Variations in the Nutritional and Anti-Nutritional Properties of Eight Accessions of Jute (*Corchorius olitorius*) Seeds

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ABSTRACT

Background: *Corchorus olitorius is an underutilized indigenous vegetable in Nigeria and it is characterized by high mineral and vitamin contents. The leaves and fresh fruits are traditionally used for making soup; however, little or no utility is placed on the dried seeds. Determination of the nutritional quality of the dried seeds will enhance its utilization potentials, both for human and as ingredients in animal feeds.*

Objective: *The study evaluated the chemical compositions of eight accessions of C. olitorious dried seeds.*

Methods: *Dried seeds of eight accessions of C. olitorious collected from research farm of the Department of Crop Science, University of Nigeria, Nsukka were analyzed for proximate, anti-nutrient, mineral and vitamin contents using standard analytical procedures. Experimental procedures followed a completely randomized design (CRD) replicated three times. Data were subjected to ANOVA in CRD using GENSTAT statistical software.*

Results: *Accession influenced some proximate, anti-nutrient, mineral and vitamin contents of the seed. Accession Ka-2 had more moisture content (5.75%). Accession Ik-1 yielded more protein (9.85%), cyanide (43.10 mg/100 g), phenol (55.90 mg/100 g) and Lycopene (0.600 mg/100 g). Oxalate was more in Ik-3 with 47.80 mg/100 g. Accession Ib-2 gave the highest phytate (20.32 mg/100 g) and β-Carotene (0.70 mg/100 g). Concentration of tannin was more (1.43 mg/100 g) in accession Ib-3. Iron was more in Ka-1 (0.32 mg/100 g). Zinc was more pronounced (2.18 mg/100 g) in accession Ib-1.*

Conclusion: *Differences in nutritional qualities as reported could guide the utility of the crop and suggest possibility for genetic improvement.*

Keyword: *Corchorus olitorius, accessions, chemical composition*

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INTRODUCTION

Jute (*Corchorus olitorius*), an underutilized indigenous vegetable food crop in Nigeria belongs to the family Tiliaceae. It is an annual herb cultivated in the tropics for the viscosity of its leaves; it can reach a height of 2 to 4 m (1). The fruit has numerous seeds enclosed in it.

The common names of this plant species are bush okra, Jew's mallow and jute mallow (2). In

Nigeria, jute is called 'Ahihara' in Igbo, 'Ewedu' in Yoruba and 'Malafiya' in Hausa (3). The fruits are made into soup comparable to Okra and used for eating starchy balls made from millet, cassava and yam.

The leaves contain β-Carotene, calcium, iron, protein, fibre, riboflavin, vitamin B9, vitamin C and antioxidant properties (4). The leaves also have appreciable quantities of proximate and mineral contents (5). Report by Zakaria et al. (6) established that aqueous extracts of the seeds have peripheral, anti-inflammatory and anti-pyretic activities. Seeds of C. *olitorius* are utilized as demulcent, diuretic, purgative and are also used to treat chronic cystitis. The leaves are used in treating gonorrhea as well as toothache (7, 8). Fibres from the bark are used for weaving bags, net, textile production and production of absorptive fibre for surgical dressings (9).

Report of Dube et al. (10) established differences in chemical compositions of C. *olitorius* leaves collections. Earlier studies as reported by Stevens et al. (11) found variation in vitamin contents in Moringa seeds grown in Nsukka. Isuosuo et al. (12) determined the nutritional properties of 14 accessions of C. *olitorius* seeds and thus, established sufficient genetic variability in the seeds. Accession is a distinct, uniquely identified sample of seeds of plants, that is maintained as part of a germplasm collection (The U.S National Plant Germplasm System (13). As noted by Opabode and Adebooye (14), few germplasms of Jute have been collected and evaluated.

The underutilization of C. *olitorius* seed is probably associated with poor knowledge of its nutritional potentials. The seeds are majorly used for propagating the plant; otherwise they are wasted or neglected (Oloye et al. (15). Generally, seeds serve as a major source of food due to their caloric and nutritive values (16). Matsufuji et al. (17) opined that seeds could serve as raw materials for industries. There is however, limited information on nutritional compositions of C. *olitorius* seeds especially, as influenced by accessions. Thus, this study evaluated the chemical compositions of eight accessions of C. *olitorius* seeds to unravel their nutritional potential.

