Ultra Chemistry Vol. 8(2), 251-264 (2012).

Comparative study on chemical compositions, phytochemical screening and physico-chemical properties of the seeds of *Dioclea reflexa*

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(Acceptance Date 16th July, 2012)

Abstract

Edible and Non-Edible seeds of underutilized legume, *Dioclea reflexa*, were investigated for proximate, minerals, anti-nutrient composition and phytochemical constituents. The result of the proximate analysis revealed that the edible seed was richer than that of non-edible seed only in crude fat and carbohydrate with 2.31 ± 0.34% and 56.22 ± 0.12% respectively. The minerals of the non-edible seeds exceeded those of edible in sodium, potassium, magnessium, phosphorus, zinc, iron and manganese, while edible seeds contained higher concentration of minerals only in calcium. The anti-nutrient components revealed the reason for the non-edibility of the non-edible seed with a cyanide concentration of 22.74 ± 0.37. The phytochemicals analysed include phlobatannins, saponins, steroid, cardiac glycosides, alkaloids and flavonoids which were quantitatively higher in non-edible seeds than edible seeds. Some physical and chemical properties of the *Dioclea reflexa* seeds (Edible and Non-Edible) oils were also investigated. The edible and non-edible seed oils have specific gravity of 0.9145 ± 0.01 and 0.9131 ± 0.01 respectively and refractive indices of 1.4656 ± 0.00 and 1.4648 ± 0.00 respectively at 30^{o}C. The saponification, iodine, acid values and unsaponifiable matter of the non-edible 206.090mgKOH^{-}g^{-1} of oil, 113.880g of 100^{-1} of oil, 0.980mgKOHg^{-1} and 6.200% respectively exceeded those of the edible seeds, but lower in peroxide values. The total amino acids of both edible and non-edible seeds were calculated to be 73.23g/ 100g and 84.50g/100g respectivley. It was found that glutamate was the

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most abundant, while tryptophan was the least in both. The total neutral amino acid (TNAA) of the edible and non-edible were 38.575g/100g and 53.583g/100g which formed the bulk of the amino acid.

Key words : Dioclea reflexa (Agbaarin, Ufor), Edible, Non-edible, Proximate , Minerals, Anti-Nutrients, Phytochemicals, and Amino acids.

Introduction

Leguminous plants play important role in human nutrtion[1]. They are very important, not only as food crops but possess hgh propensity to grow in depleted soils thereby serving as a medium of fertilizing succeeding crops through their unique symbiotic capability with nitrogen-fixing rhizobium bacteria which are inhabited in root nodules of the legumes, and the nitrogen balance in the soil is thereby preserved[2]. Nutritionally, legumes can supply significant amount of energy, vitamins and minerals in addition to protein. They are 2-3 times richer in protein than cereal grain[3], even some of these legumes are very rich in oil and they are mostly called oil seeds[4].

In Nigeria, the commonest food legume is cowpea (*Vigna ungiculata*). Others include bambara groundnut (V*oandzeia subterrania*), pigeon pea (*cajanus cajan*), soya bean (*Glycine max*), yam bean (*Sphenosttilis stenocarpa*) and Lima beans (*Phaseolus lunatus*). *Dioclea reflexa* is a less popular food crop in the Northern States than Eastern and Western states of Nigeria. It therefore belongs to the group of underuntilized legumes. Edible *Dioclea reflexa* dish is cherished in Ibo land where it is known as "Ufor".

Dioclea reflexa belong to the legume family called *Fabaceae*, sometimes placed in *Papilionaceae*. The *fabaceae* are herbs, vines, shrubs, trees and lianas found in both temperate and tropical areas. They comprise one of the largest families of flowering plants, numbering 630 genera, and 18000 spcies. *Dioclea reflexa* is native to West-central tropical Africa, South tropical Africa and Southern America. The plant is locally known as "Agbaarin" in Yoruba (the non-edible) and "Ufor" (the edible) in Ibo in Nigeria. It is propagated using 10-12 seeds.

The three sub-families of the *leguminosae* are sometimes classified viz: *mimosaceae, caesalpinaceae* and *papilionaceae*[5]. *D. reflexa* belong to the sub-family *papilionaceae*. This work is therefore focused on the evaluation and comparison of the chemical composition, anti-nutrients, phytochemical contents and amino acid composition of underutilized edible and non-edible leguminous seeds of *Dioclea reflexa*, with the physicochemical characterisaion of their oils.

