# Nutritional values of flamboyant (*Delonix regia*) seeds obtained in Akure, Nigeria

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## ABSTRACT

The nutritional and antinutritional compositions (phytochemical, proximate, mineral, digestibility, functional properties, phytate, tannins and oxalate.) of *Delonix regia* seed were determined. The results showed that the sample, has high protein content, Ca, Na, Mg, K and Fe. Biological value (BV) - 76.24, net protein utilization (NPU) - 60.99 and net protein value (NPV) - 46.50, WAC 200%, OAC 98%, FC 4.3% and LGC 7%. The sample showed the presence of some bioactive substances, the implication of this is that the extract may be suitable for treatment of several ailments in human and animals. The results also depicted the presence of antinutrients; it would be advisable to properly process the seed before consumption. The implications of the results were discussed.

**Keywords**: Royal Poinciana, pinnae, Nigeria, Madagascar, umbrella-like canopy, nutritional composition

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## INTRODUCTION

*Delonix regia* is known as royal Poinciana, flamboyant tree, flame tree, peacock flower. The family is Fabaceae/Leguminosae. It is native to Madagascar. This tree some say is the world's most colorful tree (Christman, 2004), the individual flowers are striking: they have four spoon shaped spreading scarlet or orange-red petals about 7.6 cm long, and one upright slightly larger petal (the standard) which is marked with yellow and white. *Delonix regia* gets to 9.1-12.2 meters tall, but its elegant wide-spreading umbrella-like canopy can be wider than its height (Nawrocki, 2004). According to Floridata.com, (2004), this tree is deciduous in climates that



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have a marked dry season, but in other areas, it is known as a semi-evergreen tree. The leaves are elegant, fernlike, twice-pinnate, and 30.5-50.8 cm long with 20-40 pairs of primary leaflets (Pinnae), each divided into 10-20 pairs of secondary leaflets. The pods are flat, woody, dark brown, 61 cm long and about 5.1 cm wide. A naturally occurring variety (var. flavida) has golden-yellow flowers (Christman, 2004). *Delonix regia* is widely cultivated and may be seen in parks and estates in tropical cities throughout the world. It tolerates hard pruning and can be kept at a small size, and even grown in the greenhouse (Nawrocki, 2004).

Throughout the world there is a dearth of man and animal feeds this has made researchers delve into looking for alternative sources. Again, all the parts of *Delonix regia* grown in Nigeria have been a waste since none of them have been exploited as foods and feeds. Reviewed literature (Christman, 2004, Nawrocki, 2004, Floridata.com, 2004) on *Delonix regia* did not show or have any information on the nutritional and antinutritional compositions of the seeds. This informed our efforts in the search. It is believed that the results of this study would add to the existing knowledge on the flamboyant tree. The outcome of the study may be useful in finding out the food values of the seeds.

The aim of this study is to examine the nutritional and antinutritional compositions of the flamboyant tree. To achieve this, these parameters would be determined (proximate and mineral compositions, digestibility, functional properties, phytochemical constituents and antinutrients (oxalate, phytate and tannins).



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**EXPERIMENTAL**

Flamboyant tree (*Delonix regia*) and the sample seed used for the analysis are depicted in Fig 1 - 4


Fig 1: Flamboyant tree showing the flowers



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Fig 2: Flamboyant tree showing the pods



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Fig 3: Pods of flamboyant tree



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Fig 4: Seeds of flamboyant

**Sample preparation**

The sample used for this study was obtained from Federal College of Agriculture, Akure, Ondo State Nigeria. The seed was screened to remove bad ones, washed in distilled water, oven dried at 105$^{o}$C for 7 days, milled in a Kenwood blender, sieved with 2mm wire mesh and stored in air-tight containers at an ambient temperature.

**Proximate Composition**

This was carried out on the seeds for ash, crude fiber, moisture, and fat in triplicate using the method described by AOAC (1990). Nitrogen was estimated by the micro-Kjeldahl method



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(Pearson 1976) and the percentage nitrogen was converted to crude protein by multiplying with 6.25. The carbohydrate was calculated by difference.

**Mineral Composition**

Mineral content was carried out by dry-ashing the seed at 550ºC for 2h, dissolving in 10% HCL (25cm$^3$) and 5% lanthanum chloride (2cm$^3$), filtering and making up to standard volume (50cm$^3$) with 10% HCl. Metals were determined with atomic absorption spectrophotometer. Total phosphorus (P) was determined using colorimeter by the phosphovanadomolybdate method (AOAC 1990).