MATERIALS AND METHODS

Experimental site: The field experiment was conducted at the Department of Crop Science Teaching and Research Farm, Faculty of Agriculture, University of Nigeria, Nsukka (07 ^{o}29' N, 06 ^{o}51' E and 400 m above sea level), Enugu State, Nigeria from August - November 2021.

Collection of *C. olitorious* germplasm: Seeds of C. *olitorious* were sourced from Kabba/Bunu Local Government Area (LGA) of Kogi State, Ikole LGA of Ekiti State and Yewa South LGA of Ogun State, Nigeria. Eight accessions sourced thereof were planted in a germplasm garden at the Department of Crop Science experimental field and named as shown on Table 1. Dried seeds extracted from the eight accessions were analyzed for proximate, anti-nutrient, mineral and vitamin contents at Simuch Scientific Analytical Laboratory, Nsukka. The experiment was arranged in a completely randomized design (CRD) and replicated three times.

Table 1: List of accessions showing State, Local Government Areas and collection centers in Nigeria and acronyms used in the study

S/N	State	LGA	Specific location	Acronyms
1	Ekiti	Ikole	Ikole	Ik-1
2	Ekiti	Ikole	Ikole	Ik-2
3	Ekiti	Ikole	Ikole	Ik-3
4	Kogi	Kabba/Bunu	Kabba	Ka-1
5	Kogi	Kabba/Bunu	Kabba	Ka-2
6	Ogun	Yewa South	Ibese	Ib-1
7	Ogun	Yewa South	Ibese	Ib-2
8	Ogun	Yewa South	Ibese	Ib-3

Proximate Analysis

Proximate contents were analyzed as recommended by Association of Official Analytical Chemists (AOAC) (18). Ash was determined by weighing 2 g of the sample into a silica dish and placed in a muffle furnace set at 600C for 3 hours till a white greyish matter was obtained. The amount of residual white greyish matter was obtained by difference. The crude fat content was determined by Soxhlet extraction with petroleum ether as solvent and crude fibre content by the acid and alkaline digestive methods. Moisture content was determined using 5 g of the ground sample, dried to a constant weight at 600C in a hot air circulating oven. The moisture was calculated as the difference in weight after drying. Crude protein in the samples was determined by the routine micro Kjeldahl procedure/technique. The carbohydrate content was estimated by difference (subtracting the sum of moisture, protein, fat, crude fibre and ash percentages from one hundred).

Anti-nutrient Analysis

Anti-nutrients were analyzed as recommended by Harborne (19). Oxalate, phenols, saponin and phytate were determined using spectrophotometer (752P) at wavelengths of 490, 425, 720 and 520 nm, respectively. Concentration of tannin and cyanide were detected using UV-VIS spectrophotometer at a wavelength of 720 and 520 nm, respectively.

Mineral Determination

The official method of AOAC (18) was adopted for the mineral analysis of the samples. Two grams of each ground sample was weighed into a silica dish, then placed in a muffle furnace and heated at 600C for three hours, allowed to cool in a desiccator and weighed. The samples were dissolved with HCl and prepared for reading using atomic absorption spectrometry (AAS). Calcium, iron, potassium and zinc were determined using atomic absorption spectrometer (AA-7000) and absorbance read at 422.7 kk-nm, 248.3 kk-nm, 766.5 kk-nm and 213.9 kk-nm wavelength respectively.

Vitamins analysis

Vitamins were determined following the analytical procedure of AOAC (20). -Carotene was determined by weighing 2.0 g of sample into a set of conical flasks. The sample was saponified, extracted with 10 ml of xylene-kerosene mixture, shaken for 30 minutes and centrifuged at 500 rpm for 25 minutes. The supernatant was run on the spectrophotometer at 328 nm and 460 nm respectively. Spectrophotometer (Spectronic 21D) was employed at a wavelength of 560 nm to determine vitamin C. Vitamin B9 and lycopene were determined using Spectrophotometer (752P) and absorbance read at 560 and 450 nm, respectively.

Statistical analysis

ANOVA was performed on triplicates data collected using GENSTAT (21) statistical software following procedures outlined for CRD. Means were separated using Duncan's Multiple Range Test at a 5% level of probability.