Materials and Methods

Materials

The two seeds (edible and non-edible) were obtained locally from herb sellers at Bisi

market in Ado-Ekiti, Ekiti State. They were identified at the Herbarium Section of the Department of Plant Science, Ekiti State University as ***Dioclea reflexa***. The seeds were sun-dried, screened to remove undesirable materials such as stones and other impurities, after which they were dehulled, milled into powder and the powder kept in an air-tight polythene bags.

Methods

The proximate analysis of the two samples *i.e.* moisture, crude fat, fiber, protein and ash were determined using the methods described by[6]. The protein content was determined using micro-kjeldhal method (N × 6.25) and the carbohydrate was calculated by difference. The calorific values were obtained by multiplying the carbohydrate, protein and crude fat by the Alwater factors of 17, 17 and 37 respectively[7].

Using the method described by[6]. The ash of each sample was 5ml of 2M HNO_3 and heated to dryness on a heating mantle. 5ml of 2M HNO_3 was added again, heated to boil and filtered through a Whatman No 1 filter paper into a 100ml volumetric flask. The filterate was made up with distlled H_2O. Calcium, potassium and sodium was determined using Jenway Digital Flame photometer (PFP7 model), while other minerals apart from phosphorus were determined using Buck Scientific atomic absobtion spectrometer (BUCK 210VGP model). The phosphorus in the sample filterate was determined by using Vanadomolybdate reagent at 470nm using colorimetric method[7] (Colorimeter SP20, Baush and Lamb).

The phytochemical screening and the anti-nutrients of the crude extracts of the seed samples of *Dioclea reflexa* which revealed the presence of phlobatannins, saponins, steroids, cardiac glycosides, alkaloids and flavonoids for the phytochemical screening and tannin, phytic acid, cyanide and oxalate for the anti-nutrients were conducted using the methods described by[8,9,10,11].

The amino acids determination was by the method of [12]. 5.0g of the samples were defatted with 30ml of petroleum spirit in a 250ml conical flask. The defatted samples were hydrolysed using 30ml of deionised water and were analysed for amino acids using Gas Chromatography.

Their oils were obtained from the seeds by solvent extractioin with the soxhlet apparatus using food grade ane. The chemical properties of the *Dioclea reflexa* seed oils were determined by the standard methods of[13].

Results and Discussion

Proximate

The proximate composition of the two seeds of *Dioclea reflexa* is presented in Table 1 and it indicated that the seeds varied significantly in thier nutrient contents and the estimated available energy values. The crude protein contents for both seeds were higher (edible; 21.89 ± 0.01%, non-edible; 23.39 ± 0.08%) when compared with other edible leguminous seed flours such as 7.11 ± 0.02% for *Hexalobus crispiflorus*, 10.81 ± 0.25% for *Clitandra togolana* as reported by[14], 10.38 ± 0.08% and 16.52 ± 0.79% for Guinea peanut(*P. glabra)*

