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Research Article

COMPARATIVE EVALUATION OF THE NUTRIENT PROFILE OF THE SEEDS OF FOUR SELECTED TROPICAL PLANTS AND MAIZE

Amata, I.A and Nwagu, K.M

Department of Animal Science Delta State University Asaba Campus, Delta State Nigeria

ABSTRACT: This study compares the proximate composition, mineral composition and the presence of anti-nutritional elements of *Zea mays* with the seeds of four selected tropical plants which include *Gmelina arborea*, *Terminalia catappa*, *Dacroydes edulis* and *Delonix regia*. The matured fruits of the test materials were collected from farmlands in Asaba, Delta State Nigeria ($6^0$14'N and $6^0$49'E). The seeds were carefully removed from the matured fruits and proximate analysis carried out to determine the levels of crude protein, crude fiber, energy, total ash and ether extract. The presence of the following mineral elements: calcium, magnesium, potassium, sodium, iron and zinc was determined. The presence of alkaloids and oxalate, which are anti-nutritional elements, was also determined. Significantly different means were separated using Duncan's multiple range procedure. Significance was reported at 5% level of probability. Significant differences between the test materials were observed for all parameters measured.

Key words: Proximate composition, anti-nutritional elements, mineral content, *Zea mays*, tropical seeds

INTRODUCTION

Animal feed is an essential part of livestock production. As the world's population increases the demand for livestock and livestock products is also increasing. Unfortunately, most of the feed resources used in the production of livestock feed such as maize, are also consumed by humans. It is therefore necessary to search for alternative sources which could be referred to as non-conventional feed resources, compare their nutritive values to the conventional feed resources and incorporate them into the production of animal feed (FAO, 1976). These feed sources are however not fully and appropriately integrated into livestock feed. This is due to very little knowledge of their potential as feed materials, the presence in some cases of anti-nutritional elements as well as lack of proper knowledge of storage capabilities especially over long periods (Ben Salem *et al*., 2002). Several studies have been carried out by different authors on the suitability and potentials of different parts of tropical plants especially those referred to as browse plants.

Amata (2012) revealed that the fresh fruit pulp of *Gmelina arborea* at all stages of growth is a good source of amino acids. Results on the proximate composition, amino acid profile and the presence of anti-nutritional factors of the seeds of *Magnifera indica* (Fowomola, 2010) serve as a guide for the possible utilization of this non-conventional feed material in the rations of livestock. Studies (Okafor, 2012) on the composition of the fresh fruit pulp of *Myrianthus arboreus* revealed appreciable levels of protein, calcium, iron and phosphorous; results also showed that the fruit is a good source of metabolizable energy. Bratte *et al* (2010) observed that replacement of maize with the seeds of the African pear (*Dacroydes edulis*) did not impart negative characteristics to the semen of broilers. Studies by Abdullahi and Abdullahi (2011) on the amino acid composition and anti-nutritional content of boiled *Delonix regia* revealed appreciable levels of amino acids and also showed that boiling overcomes the anti-nutritional factors present in the seeds. Studies with other parts of these browse plants revealed positive growth performances. Amata and Bratte (2008) observed significant growth performances when soya bean meal was replaced in the diet of rabbits with *Gliricida sepium* leaf meal. The potential of leaf meals from these tropical trees and shrubs to yield relatively higher levels of crude protein and minerals, and lower crude fiber levels than tropical grasses has also been recognized (Onwuka et al., 1989; Odunsi et al., 1996, 1999; Esonu et al., 2003; Fashina et al., 2004; Okagbare et al., 2004; Amata, 2010 and Amata and Lebari, 2011).

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This study compares the nutrient profile of maize with the seeds of four selected tropical plants, which include *Gmelina arborea*, *Terminalia catappa*, *Dacroydes edulis* and *Delonix regia*, with a view to ascertaining the suitability of any one of these tropical seeds as replacement for maize in the diet of livestock.

