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Full Length Research Paper

Nutrient content of seeds of some wild plants

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The seeds of the fruits of some wild plants; *Cassipourea congoensis* (Tunti), *Nuclea latifolia* (Luzzi), *Deterium microcarpum* (Tallow), *Balanites aegytiaca* (Betu), and *Gemlin arborea* (Melina) were analysed to establish their proximate compositions and the physico-chemical characteristics of the oils. The physico-chemical characteristics measured include saponification value (SV), iodine value (IV), peroxide value (PV), acid value (AV) and percentage free fatty acid (%FFA). Refractive index was the physical parameter measured. The iodine values of the oils were not greater than 88 g/100 g but the saponification values were in the range 122 ± 0.14 to 201 ± 0.05 mg KOH. Proximate values of the protein, oil and carbohydrate content of the seeds suggest that they may be adequate for the formulation of animal feeds. The mineral elements present also suggest that the seeds could contribute partially to the overall daily intake of these elements, subject to knowledge of the levels of the possible toxic substances. The vitamins (A and C) found to be present in the seeds are low, though could alleviate the symptoms associated with these vitamins. The cyanogenetic glucoside contents in the seeds were analyzed to establish their proximate composition. Qualitative and quantitative chemical analysis showed that all the samples studied contain hydrogen cyanide (HCN) in the form of cyanogenetic glucoside in quantities varying from 2.51 ± 0.31 mg/100g of dried sample for *D. microcarpum* to 3.75 ± 0.02 mg/100g for *G. arborea*. The aglycone for all the glucoside detected was found to be benzaldehyde.

Key words: Wild seeds, composition, oil, characteristics, antinutritional, cyanogenetic glucoside.

INTRODUCTION

Edible wild seeds are consumed frequently in Northern Nigeria especially in rural communities where a variety of edible seeds abound. Some of these are cultivated while others grow in the wild. Several of these wild species bear fruits/seeds during the dry season when cultivated fruits/seeds are scarce (Nadro and Umaru, 2004). Wild seeds offer a convenient but cheap means of providing adequate supplies of mineral, fat, protein and carbohydrate to people living within the tropics (Eromosele et al., 1991). In Northeastern part of Nigeria where common seed like cottonseeds is in short supply, it is possible for wild seeds to provide the oil, vitamin and mineral requirement of the local populace. Affordability as a factor is responsible for the high incidence of malnutrition in low-income families that traditionally have large family size in the study area. Most affected are children of preschool age group with most cases of morbidity related to inadequate intake of food containing essential nutrients (Nkafamiya et al., 2006). The availability of these nutrients in wild seeds after ingestion also depends on the antinutritional factors present in the seeds. The anti-nutrients tend to bind to mineral elements there by forming indigestible complex. Oxalate for instance binds to calcium to form complexes (calcium oxalate crystals). These oxalate crystals formed prevent the absorption and utilization of calcium. The calcium crystals may also precipitate around the renal tubules thereby causing renal stones (Ladeji et al., 2004).

Cyanogenetic glucoside is an organic compound containing sugar, and is capable of yielding cyanide on hydrolysis (Clark, 1989). Three distinct glucoside have been identified in edible species of plants: amygdlin, dhurrin and linamarin. Amygdalin was first identified in bitter almond and is also present in kernel of other fruits. Dhurrin occurs in sorghum and other grasses while linamarin, also known as phaseolunatin, is the glucoside of pulses, linseed and cassava (Henry, 1990).

Hydrocyanic or prussic acid (HCN) is one of the most

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Table 1. Physio-chemical characteristics of seed oils.