and African oak seed (*A. africana)* flours respectively as reported by[15] and also to 4.0 ± 6.0% of *Amaranthue cruentus*, a vegetable reported by[16], 19.74% for brown pigeon pea seeds as reported by[17], 16.91% for castor seeds reported by[18] and 10.81 ± 0.28% for dehulled seeds of *Pterygota marcocarpa* as reported by[19]. However, the concentrations are relatively lower compared to the 35.9% reported by[20] for calabash seeds, 43.1% for luffa cylindrical kernel[21], 27.9% for African locust bean[22], 26.20 ± 0.40%, 24.46 ± 0.32%, and 24.13 ± 0.31 for jack bean, pigeon pea and cowpea seed flours respectively[23] and 23.7- 30.8% for gourd seed[24]. Nevertheless, the edible seed sample is a good source of protein for human consumption. The values obtained for the moisture content and the associated dry matter of the seeds (11.72 ± 0.13% and 87.98 ± 0.56%, 12.58 ± 0.09% and 87.68 ± 0.47% for edible and non-edible respectively) varied significantly with those obtained for castor, jack bean, pigeon pea and cowpea, African oak and Guinea peanut, *Pterygota macrocarpa*, *Hexalobus crispiflorus* and *Clitandra togolana* seeds as reported by[14,15,19,23]. The moisture and dry matter contents of these two seeds are therefore not too suitable for an increase shelf-life of the seeds and seed-products, and would not be susceptible to microbial attack for a reasonable period of storage time. The fat content of the seeds, edible and non-edible may be too low to provide the daily total energy requirement which is about 6.07g, with the edible seed containing 2.31 ± 0.34% and non-edible seed, 2.20 ± 0.03%. Hence, the seeds are not a veritable source of fat and oil both potential domestic and industrial usage respectively. Although, these values are extremely low as compared to 74.40 ± 0.57% of *Pterygota macrocarpa*[19], 36.91% of castor seeds[18], 35.86±0.41% of *Hexalobus crispi-florus*[15], 43.2% of calabash kernel[25], 23.5% for soya bean seed[26]. However, these values are higher than 1.95 ± 0.04% for jack bean[23]. The carbohydrate contents of the edible and non-edible seeds; 56.22 ± 0.12% and 51.83 ± 0.21% respectively are both higher than that of groundnut flour; 31.5% [27] , African oak (*A. africana*; 45.92 ± 0.72%) and African locust bean; 41.10% [22], although, the edible seed serves as a better source of carbohydrate compared to the non-edible. The metabolizable energy value of 1413KJ/100g and 1360KJ/ 100g calculated for the sample showed that *Dioclea reflexa* is a concentrated source of energy within the recommended dietary allowance for children[28]. However, the result of the edible *Dioclea reflexa* seeds significantly vary with that of [14] who reported the nutritional adequacy of the same sample with a proximate composition of 9.02 ± 0.01% moisture, 90.98 ± 0.01% dry matter, 13.81 ± 0.20% crude protein, 8.18 ± 0.16% crude fibre, 8.30 ± 0.30% crude fat, 3.11 ± 0.16% ash and 1507KJ/100g total energy.

Mineral Composition :

Generally, minerals from plant sources are less bio-available than those from animal sources[29]. As shown in Table 2, the mineral composition and concentrations of non-edible seeds in terms of sodium (Na), potassium (K), magnessium (Mg), phosphorus (P), zinc (Zn), iron (Fe) and manganese (Mn) are higher than those of edible seeds. Calcium is only high in edible compared to non-edible, which is important

Table-1. Proximate composition of *Dioclea reflexa* (Edible and Non-Edible)seeds

Proximate composition(%)	EDIBLE	NON-EDIBLE
Crude protein	21.89 ± 0.01	23.39 ± 0.08
Crude fat	2.31 ± 0.34	2.20 ± 0.03
Crude fibre	3.40 ± 0.06	4.71 ± 0.08
Ash	4.47 ± 0.54	5.30 ± 0.02
Moisture	11.72 ± 0.13	12.58 ± 0.09
Carbohydrate	56.22 ± 0.12	51.83 ± 0.21
Dry matter	87.98 ± 0.56	87.68 ± 0.47
Available Energy[a] (KJ/100g)	1413	1360

[a]Calculated metabolisable energy (KJ/100g sample)= (Protein × 17 + %Fat × % Carbohydrate × 17)

for strong bones and teeth formulation. However, the Ca/P ratio was found to be 4.82 which very rich and the Na/K was found to be 17.61 which is equally good for effective health utilization in the edible seeds. In animals, a Ca/P ratio above 2.0 helps to increase the absorption of calcium in the small intestine. Food is considered "good" if the ratio Ca/P is >1 and "poor" if <0.5[30,31]. The recommended Na/K ratio is 0.6 and for edible seeds of Dioclea reflexa, it is 17.61 which is grossly at variance for healthy diet, and therefore will provide manifestation of high blood pressure.

Table 2. Mineral composition of *Dioclea reflexa* (Edible and Non-Edible)seeds

Minerals	EDIBLE	NON-EDIBLE
Sodium, (%)	0.898 ± 0.00	0.921 ± 0.02
Potassium, (%)	0.051 ± 0.00	0.068 ± 0.00
Magnesium, (%)	0.440 ± 0.00	0.458 ± 0.01
Calcium, (%)	0.246 ± 0.01	0.231 ± 0.02
Phosphorus (%)	0.292 ± 0.00	0.319 ± 0.01
Zinc (mg/kg)	64.050 ± 0.21	64.950 ± 0.35
Iron (mg/kg)	6.835 ± -0.21	7.275 ± 0.09
Manganese (mg/kg)	7.685 ± 0.57	7.780 ± 0.51

Phytochemical Screening :