Gmelina arborea is a fast growing tree frequently planted in plantations which originated from Southern Asia and Pakistan. It is usually propagated by seeds, cuttings and stumps (Alan, et al., 1985). The fruit is a drupe which is between 1.8 and 2.5cm long, it is ovoid in shape and is seated on an enlarged calyx. The fruit is glossy and yellow when ripe, the mesocarp is succulent and has an aromatic aroma, and the endocarp is bony and usually 2-celled. The specie can be propagated by seeds, cuttings and stumps (Alan, *et al*, 1985). Germination rate of the fresh seed is 65-80% and occurs during the rainy season after the fruits fall from the tree. The fresh seeds can be stored at room temperature for up to six months and should be soaked in water at room temperature for 24hrs before planting.

Terminalia catappa is a large deciduous tree originally from India and grows up to ninety feet high. It has large nutty fruits that taste like commercially grown almonds. The fruits are large and nutty, which taste like commercially grown almonds. Typically, one to five fruits develop on the basal part of the flower spike. The fruit is ovoid and has a smooth skin, as it matures; it changes color from green, to yellow and becomes bright red or dark purplish red on maturity. The kernel consists of two delicate and intricately entwined cotyledons enclosed in a cream colored envelope with red testa. The tree thrives in moist and well drained soils and requires full sunlight.

Dacroydes edulis belongs to the family Burseraceae and is commonly referred to as African pear and is a native tree of tropical West Africa. The plant bears edible fruits and oil seeds which are used as food and fodder and grows up to eighteen meters high and exudes an odiferous gummy substance from injured or excised portions of the stem. The fruit consists of large seeds surrounded by thin mesocarp. The fruit is red and turns blue-black when ripe.

Delonix regia also known as flame of the forest belongs to the family leguminosae. It is a semi-deciduous tree and grows to heights of about eighteen meters. The plant is easily propagated from seeds that have hard woody testa and take a long time to germinate. The fruits are long pods, which dangle from the branches and are green and flaccid when young and later turn dark brown and hard when matured. On ripening, the mature fruit splits open into two halves revealing the elongated hard seeds.

MATERIALS AND METHODS

Matured fruits of *Gmelina arborea*, *Terminalia catappa*, *Dacroydes edulis*, *Delonix regia* and *Zea mays* were collected from farmlands in Asaba, Delta State Nigeria ($6^0$14'N and $6^0$49'E). The seeds were carefully removed from the matured fruits and put in polythene bags to prevent moisture loss and possible contamination during transportation to the laboratory. Taxonomic identification of the seeds was carried out in the Agronomy unit of the Delta State University Research and Teaching laboratory. A portion of the fresh seeds was used for moisture content determination, according to methods recommended by AOAC (1990). The other portion was prepared and used for chemical analysis by washing with distilled water to remove all impurities and dried at room temperature to remove residual moisture, then placed in an oven and oven dried at 55^0C for 24h. The dried seeds were ground into powder using a milling machine and then sieved through 20 inch mesh sieves. Proximate analysis was carried out using methods recommended by AOAC (1990). The following parameters were determined: total ash, crude protein, crude lipid, crude fiber, ether extract, metabolizable energy and nitrogen free extract.

The following mineral elements: calcium (Ca),potassium (K), sodium (Na), iron (Fe) and zinc (Zn) were determined using methods recommended by Funtua (1999, 2004) with energy dispersive X-ray fluorescence (EDXRF) transmission spectrophotometer, carrying an annular 25mG 109 Cd isotope excitation source that emits Ag-k, X-rays (22.1kv) and Mo X-ray tube (50kv, 5mA).Magnesium (Mg) was determined after the samples were subjected to wet digestion with nitric/perchloric/sulfuric acid mixture (9:2:1 v/v/v), followed by analysis using complexometric methods (AOAC, 1990).

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Oxalate was determined by acid digestion of the samples, using 15µ H_2SO_4, followed by filtration using Whatman No.1 filter paper. The filtrate was titrated hot (80-90^oC) against 0.1M $KMnO_4$ solution to a faint pink color that persists for 30 seconds. Alkaloids were determined after extraction with a 3ml solution of methanol containing 10% acetic acid. Ammonium hydroxide was added drop-wise to the extract and formation of a precipitate was taken as an indication of the presence of alkaloids.

