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Research Article

COMPARATIVE EVALUATION of THE AMINO ACID AND MINERAL CONTENTS OF THE FRUITS of GMELINA ARBOREA TREE DURING GROWTH and DEVELOPMENT

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ABSTRACT: This study assessed the changes in amino acid content, the mineral content and the anti-nutritional content of the fruits of Gmelina arborea tree during growth and development, with the aim of evaluating its suitability to provide manageable levels of these components in the feed of livestock in the form of non-conventional feeding materials. Fruits at various stages of growth and development were collected from the Gmelina plantation of the Research and Teaching Farm, Delta State University, Asaba Campus, Delta State, Nigeria. The different growth stages studied were as follows: Unripe fruit (green color), ripe fruit (yellow color) and matured fruit (dark brown color). Eleven amino acids were analyzed; ten of them essential amino acids. The concentrations of the following mineral elements were determined: Zinc, copper, iron, magnesium and calcium. The presence of some anti-nutritional elements was also determined. Data collected were subjected to a one-way analysis of variance procedure. Significantly different means were separated using Duncan's multiple range procedure. Significance was reported at 5% level of probability. Amino acids detected were of high grades and the proportions compared favorably to FAO/WHO standards. Significant differences exist between the means of the samples analyzed. The minerals determined were present in the ranges of reported values, with significant differences existing between the different stages of growth. Concentration of anti-nutritional factors detected was minimal and below levels that could cause nutritional problems if used in the feed of livestock. Results obtained were within the ranges of reported values.

Key words: Gmelina arborea, growth and development, amino acids, mineral concentration anti-nutritional factors

INTRODUCTION

Animal feed has and will always be an essential part of livestock production. As the world's population increases the demand for livestock and livestock products has increased. Most of the feed resources used in the production of livestock feed are also used for human consumption, it is therefore necessary to seek alternative sources such as non- conventional feed resources and incorporate them into the production of animal feed[1]. However, these feed sources are still not fully and appropriately integrated into livestock feed due to an unbalanced supply of nutrients, mainly energy and nitrogen, the presence of undesirable compounds (tannins, saponins, glucosinolates and other anti-nutritional factors) and the difficulties of storage over long periods [2].Several studies have been carried out on the use of these non-conventional feeding resources. The use of certain plant leaves in the diet of goats was compared [3] and it was concluded that browse plants such as *Parkia filicodia*, *Tephrosia braceteolata* and *Gmelina arborea* have great potential in livestock feeding. The effect of *Glricidia sepium* leaf meal replacement of soya beans in the diet of rabbits was investigated [4] and significant positive growth performances were observed.

In related studies, the effect of replacement of growers mash with *Gliricidia sepium* leaf meal on the growth of Chinchilla rabbits was studied [5]; significant positive growth responses and cost reduction were observed. In another study, it was observed that feeding *Gliricidia sepium* leaf meal neither affected the hematological, serological nor the carcass characteristics of weaned rabbits in the tropics [6]. In a related study with browse plants,it was observed that replacement of maize with the seeds of the African pear (*Dacroydes edulis*) did not impart negative characteristics to the semen of broiler breeder chicks [7].

Studies on the composition of the fresh fruit pulp of *Myrianthus arboreus* revealed appreciable levels of protein, calcium, iron and phosphorous and it is also a good source of metabolizable energy [8]. Recent studies [9] on the nutritive value of the leaves of *Myrianthus arboreus* revealed that the leaves are a good source of nutrients with very low concentrations of anti-nutritional factors. This study looks at the potential of the fresh fruit pulp of *Gmelina arborea* as non-conventional feeding material.