**Digestibility composition**

The digestibility was performed using a detailed procedure as described by Adeola (1995).

**Antinutritive Compositions**

Phytate was determined using Young and Greave (1940) method. Phytate P as a percentage of total P was calculated (Balogun and Fetuga (1989). Oxalate was investigated with the methods proffered by Day and Underwood (1986). Tannins were determined by the quantitative methods of Markkar and Good child (1996).

**Functional Properties**

Oil and water absorption capacities were measured by the procedures of Sosulski (1962). The foaming capacity and least gelation capacity were determined using the methods of Coffman and Garcia (1977).

**Phytochemical composition**

Flavonoids, Alkaloids, saponins, cardiac glycosides tannins were determined qualitatively using the methods of Trease and Evans (1983) and Harbone (1973).



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**Statistical analysis**

All data generated were statistically analyzed using the SPSS for Windows 10.0

**RESULTS AND DISCUSSION**

Table 1 shows the summary of the phytochemical composition of the seed analyzed. It showed that they were either clearly or slightly present. These results compared with the results obtained for aqueous root extract of *Raphia hookeri* (Akpan and Usoh 2004) crude extracts of *Gliricidia sepium, Tectona grandis* and *Hevea bracilliest* (Eluyode and Alabi, 2007; Abulude *et al*., 2011), and aqueous leaves extracts of *Boerhavia diffusa* and *Commelina midiflora* (Ujowundu *et al*., 2008). The presences of these bioactive substances in the seed extract have been reported to have pharmacological functions which may act synergistically (Akpan and Usoh 2004). Some bioactive substances act as an anti-nutritional factor. Saponins reduce the uptake of certain nutrients including glucose and cholesterol at the gut through intra-lumental physicochemical interaction. It has been reported to have hypocholesterolemic effects. Alkaloids inhibit certain mammalian enzymic activities such as those of phosphodiesterase prolonging the action of cyclic AMP. They also affect glucagons and thyroid stimulating hormones, white some have been reported to be carcinogenic. Flavonoids have been found to have anti-oxidation effects in animals (Ujowundu *et al*., 2008).

The implication of the presence of all these bioactive substances, the extract may be suitable for treatment of several ailments in human and animals. Saponins are special classes of glycosides which have been reported to possess soapy properties and active microbial agents (Banso and Adeyemo 2006) Tannins have also been reported to prevent the development of microorganisms by precipitating microbial protein and making nutritional proteins unavailable to the (Sodipo *et al*., 1991). Alkaloids are poisonous but they have been proved to be useful in correcting renal disorders.

Proximate composition (Table 2) of the seed is higher than those reported for Ogi and its by-product (Abulude *et al*., 2007), *Gnetum africanum* (AFANG) seeds (EKOP 2007), seed of *Jatropha curcas* and *Luffa cylindrical* (Abulude *et al*., 2006) but compared with results of Ogunkoya *et al*., (2006) on *Epicrates anguifer*. Less mineral is absorbed from foods high in fiber especially when they also contain phytate. This does not mean fiber should be avoided but



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excess is not tolerable. The dietary fiber intake is 25-30g/day, but in many developed countries the actual average intake is closer is 15g (Cleveland *et al*., 1996). The high values of carbohydrate and protein in the sample would complement favorably those nutrients from other sources, ash value could be an evidence of the high mineral content of the sample. The crude fibre in the sample would do bulk elimination of faeces thereby reducing cancer of the colon while the low crude fat could be evidence that flamboyant seed might not promote coronary heart disease (CHD), it could promote palatability to foods, reduce emptying time of the stomach, decreases intestinal motility and ensures dietary supply of essential fatty acids and fat-soluble vitamins Christian (2007). This food seed seems to be a promising alternative source of food nutrient.

It is worthy to note that Ca in conjunction with Mg, P, Mn, Vitamin, Chlorine and Proteins are involved in the formation of bone (Abulude 2001). It also plays an important role in blood clothing, coordination of inorganic elements present in the body and balancing of Ca and pH is very important that the normal Ca levels in the diet should be balanced throughout life. Increasing dietary K has lowered blood pressure in humans, which by itself should reduce the risk of stroke, however, some of the protective effects of K appears to extend beyond its ability to lower blood pressure. Maintaining a high K intake may be achieved by consuming flamboyant. Mn is known for normal bone metabolism and important enzyme reactions, maintenance of normal nerve, brain and thyroid functions. Its deficiency is uncommon but can affect the brain, glucose tolerance, normal reproduction skeletal and cartilage formation (Keen *et al* 1999). Zn supports the health of the immune system, normal synthesis of protein and the health of reproductive organs (especially in men) the deficiency of Zn adversely affect normal physical growth skin, nerve health, natural healing ability and immune function especially in infants. In is necessary for blood nerves, joints, heart, skin, liver and the immune systems. It is also critical to the absorption and utilization of both Zn and Fe. The inability to produce important antioxidant enzymes and a shortage of red blood cell has been implicated by Cu deficiency and excess Cu in the diet decreases retention and utilization of Zn (Reddy and Love 1999), about 1-10% of plant Fe is said to be absorbed by the body. This can be improved by the presence of animal Fe (Esiet and Kayode 2007).



