds

Crop-seed	*Family*	*Tannic acid (g/100 g dry matter)*	*Phytic acid (mg/100 g dry matter)*
Carapa procera	Meliaceae	0·89	330
Cedrella odorata	Meliaceae	0·46	1 200
Azadirachta indica	Meliaceae	0·60	350
Terminalia catappa	Combretaceae	0·40	1 580
Vitex doniana	Combretaceae	0·67	630
Xylopia aethiopica	Anonaceae	0·66	530
Monodora termifolia	Anonaceae	0·17	650
Rouvoliia vomitoria	Apocynaceae	0·34	351
Bixa orellana	Bixaeceae	0·51	333
Spondias Mombin	Anacardiaceae	0·59	830
Adansonia digitata	Bambaceae	0·98	375
Lophira alata	Ochnaceae	1·15	725
Dioscoreophyllum cumminsii	Meniperinaceae	0·16	880
Hyphaene thebaica	Palmae	1·11	330
Blighia sapida	Sapindaceae	0·71	1 030
Treculia africana	Moraceae	0·36	890
Coula edulis	Olacaceae	0·11	750
Eucalyptus deglupta	Myrthaceae	0·33	976

[a] Mean of duplicate or triplicate analyses.

Lophira alata. High tannic acid contents were obtained in the seeds of *Hyphaene thebaica* (1·11%), *Adansonia digitata* (0·98%), *Carapa procera* (0·89%) and *Dioscoreophyllum cumminsii* (0·76%).

Phytic acid values ranged between 330 mg/100 g dry matter in *Carapa procera* and 1580 mg/100 g dry matter in *Terminalia catappa*. Values of 1200 mg/100 g dry matter, 1030 mg/100 g dry matter, 197 mg/100 g dry matter and 890 mg/100 g dry matter were, respectively, obtained in *Cedrella odorata*, *Blighia sapida*, *Eucalyptus deglupta* and *Treculia africana*.

TABLE 2
Oxalate Contents[a] (mg/100 g dry matter) of Some Under-utilized Crop-Seeds

Crop-seed	*Family*	*Total oxalate*	*Soluble oxalate*	*Soluble as % of total*
Carapa procera	Meliaceae	14·0	7·00	50·0
Cedrella odorata	Meliaceae	13·2	7·60	57·5
Azedirachta indica	Meliaceae	7·60	1·80	23·7
Terminalia catappa	Combretaceae	5·77	3·15	54·6
Vitex doniana	Combretaceae	7·32	6·75	92·2
Xylopia aethiopica	Anonaceae	5·34	4·38	82·0
Monodora termifolia	Anonaceae	11·0	6·30	57·4
Rouvoliia vomitoria	Apocynaceae	5·81	1·80	31·0
Bixa orellana	Bixaeceae	8·44	4·50	53·3
Spondias Mombin	Anarcadiaceae	10·1	5·85	57·8
Adansonia digitata	Bombaceae	12·1	4·96	40·9
Lophira alata	Ochnaceae	9·85	6·10	61·9
Dioscoreophyllum cumminsii	Meniperinaceae	7·31	3·15	43·1
Hyphaene thebaica	Palmae	9·57	6·65	69·5
Blighia sapida	Sapindaceae	7·60	1·35	17·8
Treculia africana	Moraceae	6·19	2·25	36·4
Coula edulis	Olacaceae	6·75	3·15	46·7
Eucalyptus deglupta	Myrthaceae	10·7	3·60	33·7

[a] Mean of duplicate analyses.

Oxalate contents, expressed as mg/100 g dry matter, are presented in Table 2. Total oxalate ranged between 5·34 mg/100 g dry matter in *Xylopia aethiopica* and 14·0 mg/100 g dry matter in *Carapa procera*. Soluble oxalate, expressed as a percentage of total oxalate, showed very high percentages of soluble oxalate in *Vitex doniana* (92·2%) and *Xylopia aethiopica* (82·0%). The lowest level of soluble oxalate was obtained in *B. sapida* (17·8%).

DISCUSSION

The results presented in this study suggest fairly high levels of tannic acid, phytic acid and oxalates. Low levels of tannic acid were obtained in *Coula edulis*, *Monodora termifolia*, *Eucalyptus deglupta* and *Treculia africana*. It is important also to note that most of the seeds which contained low levels of tannic acid, however, contained moderate to high levels of phytic acid.

Not much information appears to exist in the literature on the toxic effects of tannins. However, Swain (1965) and Tamir & Alumot (1970) have shown strong interactions with proteins and divalent metals resulting in insoluble complexes that are not readily digestible by monogastric animals (Chang & Fuller, 1964). Lower protein digestibility, lower weight gains and lower PER values have been reported in chicks (Chang and Fuller, 1964) and in rats (Glick & Joslyn, 1970) fed diets high in tannic acid.

The high levels of tannic acid in seeds of *Adansonia digitata*, *Hyphaene thebaica* (which are extensively used as food in Northern Nigeria) and *Xylopia aethiopica* (used as condiment in Eastern Nigeria) may have serious implications for their nutritional values.

Phytic acid was encountered in all species investigated. This is in accordance with the views of Hall & Hodges (1966) and Lolas & Markaris (1975) who reported the widespread occurrence of phytic acid in plants. The occurrence of the acid in all the species is also in accord with the reports of William (1970) who regarded phytin as a constituent of plant materials which can be used as a source of phosphorus and cations during the germination of seeds, and as an initiator of dormancy (Sonolev & Radionova, 1966).

Several workers have attributed the incidence of several mineral deficiency symptoms in animals to the occurrence of phytin in seeds. Phytin complexes with metallic cations, especially calcium, magnesium and iron, and can reduce their availability in the intestinal tract (Oberleas, 1973; Rackis, 1974). Magnesium deficiency in rats (Roberts & Yudkin, 1960) and decreased zinc availability in chicks (O'Dell *et al.*, 1958) have both been ascribed to the phytin content in feeds.

The high contents of phytin in the kernel of *T. catappa*, seeds of *Spondias Mombin*, *Blighia sapida* and *Treculia africana* (which are taken largely as food supplements by children in the rural areas of Nigeria) may have significant effects on the utilization of the divalent metals by chelating them, thus reducing their availability. This may result in various degrees of bone diseases in these rural children, depending on the level of consumption of the seeds and kernels.

Wide variations were obtained in both the total and soluble oxalates. When the soluble oxalate was expressed as a percentage of the total, the variations became more pronounced. Most seeds showed moderate to very high levels of soluble oxalate. A greater proportion of the oxalates in *Vitex doniona*, *Xylopia aethiopica*, *Monodora termifolia*, *Spondias Mombin*, *Lophira alata* and *Hyphaene thebaica* is in the soluble form. It is either in the form of sodium or potassium oxalate and, because both are soluble salts, they are not likely to cause oxalate poisoning. On the other hand, in these seeds with high insoluble oxalate, their oxalates are likely to be in the form of either calcium or magnesium oxalates. Both oxalates are likely to cause reduced availability of their cations and, because they are insoluble, may be deposited in the alimentary canal and organs like the kidney and liver. They are therefore likely to cause oxaluria and oxalemia (Clearke & Clearke, 1975) in animals using them.

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