MATERIALS and METHODS

This study was carried out at the Delta State University, Research and Teaching Farm, Asaba Campus, Delta State Nigeria (6º14'N and 6º49' E)

The fruits at three different stages of growth and development: the unripe fruit (green color), the ripe fruit (yellow color) and the matured fruit (dark brown color), collected from the Gmelina plantation in the Research and Teaching Farm of the University were washed with distilled water and dried at room temperature to remove residual moisture, the seeds were removed, then the fresh fruit pulp was placed in paper envelops and dried in an oven at 55ºC (24hrs). The dried fruit pulps were then ground into powder and sieved through 20 inch mesh sieves. The powder was then used for analysis. Determination of amino acids was carried out by ion exchange chromatography, using a Technicon Sequential Multisampling (TSM) amino acid analyzer [10].The following mineral elements ,Copper (Cu), Calcium(Ca), Iron (Fe) and Zinc(Zn) were determined using recommended methods [11,12], which use Energy Dispersive X-ray Fluorescence (EDXRF) transmission spectrophotometer, carrying an annular 25mG 109Cd isotope excitation source, that emits Ag-k, X-rays (22.1kv) and Mo X-ray tube (50kv.5mA).For the determination of Magnesium, the samples were first subjected to wet digestion with nitric/perchloric/sulfuric acid mixture (9:2:1 v/v/v) and then analyzed using complexometric methods [13].
The following anti-nutritional factors were determined: oxalate, phytic acid, phenol, tannin, alkaloids and saponin.Quantitative estimation of tannins in the samples was carried out using the modified vanillin-HCl methanol method [14]. A standard curve of tannic acid was prepared for measurement of the concentration of tannins in the sample [13]. Phytic acid was determined using prescribed methods [15]. A standard curve of different $Fe(NO_3)_3$ concentrations were plotted against the corresponding reading on the spectrophotometer, to calculate the ferric ion concentration. The phytate phosphorous was calculated from the concentration of ferric ion, assuming a 4:6 iron: phosphorous molar ratio.Oxalate was determined by acid digestion, using $15\mu H_2SO_4$, followed by filtration using a Whatman No.1 filter paper. The filtrate was titrated hot (80 – 90ºC) against 0.1 N $KMnO_4$ solution to a faint pink color that persists for 30seconds.For the determination of alkaloids, extraction was carried out using 3ml solution of methanol containing 10% acetic acid. Ammonium hydroxide was added drop- wise to the extract. Formation of a precipitate was taken as an indication of the presence of alkaloids.Saponins were determined by extraction in 50% aqueous methanol, followed by transfer to a test tube with constant vigorous agitation. Formation of persistent foam at the surface was taken as an indication of the presence of saponins. Phenol was determined using recommended methods [13]. Data collected were subjected to a one-way analysis of variance procedure, using the IRRISTAT for windows (version 5.0) computer software. Significantly different means were separated using Duncan's multiple range test procedure [16]. Significance was accepted at 5% level of probability.

RESULTS AND DISCUSSION

Eleven amino acids were analyzed and were found in varying proportions. The proportions of the amino acids in the samples compare favorably with FAO standards [17]. Significant (P<0.05) differences exist between the means of the samples analyzed. All the essential amino acids were detected in the samples analyzed. The samples also contained two sulfur amino acids which makes them good sources for livestock feed supplementation in regions where chronic deficiency of sulfur-containing amino acids occur. The matured sample (dark brown color) had the highest concentration of methionine which is a sulfur containing amino acid. Results obtained show that the essential amino acids were present in good quantities (Table 2), this supports the claim that the amino acid content in plant materials although low in some cases is of very high grade[18]. Results also show that the aromatic nature and sulfur concentration of the amino acids increase with maturity (Table2).