Seed oils	SV (mg KOH)	IV (g/100g)	PV (mEq/kg)	AV (mgKOH/g)	%FFA as oleic acid	RI (20°C)
Cassipourea congoensis	189±0.02	81±0.11	3.5±0.01	0.36±0.09	0.18±0.03	1.459±0.02
Nuclea latifolia	201±0.05	80±1.12	80±1.12	0.25±0.11	0.13±0.06	1.457±0.04
Deterium microcarpum	191±0.12	87±0.05	2.8±0.36	0.39±0.20	0.20±0.10	1.460±0.24
Balanites aegytiaca	122±0.14	70±1.14	4.3±0.16	0.72±0.36	0.32±.0.18	1.449±0.45
Gemlina arboea	103±1.12	72±1.25	3.9±0.19	0.50±0.51	0.23±0.26	1.452±0.17

Values are means ± SD for 3 determinations.

toxic and rapidly act as common poisons; its sodium and potassium salts are only slightly toxic (Clark, 1989). Consumption of food substance containing HCN may cause death within few minutes to 3 h, depending on the concentration consumed in the food (Leiner, 2000). Death has also occurred in young children after eating apricot and other seeds containing cyanogenetic glucoside (Sayre and Kamkal, 2004). The toxic action of HCN is due to the cyanide ion whose toxic properties are shared by all the soluble inorganic cyanide salts present in the samples (Smith et al., 2003).

These plants are mostly found in Sudan-Savanna and Northern region of Nigeria. Of the five plants the fruits from *Cassipourea congoensis, Nuclea latifolia* and *Balanites aegytiaca* are edible while the fruits of the other plants are not known to be edible. The fruits of *C. congoensis* in particular are used as a substitute for tamarind in preparing local pap in Michika Local Government Area of Adamawa State, Nigeria (Nkafamiya et al., 2006). The seeds of these plants are not known to be edible. Yet, they are available in abundance, albeit seasonally and it seems reasonably to assess their nutriational values for utilization as animal feeds and possible for human consumption. Also in view of the poisonous nature of HCN and its prevalence in many edible plant seeds and nuts, the screening of these food substances was therefore considered useful. This paper presents the physico-chemical characteristics, proximate and mineral compositions, vitamins, antinutritional factor and HCN in the form of cyanogenetic glucoside.

MATERIAL AND METHODS

Collection and treatment of samples

Dried seeds of the five plants were collected from Nkafamiya Wulla Michika locals Government Area of Adamawa State, Nigeria. They were cleaned to remove dirt, sun-dried for three days and finally ground in an electric mill (National Food Grinder, Model MK308, Japan). It was then passed through a 40 mesh sieve and stored in a refrigerator at 5°C.

Analysis of the samples

The oil from the seeds of the five plants was soxhlet extracted with petroleum ether (40 - 60°C) and was then characterized by standard method for oil and fat analysis (AOAC, 1980). All reagents used for the analyses were of analytical grades and were not subjected to further purification. Refractive index was measured with an Abbe Refractometer at 25°C and corrected to 20°C as described by (AOAC, 1980).

Ash, crude lipid, crude fiber and protein were determined by AOAC methods 1980. The carbohydrate content was calculated by difference, that is, 100- (sum of percentages of moisture, ash, protein and lipid). Energy value (kcal/kg) was calculated by multiplying the values obtained for carbohydrate, protein, fat and adding up the values as describe by Robson et al. (1972) and Maragoni and Ali (1987). For mineral analyses, 2 g of the dried grind sample were mixed with 20 ml of nitric/perchloric acid (5:1v/v). The mixture was allowed to stand overnight and then heated to 80°C on a hot plate for approximately 2 - 3 h after which a clear solution was then heated to dryness and reconstituted with deionized water. The concentration of the iron, zinc, calcium, copper and lead were determined using atomic absorption spectrophotometer (Philip Model sp9, UK). Sodium and potassium were determined by flame emission techniques. The content of β-carotene in the seeds was determined using the chromatographic procedure described by Ranagana (2004). Vitamin A was calculated using the relationship (Robson et al, 1972):

0.6µg of β-carotene = 0.3µg pf pure vitamin A

The vitamin C content was determined spectrophotometrically (λ = 760 mm) as describe by Paul and Pearson, (2005). All analyses were carried out in triplicate and data were analysed by Analysis of Variance (ANOVA). Duncan's Multiple Range Test was used to compare mean variance. Significance was accepted at 5% level of probability following Steel and Torric procedures (1980). Total oxalate was determined according to Day and Underwood (1986). Saponin was determined using the method of Birk et al. (1963) as modified by Hudson and El-Difawi (1979). While phytate was determined using the method of Reddy and Love (1999). Tannin was however determined using the method of Trease and Evans (1978). The qualitative, extraction and quantitative analysis of HCN was done by method described by Nkafamiya and Manji (2006). Also melting point of the hydrazones was determined by the method described by Vogel (1996).