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The results (Table 3) of the elemental contents of the sample were on the high side. In comparison with other literature (Table 4), it was found that the values obtained in this study were either not in agreement or agreement with results obtained for other samples. From the results it could be deduced that this seed is a potential good source for all the minerals determined. The differences in our results and others could be due to cultivars, location, soil conditions, rainfall and other reasons, minerals if adequately taken known to be helpful in the reduction of diseases associated with them. It is advisable not to over process the seeds because of the known fact that processing aids in loss of nutrients (Ejoh *et al*., 2007).

Results of the functional qualities (Table 5 showed thus: WAC 200%, OAC 98%, FC 4.3% and LGC 7%. These results agreed with values reported for *Cucumeropsis edulis* seeds (Abulude *et al*., 2006) but higher than values recorded for some Nigerian cowpea varieties (Chinma *et al*., 2008). WAC is considered a critical function of protein in viscous food, like soups, graves, doughs, bake products etc, hence, flamboyant may be useful in these food formulations. OAC is important since oil acts as flavor retainer and increases the taste of foods. The ability of the protein to form gels and provide a structural matrix for holding water, flavors, sugars and food ingredients is useful in food applications and in new product development, thereby providing an added dimension to protein functionality.

The average protein digestibility, biological value (BV) net protein utilization (NPU) and net protein value (NPV) (Table 6) ranged thus: 76.24, 60.99, 46.50, and 7. These results followed the trends on some tropical plants (Abulude 2005) and *Sphenostylis stenocarpa* (Adeyeye 1997). BV measures the proportion of absorbed protein from a diet that is retained while NPU measures the proportion of the consumed protein that is retained. Supplementation of the seed under this study with cysteine and methionine could improve BV and NPU.

## CONCLUSION

The present study revealed that the seed under the study has high protein content, Ca, Na, Mg, K and Fe. Good protein digestibility and functional properties. It is advisable to supplement the intake of this seed with other foods which are highly nutritious and proper processing should be ensured before consumption.



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**REFERENCES**

Abulude F.O (2001): Mineral and phytate contents of vegetables grown in Nigeria and calculation of their phytate: Zn and Ca: phytate molar ratio. *Adv. Food Sci.* 23:36-39.

Abulude F.O.; (2005): In in vitro digestibility of some tropical plant seeds. *La Riv. Ital. Del. Sost. Grasse* 82(3): 152-154.

Abulude F.O, Lawal L.O, Ogunkoya M.O, Akinjagunla Y.S and Obajowolo O.E (2006): Functional qualities of raw and processed melon (*Cucumeropsis edulis*) seeds. *Pak. J. Ind. Res.* 49(6):427-430

Abulude F.O, Eluyode O.S and Kolawole P. (2006): Nutritional and antinutritional compositions of underutilized seeds of jatropha (*Jatropha curcas)* and Loofah (*Luffa cylindrical*) *J. Res. Agric.* 3(2): 28-32.

Abulude F.O, Adesanya W.O, Ogunkoya M.O, Elemide O.A and Esiet E.E. (2007): Nutritional composition of Ogi and its by-products. *Acta Alimentaria* 36(4): 489-493.

Abulude, F.O., Adesanya, W. O and Afowowe Feyisayo Kemi (2011). Phytochemical Screening of Bark, Leaves and Roots of Flamboyant Tree (*Delonix regia). Adv. Student Res*. 1 (Issue 2) Oct: 20 – 26.

Adeola O.F. (1995): Protein quality, chemical and mineral contents of some local grains. Final Diploma Thesis. The Federal University of Technology Akure. Unpublished.

Adeyeye E.I (1997): The effect of heat treatment on the in intro multi enzyme digestibility of protein of six varieties of African yam bean (*Spehnostylis stenocapa)* flour. *Food Sci. and Nutr*. 60(4): 509-512.