Data collected were subjected to a one-way analysis of variance procedure, using IRRISTAT for windows (version 5.0) computer software. Significantly different means were separated using Duncan's Multiple Range Test procedure (Duncan, 1955). Significance was accepted at 5% level of probability.

RESULTS AND DICUSSION

The proximate composition of the test materials is presented in Table 1. Results for moisture content indicate significant (P<0.05) differences between the means, with *Gmelina arborea* and *Terminalia catappa* having significantly higher values than *Zea mays* while *Dacroydes edulis* had lower values. Significant (P<0.05) differences also exist between the means for crude protein values with *Terminalia catappa* having higher values and *Gmelina arborea* and *Dacroydes edulis* having values similar to *Zea mays*. Results for crude fiber showed significant (P<0.05) differences between the means, with *Dacroydes edulis* and the other test materials having higher values than *Zea mays*. The ether extract values show significant (P<0.05) differences between the means with *Terminalia catappa*, *Dacroydes edulis* and *Gmelina arborea* having higher values than *Zea mays* while *Delonix regia* had lower values. The results for gross energy values reveal significant (P<0.05) differences between the means with *Zea mays* and *Delonix regia* having higher values than *Gmelina arborea* and *Terminalia catappa*, while *Dacroydes edulis* had the lowest values. Total ash values of the test materials revealed significant (P<0.05) differences between the means with *Terminalia catappa* having significantly higher values than *Zea mays* and the other test materials. The nitrogen free extract (NFE) of the test materials shows significant (P<0.05) differences between the means, with *Zea mays* and *Delonix regia* having higher values than *Dacroydes edulis*, *Terminalia catappa* and *Gmelina arborea*.

Table 1 Proximate Composition of *Zea mays* and the seeds of four selected tropical plants

Parameter	*Zea mays*	*G arborea*	*T catappa*	*D edulis*	*D regia*
Moisture (%)	3.57^{c}	24.47^{a}	8.31^{b}	1.48^{d}	2.41^{cd}
Crude Protein (%DM)	7.27^{c}	7.29^{c}	19.97^{a}	7.91^{c}	13.24^{b}
Crude Fiber (%DM)	2.49^{e}	19.89^{b}	8.54^{d}	23.96^{a}	11.10^{c}
Ether Extract (%DM)	13.38^{c}	23.97^{b}	33.65^{a}	32.65^{a}	0.82^{d}
Total Ash (%DM)	1.00^{b}	2.04^{b}	4.52^{a}	1.71^{b}	1.90^{b}
Gross Energy (kcal/kg)	3613.0^{a}	2753.0^{c}	1753.0^{d}	595.5^{e}	3479.0^{b}
NFE (%DM)	71.86^{a}	27.52^{b}	25.01^{b}	32.39^{b}	70.53^{a}

$^{a\ b}$ = Means with different superscripts within a row differ significantly (P<0.05)

Table 2 Anti-nutritional Content of *Zea mays* and the seeds of four selected tropical plants (mg/g)

Parameter	*Zea mays*	*G arborea*	*T catappa*	*D edulis*	*D regia*
Alkaloid	0.21^{c}	1.43^{b}	0.25^{c}	3.61^{a}	1.39^{b}
Oxalate	0.012^{cd}	0.015^{b}	0.014^{bc}	0.025^{a}	0.011^{d}

$^{a\ b}$ = Means with different superscript within a row differ significantly (P<0.05)

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The results of the anti-nutritional content of *Zea mays* and the other test materials are given in Table 2.

The alkaloid contents of the test materials except *Terminalia catappa* are significantly (P<0.05) higher than the alkaloid content of *Zea mays*, with *Dacroydes edulis* having the highest values. The results also show that the concentrations of oxalate in *Dacroydes edulis* and *Gmelina arborea* are significantly (P<0.05) higher than that of *Zea mays* while *Terminalia catappa* and *Delonix regia* have roughly equal concentrations of oxalate with *Zea mays*.