Results

Effect of accessions on proximate traits of C. olitorious seeds as shown in Table 2 indicated no significant variation ($p > 0.05$) on ash, carbohydrate, fat and fibre but moisture and protein varied significantly. Accession Ka-2 exceeded others with respect to concentration of moisture (5.75%), although this value was at par with 4.83, 4.75, 4.57 and 4.38% obtained in accessions Ka-1, Ik-1, Ib-1 and Ib-2, respectively. The least moisture content (2.63%) was recorded in the seeds of Ik-3. Interestingly, Ik-1 yielded more protein (9.85%) which was statistically similar to 9.31, 8.32, 8.31 and 7.77% obtained in accessions Ik-3, Ib-3, Ib-2 and Ik-2, respectively; Ka-1 had low (6.57%) protein content.

Table 3 shows that accessions significantly ($p < 0.05$) influenced cyanide, oxalate, phenol, phytate and tannin contents of C. olitorious seeds but saponin did not vary statistically. Accession Ik-1 possessed the highest cyanide and phenol with respective values of 43.10 and 55.90 mg/100 g. Accession Ib-2 and Ib-3 had the least cyanide and phenol content of 14.80 and 12.10 mg/100 g, respectively. Oxalate was highest in Ik-3 with

Table 2: Effect of accessions on proximate qualities (%) of *C. olitorious* seeds

Accessions	Ash	CHO	Fat	Fibre	Moisture	Protein
Ik-1	6.14^{a}	74.24^{a}	5.01^{a}	0.02^{a}	4.75^{a}	9.85^{a}
Ik-2	7.62^{a}	75.75^{a}	5.75^{a}	0.01^{a}	3.13^{c}	7.77^{a}
Ik-3	6.00^{a}	75.79^{a}	6.25^{a}	0.01^{a}	2.63^{d}	9.31^{a}
Ka-1	7.00^{a}	76.87^{a}	4.76^{a}	0.01^{a}	4.83^{a}	6.57^{d}
Ka-2	8.50^{a}	73.46^{a}	5.00^{a}	0.02^{a}	5.75^{a}	7.33^{b}
Ib-1	7.57^{a}	75.84^{a}	5.00^{a}	0.02^{a}	4.57^{a}	7.01^{c}
Ib-2	6.89^{a}	73.48^{a}	6.94^{a}	0.01^{a}	4.38^{a}	8.31^{a}
Ib-3	4.88^{a}	77.65^{a}	5.75^{a}	0.01^{a}	3.38^{b}	8.32^{a}

Ik-1 (Ikole 1), Ik-2 (Ikole 2), Ik-3 (Ikole 3), Ka-1 (Kabba 1), Ka-2 (Kabba 2), Ib-1 (Ibese 1), Ib-2 (Ibese 2) and Ib-3 (Ibese 3). CHO–carbohydrate. Means followed by the same letter in each column are not significantly different at 5% level of probability.

Table 3: Effect of accessions on anti-nutrient contents (mg/100 g) of *C. olitorious* seeds

Accessions	Cyanide	Oxalate	Phenol	Phytate	Saponin	Tannin
Ik-1	43.10^{a}	37.30^{a}	55.90^{a}	12.00^{c}	3.88^{a}	0.76^{c}
Ik-2	22.40^{e}	46.50^{a}	39.40^{b}	12.68^{b}	3.06^{a}	1.39^{a}
Ik-3	29.70^{c}	47.80^{a}	24.20^{e}	9.39^{e}	3.89^{a}	1.42^{a}
Ka-1	21.70^{f}	40.70^{a}	35.30^{d}	9.85^{d}	4.38^{a}	1.07^{a}
Ka-2	25.40^{c}	20.30^{b}	20.80^{f}	16.96^{a}	6.69^{a}	0.84^{b}
Ib-1	30.40^{b}	30.40^{a}	37.20^{c}	6.62^{g}	3.24^{a}	0.60^{d}
Ib-2	14.80^{g}	43.90^{a}	17.40^{g}	20.32^{a}	4.42^{a}	1.04^{a}
Ib 3	24.00^{d}	32.20^{a}	12.10^{h}	8.73^{f}	3.76^{a}	1.43^{a}

Ik-1 (Ikole 1), Ik-2 (Ikole 2), Ik-3 (Ikole 3), Ka-1 (Kabba 1), Ka-2 (Kabba 2), Ib-1 (Ibese 1), Ib-2 (Ibese 2) and Ib-3 (Ibese 3). Means followed by the same letter in each column are not significantly different at 5% level of probability.