RESULTS AND DISCUSSION

Table 1 represents the physico-chemical characteristics of the oils from five different seeds. The saponification values of the oils are high and are in the range 189 ± 0.02 to 201 ± 0.05 mg KOH with exception of the oils from *B. aegytiaca* (122 ± 0.14 mg KOH), and *G. arbrea* (130 ± 1.12 mg KOH). The SV are thus within the range

Table 2. Proximate composition (g/100 g dry weight) of seeds.

Seed	Oil (%)	Crude Protein	Crude lipid	Crude fiber	Carbohydrate	Ash	Moisture	Food energy (kCal/kg)
Cassipourea Congoensis	28±1.01	26.01±0.12	12.91±0.07	6.57±0.18	36.75±0.11	36.75±0.11	7.50±0.03	4436±1.04
Deterium Microcarpum	43±2.00	7.2±0.14	11.12±0.09	5.21±0.17	66.01±0.31	3.76±0.10	4.51±0.15	4448±0.57
Nuclea latifolia	27±0.65	22.32±1.00	12.11±0.36	6.27±0.13	30.00±0.01	5.67±0.02	6.00±0.12	4337±1.12
Balanites Aegytiaca	38±0.71	30.41±0.07	10.00±0.61	4.55±0.13	25.00±0.13	0.59±0.11	4.42±0.11	4560±0.07
Gemlina arboea	45±1.12	9.51±0.05	10,25±0.16	5.41±0.23	62.00±0.51	0.85±0.25	5.26±0.22	4446±0.09

Values are means ± SD for 3 determinations.

of some edible oils (Eromosele and Eromosele, 1993), such as palm oil (196 - 205), groundnut oil (188 - 190) and corn oil (187 - 196). The iodine values are not greater than 88 g/100 g with the lowest values of 70 ± 1.14 and 72 ± 1.25 g/100g for *B. aegytiaca* and *G. arborea,* respectively. However, the IV of the oils is comparable with those of groundnut oil (84 - 99), olive (79 - 90), caster oil (81 - 91) and thus may be classified as non-drying oils. The PV of the oils was relatively low (2.8 ± 0.36 to 4.5 ± 0.12 mEq/kg) and was determined immediately after the extraction of the oils. This indicates that the oils have not gone bad (Magnus, 1992). The refractive index of the oils (1.449 - 1.460), are also within the range of some edible oils like cottonseeds and groundnut oils (Kamal and Kamal, 1992). The acid values of the oils are low and are in the range 0.25 ± 0.11 - 0.72 ± 0.36 mgKOH/g. The corresponding percentage free fatty acids (%FFA as oleic acid) varies between 0.13 ± 0.06 – 0.32 ± 0.18. The low AC and %FFA indicates that the oils may have long shelve life (Passera, 1981). Hence judging by the SV and AV the oils may be suitable for soap making.

The nutritional status of the seeds is presented in Table 2. Apart from *C. congoensis*, *B. aegytiaca* and *N. latifoloia* with edible mesocarp, there is no information regarding edibility of the seeds of all the plants. However, as can be seen in Table 2, the oil contents of the seeds are high and in the range 28 - 45% (w/w).