Table 3 Mineral content of Zea mays and the seeds of four selected tropical plants (ppm)

Parameter	Zea mays	G arborea	T catappa	D edulis	D regia
Calcium	241[b]	0.31[e]	957[a]	1.34[d]	183[c]
Magnesium	0.13[e]	0.54[d]	45.4[b]	2.7[c]	230[a]
Potassium	0.93[d]	1.81[c]	184.1[a]	13.4[b]	1.81[c]
Sodium	0.72[c]	0.16[e]	58.4[a]	2.26[b]	0.48[d]
Iron	16.1[c]	107.4[a]	58.6[b]	6.26[d]	2.10[e]
Zinc	23.76[d]	47.66[b]	88.45[a]	2.70[e]	32.2[c]

[a b] = Means with different superscript within rows differ significantly (P<0.05)

The results of the mineral contents of Zea mays and the seeds of the four selected tropical plants are presented in Table 3.

The results reveal significant (P<0.05) differences between the means. *Terminalia catappa* has significantly higher calcium values than *Zea mays* and the other test materials. *Zea mays* on the other hand has higher calcium values than *D regia*, *D edulis* and *G arborea* respectively. All the test materials have higher magnesium values than *Zea mays* with *Delonix regia* having significantly (P<0.05) the highest values. Results show that *Terminalia catappa* has significantly (P<0.05) higher potassium content than the other test materials while *Zea mays* has the lowest content. Results for sodium content of the seeds revealed significant (P<0.05) differences between the means, with *T catappa* having significantly higher values than *Zea mays* and the other test materials. The values for Zea mays were higher than values for *D regia* and *G arborea* but lower than the values for *D edulis*. The iron content of *Gmelina arborea* was found to be significantly (P<0.05) higher than that of *Zea mays* and the other test materials with *D regia* having the lowest iron content. Zinc was found in varying amounts in the test materials with *Terminalia catappa* having significantly (P<0.05) higher values than *Zea mays* and the other test materials, with the lowest amounts in *D edulis*. The results in Table 3 show that the zinc content of *Terminalia catappa* is significantly (P<0.05) higher than that of *Zea mays* and the other test materials. The zinc contents of *G arborea* and *D regia* are also significantly higher than that of *Zea mays*. However the zinc content of *D edulis* is lower than that of *Zea mays* and the other test materials.

CONCLUSION

This study was conducted to look at the possibility of replacing *Zea mays* in the diet of livestock with any of the seeds of four selected tropical plants which include: *Gmelina arborea*, *Terminalia catappa*, *Dacroydes edulis* and *Delonix regia*.

Zea mays provides the energy in the diet of livestock, in this study only *Delonix regia* had gross energy values close to *Zea mays* whose energy value is significantly higher than the other test materials. This means that as a source of energy, *Delonix regia* could be used to replace *Zea mays* as a source of energy. The test materials are a better source of fiber than *Zea mays* and could be considered if the requirement is for fiber.

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Fiber is useful for maintaining bulk, motility and an increase in intestinal peristalsis by surface extension of the food in the intestinal tract (Mathenge,1997). The protein contents of *Terminalia catappa* and *Delonix regia* are significantly ($P<0.05$) higher than that of *Zea mays* and this means that the seeds of these two plants can be consider as protein sources in the diet of livestock. However metabolic trials should be carried out to determine the levels of inclusion of these materials in the diet of livestock. The seed of *Dacroydes edulis* might not be considered a suitable replacement for *Zea mays*, due to the fact that its energy level is much lower, and the concentration of alkaloids is quite high and might cause some nutritional disorders if ingested in large quantities. The alkaloid content of *Delonix regia* is slightly on the high side; however, recent studies (Abdullahi and Abdullahi, 2011) have shown that boiling of the seeds reduces the concentration of the anti-nutritional content.

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