The phytochemical screening conducted on the crude extracts of the seeds of edible and non-edible *Dioclea reflexa* revealed the presence of phlobatannin, saponin, steroid, cardiac glycosides, alkaloid and flavonoids in Table 3. They are known to exhibit medicinal activity as well as physiological activity[32]. Steroidal compounds are of importance and interest in pharmacy due to their relationship with such compounds as sex hormones[33]. Flavonoids have been shown to have antibacterial, anti-inflammatory, antiallergic, antimutagenic, antiviral, antineoplastic, anti-thrombic and vasodilatory activity[34]. The potent antioxidant activity of flavonoids, their ability to scavenge hydroxyl radicals, superoxide anions and lipid peroxy radicals may be the most important functions of flavonoids[34]. Various studies have shown that saponins although non-toxic can generate adverse physiological responses in animals that consume them. They exhibit cytotoxic effect and growth inhibition against a variety of cell making them have anti-inflammatory and anticancer properties. They also show tumor inhibiting activity on animals[35]. From the phytochemical result, the presence of secondary plant products in the seeds of the non-edible *Dioclea reflexa* that are biologicallyimportant *e.g.* saponins and flavonoids contributes to its medicinal value thus they can be potential sources of useful drugs.

Table 3. Phytochemical constituent of *Dioclea reflexa* (Edible and non-Edible)seeds

Phytochemical	EDIBLE	NON-EDIBLE
Phlobatannin	0.013 ± 0.00	0.028 ± 0.00
Saponin	0.222 ± 0.01	0.260 ± 0.01
Steroid	0.006 ± 0.00	0.013 ± 0.00
Cardiac glycosides	0.022 ± 0.00	0.041 ± 0.00
Alkaloids	0.635 ± 0.00	0.687 ± 0.01
Flavonoids	0.006 ± 0.00	0.011 ± 0.00

Anti-Nutrients :

Table 4 presents the results of the anti-nutrients found in the crude extracts of the edible and non-edible seeds of *Dioclea reflexa.* Tannins, phytic acid and oxalate are signifcantly low in both seeds but are higher in the non-edible ones. The presence of antinutritional factors is one of the major drawbacks limiting the nutritional and food qualities of legumes[36]. Tannins have been claimed to affect adversely protein digestibility[37] by forming complexes with protein[38] and carbohydrates[38], a high consumption may be hazardous. At about 0.036%, the tannin content of the edible seeds of *D. reflexa* is very low and can be assumed to be non-toxic. This value and that of non-edible (0.046%) seeds were lower than 13.3% cashew nut, 19.1% fluted pumpkin[39], 7.0% hulled seed of *P. macrocarpa* [19], 7.00 ± 0.04% and 7.33 ± 0.02% of whole and dehulled seeds of *Pterygota macrocarpa*[19], 3.53% guinea peanut (*P. glabra)* and 2.67% African oak

(*A. Africana*[15]. It is apparent from this study that non-edible seeds of *D. reflexa* recorded higher antinutrient compositions than the edible seeds. However, the extremely high level of cyanide (22.75mg/kg) in the non-edible seeds may account for its non-edibility but the level of cyanide in edible seeds (4.78mg/kg) is considerably low to be considered as toxic.

Table 4. Anti-Nutrients of *Dioclea reflexa* (Edible ad Non-Edible) seeds

Anti-Nutrients	EDIBLE	NON-EDIBLE
Tannin (%)	0.036 ± 0.00	0.046 ± 0.00
Phytic acid (%)	0.163 ± 0.01	0.273 ± 0.01
Cyanide (HCN) (mg/kg)	4.780 ± 0.01	22.745 ± 0.37
Oxalate (%)	0.091 ± 0.01	0.154 ± 0.00

Physico-chemical Characterization of the seed oils :