The crude protein content of the seeds of *C. congoensis, B. aegytiaca* and *N. latifolia* are corresponding higher and are comparable with values for cotton-seeds (28.72 ± 1.0) (Eka and Isbell, 1984), papaya (20 .49 ± 0.79 for endosperm and 30.54 ± 1.02 for the sarcotesta) (Passera, 1981), and shelled rubber seed (23.0) (Ukhum and Uwatse, 1988). The values for the crude protein in *Deterium microcarpum* and *G. aborea* are comparatively low but with correspondingly high protein values. The seeds have high food energy and can be used to supplement the daily energy intake of the consumers of their food products. Admittedly, none of the seeds can yet be considered safe for consumption since the toxicity levels for the seeds are yet to be established. However, the nutritional status of the seeds, based on the parameters in Table 2, seems to suggest that the seeds may be adequate for formulating animal feeds.

The mineral compositions of the seeds are listed in Table 3. Iron and zinc are among the essential elements for humans and their daily requirements for adult are 15 and 18 mg, respectively (Kampali and Pali, 2004). Though the level of iron and zinc are low in the seeds, they could contribute partially to the overall daily intake of these elements.

The levels of vitamin A and C in the seeds are also shown in Table 3. The vitamin C content is high in *C. congoensis* and low in the other seeds. The low values are comparable with that of groundnut (9.8 mg/100 g) (Barminas et al., 1998). Vitamin A content of the seeds is also low, though it can however help to alleviate symptoms of vitamin A deficiency.

Table 4 showed the results of antinutrients present in the seeds. However the levels of antinutrients in the analysed seeds are low to significantly interfere with nutrients utilization. They are below the established toxic level.

Table 5 presents a qualitative determination of cyano-genetic glucoside and melting point of the hydrazones in different samples. All the samples contain cyanogenetic glucoside are indicated by positive sign (+) and the results of the melting points of all the samples indicate that benzaldehyde is present, which is the hydrolysed product of amygdalin with melting point of 237°C (Vogel, 1996).

Table 6 present the concentration of benzaldehyde in mg per 100 g of dried sample, determined by the use of UV calibration curve of pure benzaldehyde. *G. arborea* has the highest concentration (1.98 ± 0.05 mg/100g) and *D. microcarpum* has the lowest (1.00 ± 0.20). The concentration of HCN in various samples in mg per 100 g

Table 3. Mineral composition (mg/100g dry weight) of seeds.

Seed	Ca	Na	K	Zn	Cu	Fe	Pb	Vitamin A	Vitamin C
Cassipourea Congoensis	100±0.27	4.91±0.02	275±0.99	7.01±0.67	13.00±1.15	6.69±0.02	nil	4.50±0.28	310±0.21
Deterium Microcarpum	117±1.47	5.17±0.18	220±2.11	4.47±0.17	14.01±0.21	5.45±0.08	nil	5.10±1.21	7.21±1.22
Nuclea latifolia	107±2.41	8.11±0.19	140±0.12	5.60±1.10	12.00±0.27	8.71±0.03	nil	6.02±0.77	5.67±0.23
Balanites Aegytiaca	115±0.71	6.03±2.00	157±2.12	8.60±0.30	16.21±0.17	7.15±0.61	nil	5.71±0.45	4.98±0.14
Gemlina arboea	117±0.89	7.11±0.13	189±0.25	6.67±0.38	17.25±0.05	7.26±0.08	nil	7.18±0.35	6.71±0.14

Values are means ± SD for 3 determinations.

Table 4. Oxalate, pyhtate, saponin and tannin content (%) of the seeds.

Seed	Oxalate	Pyhtate	Saponin	Tannin
Cassipourea congoensis	10.21±1.11	2.00±0.14	7.17±0.18	2.84±0.12
Deterium microcarpum	9.05±0.16	1.90±0.67	7.00±1.12	2.91±0.52
Nuclea latifolia	10.15±0.13	2.15±0.21	7.10±0.68	2.15±0.41
Balanites aegytiaca	10.01±0.12	2.18±0.14	7.15±0.15	2.00±0.27
Gemlina arboea	9.16±0.13	1.97±0.16	6.98±0.71	2.34±0.78

Values are means ± SD for 3 determinations.