47.80 mg/100 g, for this trait, accession Ik-2 (46.50 mg/100 g), Ib-2 (43.90 mg/100 g), Ka-1 (40.70 mg/100 g), Ik-1 (37.30 mg/100 g), Ib-3 (32.20 mg/100 g) and Ib-1 (30.40 mg/100 g) were all at par but differed statistically from Ka-2 (20.30 mg/100 g). Highest value for phytate (20.32 mg/100 g) was obtained in seeds of accession Ib-2, although the value recorded here was not statistically different from 16.96 mg/100 g recorded in seeds of Ka-2 accession. Concentration of tannin was more (1.43 mg/100 g) in accession Ib-3 which was statistically the same with 1.42, 1.39, 1.07 and 1.04 mg/100 g recorded from accessions Ik-3, Ik-2, Ka-1 and Ib-2, respectively. Accession Ib-1 had the least phytate and tannin with respective values of 6.62 and 0.60 mg/100 g.

Among the mineral contents studied, iron and zinc were significantly ($p < 0.05$) affected by accession while calcium and potassium were not different statistically (Table 4). Iron content (0.32 mg/100 g) in the seed of C. olitorious was more concentrated in accession Ka-1, which was closely followed by Ib-2 and Ka-2 with 0.29 mg/100 g, respectively. The least value for iron (0.23 mg/100 g) was obtained in the seeds of accession Ib-1. Zinc was more pronounced in

Table 4: Effect of accessions on mineral contents (mg/100 g) of *C. olitorious* seeds

Accessions	Calcium	Iron	Potassium	Zinc
Ik-1	127.5[a]	0.24[d]	10.43[a]	1.78[c]
Ik-2	125.0[a]	0.24[d]	12.47[a]	1.85[b]
Ik-3	118.8[a]	0.26[b]	10.54[a]	1.72[e]
Ka-1	118.1[a]	0.32[a]	12.99[a]	1.74[d]
Ka-2	108.1[a]	0.29[a]	18.06[a]	2.03[a]
Ib-1	128.1[a]	0.23[e]	13.63[a]	2.17[a]
Ib-2	120.6[a]	0.29[a]	14.55[a]	1.74[d]
Ib-3	113.4[a]	0.25[c]	15.12[a]	1.68[f]

Ik-1 (Ikole 1), Ik-2 (Ikole 2), Ik-3 (Ikole 3), Ka-1 (Kabba 1), Ka-2 (Kabba 2), Ib-1 (Ibese 1), Ib-2 (Ibese 2) and Ib-3 (Ibese 3). Means followed by the same letter in each column are not significantly different at 5% level of probability.

Table 5: Effect of accessions on vitamin contents (mg/100 g) and Lycopene of *C. olitorious* seeds

Accessions	B_9	Vitamin C	β-Carotene	Lycopene
Ik-1	2.78[a]	24.06[a]	0.07[b]	0.60[a]
Ik-2	3.44[a]	26.60[a]	0.06[c]	0.42b
Ik-3	2.59[a]	21.88[a]	0.06[c]	0.32[d]
Ka-1	2.18[a]	17.66[a]	0.04[e]	0.47[a]
Ka-2	2.96[a]	19.51[a]	0.07[b]	0.40[c]
Ib-1	2.11[a]	20.12[a]	0.05[d]	0.42[b]
Ib-2	1.99[a]	22.51[a]	0.70[a]	0.42[b]
Ib-3	1.89[a]	16.54[a]	0.05[d]	0.40[c]

Ik-1 (Ikole 1), Ik-2 (Ikole 2), Ik-3 (Ikole 3), Ka-1 (Kabba 1), Ka-2 (Kabba 2), Ib-1 (Ibese 1), Ib-2 (Ibese 2) and Ib-3 (Ibese 3). B_9 – vitamin B_9. Means followed by the same letter in each column are not significantly different at 5% level of probability**.**

accession Ib-1 with 2.17 mg/100 g but similar with 2.03 mg/100 g from accession Ka-2. However, Ib-3 accession had the least zinc content (1.68 mg/100 g).

As shown in Table 5, accession asserted significant ($p < 0.05$) influence only on - Carotene and lycopene but vitamin B9 and C were statistically similar. -Carotene (0.70 mg/100 g) was more deposited in accession Ib-2, the least value (0.04 mg/100 g) was recorded in accession Ka-1. Accession Ik-1 had the highest amount of lycopene (0.60 mg/100 g), although statistically similar with 0.47 mg/100 g recorded in Ka-1 while Ik-3 gave the least value of 0.32 mg/100 g.