Generally, oils are lighter than water. Some however, are heavier than water especially those which contain higher amounts of oxygenated constituents of the aromatic series[40]. Table 5 revealed that specific gravity, peroxide value and refractive index values of the edible seeds are greater than those of the non-edible, while the non-edible seeds are only greater in saponification, iodine, acid and unsaponifiable values. Most popular plant oils have specific gravity ranging from 0.9100 to 0.9400 and specific gravity of 0.92 is considered a pretty good one for any cooking oil [41]. Some authors have stated that the specific gravity suitable for edible oils range from 0.8114 to 1.0714 [42] and for oils used for fuel from 0.87136 to 1.0714[43]. These specific gravities range, compared to those of current study in Table 5 indicate that crude oils from the two species of *Dioclea reflexa are* in the range of common cooking oils in regards of their specific gravities values (0.8714 to 0.9314). For fuel, oils that are denser contain more energy. The refractive index for that of edible is fairly higher than that of the non-edible because of its appearance which looks more concentrated than the non-edible. In the current results, the acid value of non-edible (0.980 ± 0.04) is greater than the edible (0.900 ± 0.03), revealing one of the reasons the edible seeds are safer and better in consumption than the non-edible ones. However, compared to other seed oils, both the non-edible and edible seeds are far lower; *T. vogelii, P. macrophylla, C. grandiflora* and *M. arboreus* with acid values 3.72, 5.31, 5.03 and 4.39 respectively [44] with their acidities close to that of crude palm oil as studied by[45]. Thus, the low acid value makes them suitable for soap making[46]. The minor substances of the oil contained in unsaponifiable matter have antioxidant and other health benefits in animals and in human subjects and useful in softening the skin[47, 48,49]. Being compared to coconut oil and groundnut oil, cotton seed, palm and sunflower seed oils studied by[50]; they are more than four times greater. Many edible oils have saponification value between 193 and 200[51]. The edible seeds of *Dioclea reflexa* have value that is within this range, while that of non-edible is evidently found outside the range. The peroxide value of the edible seeds is very high and it is highly oxidized oil, therefore the oils are generally unacceptable for the presence of odour and flavour in their contents[51].

Table 5. Physicochemical properties of *Dioclea reflexa* seeds (Edible and Non-Edible)

Properties	EDIBLE	NON-EDIBLE
Specific gravity (30°C)	0.9145 ± 0.01	0.9131 ± 0.01
Saponification value (mg/KOH/g of oil)	195.01 ± 1.88	206.090 ± 3.11
Peroxide value (meq/kg)	11.060 ± 0.08	10.125 ± 0.04
Iodine value (g /100g of oil)	108.980 ± 2.35	113.880 ± 1.98
Acid value(mg KOH/g of oil)	0.900 ± 0.03	0.980 ± 0.04
Unsaponifiable matter (%)	5.865 ± 0.06	6.200 ± 0.08
Refractive index (30°C)	1.4656 ± 0.00	1.4648 ± 0.00

Amino acid Concentration :

In the result of amino acid analysis from Table 6.1, in both edible and non-edible seeds, glutamate (Glu) had the highest value of 12.78g/100g and 10.13g/100g respectively and tryptophan (Trp) had the least value of 0.25g/100g and 0.18g/100g respectively. The Glu value of the two samples followed the same trend reported for both fermented and unfermented cocoa nibs[52] and oil seeds[24]. The glutamate values for both the edible and non-edible seeds are higher than *limoclaria spp.* (1.01g/100g) but are lower compared to *Archachatina maginata* (14.4g/100g) and seeds of Mucana puriens ver puriens 14.11g/100g[53]. From Table 6.1, the total amino acids (TAA) were 73.228/100g and 84.495g/100g for edible and non-edible seeds respectively. These values were lower to those reported for the seeds of mucana puriens (92.43g/100g)[53] but higher than that reported in fermented cocoa nibs (70.8g/100g)[52].

Table 6.1. Amino acid composition of *Dioclea reflexa* seeds (Edible and Non-Edible)

Amino acids	Concentration (g/100g)	
	Edible	Non-Edible
Glycine	4.39	7.94
Alanine	3.16	7.23
Serine	2.34	4.78
Proline	2.13	3.23
Valine *	3.83	7.17
Threonine *	2.41	3.84
Isoleucine *	3.83	4.83
Leucine *	6.63	6.58
Aspartate	8.76	7.96
Lysine *	4.38	4.81
Glutamate	12.78	10.13
Methionine *	1.05	1.14
Phenylalanine *	3.78	4.48
Histidine *	2.20	3.10
Arginine *	6.54	4.91
Tyrosine	3.07	1.97
Tryptophan *	0.25	0.18
Cystine	1.69	0.23

*Essential amino acids

The total non-essential amino acid (TNEAA) in Table 6.2 for both seeds (edible and non-edible) was 38.328g/100g and 43.474g/100g respectively. The TNEAA was 52.34% and 51.45% for edible and non-edible seeds respectively meaning that it formed the bulk of the amino acid. The total essential amino acid (TEAA) with histidine which were 34.900g/100g and 41.021g/100g for edible and non-edible seeds which were lower compared to melon oil seeds (53.44g/100g)[24] but were higher compared to 22.69g/100g *B. sapida*[55]. The TEAA without histidine were 32.705g/ 100g and 37.919g/100g (edible and non-edible respectively). However, for the edible, the %TNEAA was 52.34% while the %TEAA was 47.66% (with histidine) and 44.6% (without histidine). This shows that the protein of the edible seeds of *D. reflexa* is still higher in quality compared to those of soyabean, cowpea[54] and pigeon.