Table 5. Qualitaive determination of cyanogenetic glucoside.

Seed	Observation	Melting point
Cassipourea congoensis	+	237.00 ± 0.22
Deterium microcarpum	+	239.00 ± 2.01
Nuclea latifolia	+	234.01 ± 0.76
Balanites aegytiaca	+	233. 00 ± 0.18
Gemlina arboea	+	233.06 ± 0.29

Values are means ± SD for 3 determinations.

of dried sample are also listed in Table 6. *G. arborea* has the highest concentration of 3.75 ± 0.02 mg and *D. microcarpum* 2.51 ± 0.31mg with the least. The results indicate presence of the HCN in the form of cyanogenetic glycoside is very much below the threshold level of 60 mg per day in adult (Monago and Akhidue, 2002).

The IR spectra of the samples fall within the range of 2280-2200 cm^{-1} (due to C≡N) absorption band, which confirms the present of the cyanide. Hydrocyanic acid poisoning occurs in most countries because of the occurrence of plants, which contain toxic quantities of cyanide. When consumed in large amounts, the affected men and animals may die (Coop and Balkely, 1994). In man, cyanide poisoning can be treated by producing a high concentration of methemoglobin ($Hb\text{-}Fe^{3+}$) by administration of nitrite.

$$Hb\text{-}Fe^{2+} + NaNO_2 \longrightarrow Hb\text{-}Fe^{3+}$$ (Louis, 1995).

Methemoglobin competes with cytochrome oxidant ($Cyt\text{-}Fe^{3+}$) for cyanide ion. The concentration gradient favours methemoglobin; cyanomethemoglobin (Fe-FeCN) is formed and cytochrome oxidase is restored (Lawrence, 1993).

$$Hb\text{-}Fe^{3+} + Cyt\text{-}FeCN \longrightarrow Hb\text{-}FeCN + Cyt\text{-}Fe^{3+}$$

Actual detoxication is then achieved by administration of thiosulphate which under the influence of sulfurtrans-ferase reacts with cyanide to form thiocyanate(SCN) a relatively non-toxic substance readily excreted in the urine.

$$Na_2S_2O_3 + CN^- \xrightarrow[\text{SCN Oxidase}]{\text{Sulfurtransferease}} SCN + Na_2SO_3$$

In animals the treatment is achieved through intravenous injection of a mixture of sodium nitrite and sodium thiosulphate (Sharman, 1989). The dose rate is 3 g of sodium nitrite and 15 g sodium thiosulphate in 200 g of water for cattle; for sheep 1g of sodium nitrite and 2.5 g of sodium thiosulphate in 50 g of water. Treatment may have to be repeated because of further liberation of HCN.

In conclusion, analyses of the seed oils indicate that

Table 6. Concentration of benzaldehyde and HCN in the various samples.

Seed	Conc. of benzaldehyde (mg/100g dried samples)	Conc. of HCN (mg/100g dried samples)
Cassipourea congoensis	1.05 ± 0.01	2.96 ± 0.28
Deterium microcarpum	1.00 ± 0.20	2.51 ± 0.31
Nuclea latifolia	1.25 ± 0.25	3.00 ± 0.19
Balanites aegytiaca	1.61 ± 0.85	3.51 ± 0.19
Gemlina arboea	1.98 ± 0.05	3.75 ± 0.20

Values are means ± SD for 3 determinations.

the physico-chemical characteristics are comparable with those of many edible oils. The iodine value of the oil is not greater than 88 g/100 g and suggests that the oil is non-drying oil. The saponification value is however high, suggesting that the oil may be suitable for soap making. Proximate and mineral composition of the seeds also indicates that they could be alternative sources of human food and could find immediate application in mixed animal feed. However, amino acid analyses and feeding studies are needed before they can be used this way. The analysis for the present of cyanogenetic glucoside content in the seeds indicates that HCN in the form of cyanogenetic glucoside was present in all the samples studied. Precaution to ensure detoxification is therefore imperative.

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