Akpan E.J and Usoh I.F (2004): Phytochemical Screening and effect of aqueous root extract of *Raphia hookeri* (Raffia palm) on metabolic clearance rate of ethanol in rabbits. *Biokemistri* 6(1):37-42.

AOAC (1990): Official methods of Analysis. 15th ed. Washington DC: Association of Official Analytical Chemists.

Awadelkareem A.M., Mustafa A.I and Et Tinay A.H (2008): Protein, mineral content and amino acid profile of sorghum flour as influenced by soybean protein concentrate supplementation. *Pak. J. Nutr*. 7(3): 475-479.

Balogun A.M and Fetuga B.L (1989): Anti-nutritional components in some lesser known leguminous crop seeds in Nigeria. *Bio. Wastes* 28:303-308.

Banso A and Adeyemo S. (2006): Phytochemical screening and antimicrobial assessment of *Abutilon mauritianum, Bacopa monnifera* and *Datura stramonium*. *Biokemistri* 18(1):39-44

Chinma C.E. Alemede I.C and Emelife I.G (2008): Physicochemical and functional properties of some Nigerian cowpea varieties. *Biokemistri* 18(1): 22 -27

Christian A (2007): Fluted pumpkin (*Telfaria occidentalis* hood F.) Seed: A nutritional assessments. *Electr. J. Environ Agric, Food Chem*. 6(2): 1787-1793.

Cleveland L, Goldman J and Borrud L (1996): Results from USD's 1994 containing survey of food intakes by individuals and 1994 diet and health knowledge survey. P1-65 Riverdale, MD, USA, USDA.



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Coffman C.W and Garcia V.C (1977): Functional properties and amino acid content of a protein isolate from mug been flour. *J. Food Tech.* 12:273-484.

Day R.A and Underwood A.L (1986): Quantitative analysis 5th (ed). Prentice –Hall Publication. Pp 701

Dubey C, Khan N.A and Srivastava A (2008): Nutritional and antinutritional evaluation of forest and hybrid legume seeds, *Electr. J. Environ. Agric. Food Chem.* 7(5): 2900-2905.

Ejoh R.A, Mconga D.V, Innocent G and Moses M.C (2007): Effect of the method of processing and preservation on some quality parameters of three non-conventional leafy vegetables. *Pak. J. Nutr*. 6(2):128-133.

Ekop A.S (2007): Determination of chemical composition of *Gnetum africanum* (AFANG) seeds. *Pak. J. Nutr*. 6(1):40-43.

Eluyode O.S and Alabi O.S (2007): Preliminary phytochemical screening of crude extracts of *Gliricidia sepium, Tectona grandis* and *Herea bracilliensi* trees. *Cont. J. Agric. Sci.* 1:22-27.

El-Qudah J.M, Dababneh B.F, Abu Jaber M.M and Ereifej K.I (2008): Variation in physiochemical characteristics, mineral concentrations and cookability of rice marketed in Jordan. *Pak. J. Nutr*. 7(1):141-145.

Esiet E.E. and Kayode B.O (2007): Proximate composition and economic feasibility of some mushrooms consumed in South Western Nigeria. *Cont. J. Food Sci & Tech*.1:7-10.

Floridata (2004): #797 *Delonix regia*. Floridata.com LC, Tallahassee, Florida USA

Harbone J.B (1973): Phytochemistry, Academic Press, London. 21:2785



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Keen C.L, Ensunsa J.C and Wastson M.H (1999): Nutritional aspect of manganese from experimental studies. *Neurotoxicology*. 20:213-223.

Markkar A.O.S and Good Child A.V (1996): Quantification of Tannins: A laboratory manual. International Centre for Agricultural Research in the Dry Areas (ICARDA), Aleppo, Syiva.25pp.

Ogunkoya M.O, Abulude F.O and Oni A.B (2006): Determination of anatomical, proximate, minerals, oxalate, tannins and phytate compositions of Cuban boa (*Epicrates anquifer*). *Electr. J. Environ, Agric, and Food Chem.* 5(1): 1161-1166.

Paul Nawrocki, (2004): *Delonix regia*. Floridata.com LC, Tallahassee, Florida USA

Pearson D (1976): Chemical analysis of foods (7th ed.) J.A. Churchill, London

Reddy M.B and Love M. (1999): The impacts of food processing on the nutritional quality of vitamins and minerals. *Adv. Exp. Med. Bio*. 459:99-106

Sodipo O.A, Akanji M.A., Kolawole F.B and Odutuga A.A. (1991). Saponins is the active heckle seed. *Biosci. Comm.* 3:171

Sosulski F.W (1962): The centrifuge method of determining flour absorption in hard red spring wheat. *Cereal Chem*. 39:344-350.