Table 6.2. Summary of the calculated essential, non-essential, acidic, basic, neutral, total sulphur and aromatic amino acids (g/100g) of *Dioclea reflexa* seeds (Edible and Non-Edible).

Amino acid	(g/100g)	
	Edible	Non-Edible
Total amino acid (TAA)	73.22782	84.49508
Percent total amino acid (% TAA)	100	100
Total non-essential amino acid (TNEAA)	38.32812	43.47412
Percent total non-essential amino acid (% TNEAA)	52.34093	51.4500
Total essential amino acid (TEAA)	34.89969	41.02096
Percent total essential amino acid (%TEAA)		
Total essential amino acid (TEAA) with Histidine	47.660	48.550
Percent total essential amino acid (%TEAA) with Histidine	34.89969	41.02096
Total essential amino acid (TEAA) without Histidine	47.660	48.550
Percent total essential amino acid (%TEAA) without Histidine	32.70483	37.91856
Total neutral amino acid (TNAA)	44.66	44.88
Percent total neutral amino acid (%TNAA)	38.57487	53.58331
Total acidic amino acid (TAAA)		
Percent total acidic amino acid (%TAAA)	52.68	63.42
Total basic amino acid (TBAA)	21.53236	18.08863
Percent total basic amino acid (%TBAA)	29.40	21.41
Total sulphur amino acid (TSAA)	13.12058	12.82214
Percent total sulphur amino acid (%TSAA)	17.92	15.18
Total aromatic amino acid (TArAA)	2.74481	1.36810
Percent total aromatic amino acid (%TArAA)		
	3.75	1.62
	7.10636	6.62094
	9.70	7.84

In Table 6.3, the %cystine for edible seeds in the TSAA of *D. reflexa* was 61.59%. While many animal proteins viz; rat, chick and pig have been reported to have a proportion of about 50%[55]; it is known that cystine can spare part of the requirements for methionine,[56] does not however give any indicatioin of the proportioin of total sulphur amino acid that can be met by cystine. The edible seeds of *D. reflexa* will effectively be applicable in this type of function based on the high proportion of %cystine in the TSAA in the seed. Total neutral amino acid (TNAA) was 52.68% and 63.42% for edible and non-edible respectively which indicate that the acids made up bulk of the amino acid. The total acidic amino(TAAA) for edible was 29.40%, higher than that of non-edible, which was the second most concentrated class, while the sulphur amino acid (TSAA) was 3.75%. For edible (2.745g/100g) which was the least concentrated class. This value is also greater than that of non-edible seeds.

Table 6.4 contains the essential amino acid scores based on whole hen's egg amino acid profile for both edible and non-edible of which arginine proved to be highest when scored in the edible, while histidine was the highest when scored for the non-edible seeds.

Table 6.4. Essential amino acid whole hen's egg scoring pattern of *Dioclea reflexa* seeds (Edible and Non-Edible)

Amino acid	Whole hen's egg (g/100g)	EDIBLE (g/100g)	Sample score	NON-EDIBLE (g/100g)	Sample score
Lysine	6.2	4.38269	0.71	4.80966	0.78
Histidine	2.4	2.19486	0.91	3.18240	1.29
Arginine	6.1	6.54303	1.07	4.91008	0.80
Threonine	5.1	2.40438	0.47	3.83565	0.75
Valine	7.5	3.83261	0.51	7.16458	0.96
Methionine	3.2	1.05419	0.33	1.13512	0.35
Isoleucine	5.6	3.82614	0.68	4.83172	0.86
Leucine	8.3	6.62545	0.80	6.57853	0.79
Phenylalanine	5.1	3.78198	0.74	4.47635	0.88

Conclusion

This work demonstrated that the edible seeds are rich in carbohydrate, protein including essential, neutral and non-essential amino acids and some minerals but low in anitinutrients and phytochemicals, and therefore eulogizes its edibility and potential use in food formulation as a good source of dietary energy. On the contrary, the non-edible seeds proved poisonous from the dangerously high amount of cyanide it contain, despite its nutritional adequacy. However, it has also revealed the potential medicinal and therapeutic uses from the phytochemicals it contained.

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