Table 1 Amino acid content

Parameter (g/100g protein)	Green	Yellow brown	Dark
Arginine	4.11^{b}	3.83^{c}	4.29^{a}
Histidine	5.31^{a}	4.19^{b}	2.96^{c}
Isoleucine	2.75^{c}	2.86^{b}	3.08^{a}
Leucine	3.40^{c}	3.73^{b}	4.13^{a}
Lysine	3.24^{b}	2.84^{c}	3.66^{a}
Cysteine	2.31^{c}	2.74^{a}	2.64^{b}
Metionine	2.04^{c}	3.15^{b}	3.81^{a}
Tyrosine	2.67^{b}	1.47^{c}	4.23^{a}
Tryptophane	3.51^{b}	3.26^{c}	4.13^{a}
Phenylalanine	4.84^{b}	5.00^{a}	3.41^{c}
Threonine	3.95^{b}	4.64^{a}	3.91^{c}

Means with different superscripts ^{abc} within rows differ significantly (p<0.05)

Table 2 The percentage comparison of the essential amino acid composition of the test materials with WHO standard (FAO, 1981). Sample/Standard multiply by 100%

Amino acids	Green	Yellow	dark	FAO protein standard
Lysine	77	67.6	87	4.2
Threonine	142	165	140	2.8
Cysteine	116	137	132	2.0
Methionine	93	137	173	2.2
Isoleucine	65	68	73	4.2
Leucine	81	89	98	4.2
Tyrosine	95	53	151	2.8
Phenylalanine	102	178	121	2.8
Arginine	103	96	107	4.0
Histidine	156	144	87	3.4

Source: FAO 1981 (Protein standards)

The mineral content of the test materials is given in Table 3. Minerals are elements that originate from the soil and are not created by living things, such as plants and animals. Yet plants, animals and humans need minerals in order to be healthy. Plants absorb minerals from the soil, therefore, minerals from plant sources may vary from place to place, because the mineral content of the soil varies according to location in which the plant was grown[19] Significant (p<0.05) differences exist between the different growth stages. Copper, iron and magnesium increased with maturity. Values obtained are comparable to ranges obtained for some other fruits samples (19, 20].

Table 3 Mineral content (mg/100gm)

Parameter	Green	Yellow	Dark brown
Zinc	1.21^{c}	2.62^{a}	1.54^{b}
Copper	0.19^{c}	0.29^{b}	0.47^{a}
Iron	4.03^{c}	4.43^{b}	5.71^{a}
Magnesium	27.9^{c}	30.9^{b}	32.9^{a}
Calcium	26.45^{b}	27.28^{a}	22.77^{c}

Means with different superscripts^{abc} within rows, differ Significantly (p<0.05)

Table 4 Anti-nutritional content (mg/g)

Parameter	Green	Yellow	Dark brown
Tannin	$.039^{b}$	$.026^{c}$	$.042^{a}$
Saponin	$.246^{c}$	$.322^{b}$	$.331^{a}$
Alkaloid	$.372^{a}$	$.294^{b}$	$.175^{c}$
Oxalate	$.012^{c}$	$.022^{b}$	$.025^{a}$
Phytate	$.038^{c}$	$.043^{b}$	$.051^{a}$
Phenol	$.130^{b}$	$.141^{a}$	$.127^{c}$

Means with different superscripts^{abc} within rows differ Significantly (p<0.05)

Table 4, shows the values of anti-nutritional factors analyzed in the test materials. Phytates and oxalates are commonly found in plant materials [21]. However the amounts detected were below the ranges that would adversely affect their nutritional values. Other components detected were also below values that can cause adverse effects if ingested.

CONCLUSION

This study revealed that the fresh fruit pulp of *Gmelina arborea* at all stages of growth are good sources of amino acids for use as non –conventional feeding materials for livestock. The amino acids detected compare favorably with FAO standards. There was significant increase in the aromatic amino acids during growth. The overall results show that the concentration of the anti-nutrtional compounds is not present in harmful levels. The mineral content of these fruits is also appreciable and can be a potential source for feed formulated with non-conventional feeing materials. These results reinforce the growing awareness that wild and semi-wild tropical plants can contribute useful amounts of amino-acids and minerals to livestock feed. However, studies should be carried out to ascertain the level of inclusion in livestock feed, the general acceptability, digestibility and feed efficiency ratio of these materials.

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