Steve Christman (2004): *Delonix regia*. Floridata.com LC, Tallahassee, Florida USA

Trease G.E and Evans W.E (1989): Pharmacognosy Bailliere Tridal p 705.

Ujowundu C.O, Igwe C.U, Enemor V.H.A, Nwaogu L.A and Okafo O.E. (2008): Nutritive and anti-nutritive properties of *Boerhavia diffusa* and *Commelina nudiflora* leaves. *Pak.J.Nutr*.7(1)" 90-92.



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Young S.M and Greaves J.S (1940): Influence of variety and treatment on phytin content of wheat. *Food Res.* 5:103-105.

Table 1. Phytochemical constituents of the seeds analyzed

| Parameters | Results |
|---|---|
| Flavanoids | ++ |
| Alkaloids | + |
| Saponins | ++ |
| Cardiac glycosides | + |
| Tannins | ++ |
| Cyangenic glycosides | + |

+ = slightly present, ++ = clearly present

Table 2. Proximate composition of seeds analyzed (%)

| Parameters | Value |
|---|---|
| Crude protein | 35.97[ab] |
| Crude ash | 5.93[a] |
| Crude Fibre | 9.83[ab] |
| Crude Fat | 9.77[ab] |
| Nitrogen free extract | 23.33[ab] |
| Moisture | 8.40[a] |

[ab]Means on the same row with different superscripts are significantly (P<0.05) different.



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Table 3. Mineral constituents of seeds analyzed ($mgkg^{-1}$)

| Parameters | Value |
|---|---|
| Ca | 318.25 [ab] |
| Na | 530.05 [ab] |
| K | 180.25 [a] |
| Mg | 325.00 [a] |
| Mn | 30.95 [ab] |
| Fe | 35.00 [ab] |
| Cu | 40.00 [ab] |
| Zn | 25.00 [a] |
| Ni | 3.00 [a] |

[ab]Means on the same row with different superscripts are significantly ($P<0.05$) different.



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Table 4. Mineral compositions ($mgkg^{-1}$) of seeds analyzed compare with other countries

| Samples Countries | Ca | Na | K | Mg | Mn | Cu | Fe | Ni | Zn | References |
|---|---|---|---|---|---|---|---|---|---|---|
| Rice (Jordan) | 31.3 – 116.9 | 31.7 – 53.0 | 26.2 – 103.2 | 36.7 - 60.7 | 0.3 – 1.0 | 0.8 – 1.4 | 2.7 – 10.0 | - | - | El-Qudah *et al*., 2008 |
| Vegetables (Cameroon) | 40.1 – 97.7 | - | - | - | - | - | 4.79 – 8.01 | - | - | Ejoh *et al*., 2007 |
| Cereals (Sudan) | 2.43 | 6.18 – 8.2 | 225.23 | - | - | 0.41 | 15.54 | - | - | Awadakareem *et al*., 2008 |
| Legumes Seeds (India) | 2.10 – 69.0 | - | - | - | - | - | - | - | - | Dubey *et al*., 2008 |
| Our study (Nigeria) | 318.25 | 530.02 | 180.25 | 325.00 | 30.95 | 40.00 | 35.00 | 3.00 | 25.00 | - |



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Table 5. Antinutrients of seeds analyzed (%)

| Parameters | Values |
|---|---|
| Total P | 217.00 [ab] |
| Phytate P | 172.0 [ab] |
| Phytate | 612.32 [ab] |
| Oxalate | 0.75 [a] |
| Tannins | 60.35 [ab] |
| Phytate P as percentage | 79.26 [ab] |

P = Phosphorus, [ab]Means on the same row with different superscripts are significantly (P<0.05) different.

Table 6. Some functional properties of seeds analyzed

| Parameters | Values |
|---|---|
| Water absorption capacity | 200 ± 0.5[ab] |
| Oil absorption capacity | 98 ± 0.5[ab] |
| Foam capacity | 4.3 ± 0.5[a] |
| Least gelation capacity | 7 ± 0.5[a] |

[ab]Means on the same row with different superscripts are significantly (P<0.05) different.

Table 7. In vitro protein digestibility of seeds analyzed

| Parameters | Values |
|---|---|
| Digestibility | 76.24 ± 0.5[ab] |
| Biological value | 60.99 ± 0.5[ab] |
| Net protein utilization | 46.50 ± 0.5[ab] |
| Net protein value | 4.77 ± 0.5[ab] |

[ab]Means on the same row with different superscripts are significantly (P<0.05) different.



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