Discussion

Proximate contents: Only moisture and protein varied with accession, this finding corroborates those of Stevens *et al*. (11) who reported minute variation in nutrient contents of 10 accessions of *Moringa oleifera* seeds in Nsukka. However, variations reported could be associated with both genetic and environmental variables. Accession Ik-1 (sourced from Ikole) that had more protein (9.85%) could be a good source of protein for human and animal consumption. Baiyeri and Samuel-Baiyeri (22) reported lower ash (2.43%), carbohydrate (9.29%), fat (0.19%) and protein

(3.45%) in C. *olitorious* seeds when compared with the results obtained in this current study, however, fibre (1.76%) and moisture (89.30%) reported were higher than the values obtained in this work. The ash (5.09%) and carbohydrate (21.99%) contents reported by Oloye *et al.* (14) in *C. olitorius* seed flour were lower than the values found in this study. Contrarily, they recorded higher crude fat (32.95%), crude fibre (6.60%) and crude protein (28.05%), but their observed moisture content (5.32%) can be compared to the value obtained in Ka-2. Akinhanmi *et al.* (23) recommended ash content of 1.00-2.50% in livestock feed. The *C. olitorious* seeds could be valuable in feed formulation. Fats aid the absorption of fat-soluble vitamins and yielding higher amount of energy (24). Carbohydrates provide energy and they minimize the wastage of proteins (25). As documented by Ishida *et al.* (26), intake of dietary fibre lowers cholesterol level, reduces the risk of developing heart diseases and breast cancer. Low moisture content of seeds ensures longer shelf life (27). Proteins boost the immune system, replace worn out tissues, promote cell division and growth (28).

Anti-nutrients: The phenol content (5.95 mg/g) as reported by Ijarotimi *et al.* (29) in *C. olitorious* seeds was lower than the values recorded in this study but their values for phytate (64.49 mg/g) and saponin (38.77 mg/g) were higher than those obtained in this work. However, their seed tannin (0.86 mg/g) was comparable with the values recorded in this study. Olagbemide and Alikwe (30) reported lower cyanide of 0.05 mg/100 g in moringa seeds but they found higher phytate (113 mg/100 g), tannin (30.00 mg/100 g) and saponin (10.00 mg/100 g) than the values reported in this work. Their oxalate content (38.33 mg/100 g) appeared comparable to the values recorded in this current study. In contrast to the results obtained in this work, Malgorzata *et al.* (31) reported high phenol value (122.60 mg/100 g) in *Viper bugloss* seed. The phenol, oxalate, phytate and saponin compositions of all the accessions of *C. olitorius* seeds were above the tolerable limits of 2% (32), 5.00% (33), 0.03% (34) and 0.20% (35), respectively. Interestingly, tannin content was within the tolerable limit of 3.3% as reported by Elfadil *et al.* (36) and could act as phytochemical. Since the seeds are not consumed raw, the anti-nutrient contents may be reduced to the minimum during cooking process. Zafar *et al.* (37) reported that poisonous effect of anti-nutrients in food samples could be reduced by boiling in water, which increases their palatability. Plant phenols have the potential to reduce the risk of developing cancer (38). Saponins are known to contain antimicrobial and anti-inflammatory activities (39). Studies by Okwu and Emenike (40) revealed that tannins are useful in preventing cancer and healing ulcerated tissues. The variation in the concentration of anti-nutrient contents in this study could be linked to the prevailing climatic conditions in each location. Variability in soil nutrients and climatic conditions may influence concentration of anti-nutrients, which could also affect the antioxidant properties (41).

Minerals: Most of the mineral contents varied with accession probably due to genetic and environmental effects; Choudhary *et al.* (42); Acho *et al.* (43) reported similar results for *C. olitorious* species. The calcium, potassium and zinc contents in this work were evidently higher than 2.61%, 1.23% and 0.94 μg/100 g reported by Isuosuo *et al.* (12) in *C. olitorius* seed. However, their iron content (1.62 mg/100 g) was higher than the values recorded in this work. The results obtained for calcium in this present study were higher relative to the value (28.90 mg/100 g) reported by Oloye *et al.* (14) in *C. olitorius* seed flour. However, iron and potassium found in this study

were lower when compared to 0.90 mg/100 g for iron and 37.20 mg/100 g for potassium recorded in their work. Appreciable amount of calcium is beneficial, since calcium is required for growth as well as maintenance of bones, teeth and muscles (44). Iron deficiency results in anaemia and impaired growth and development in children. Zinc is necessary for growth and development (45). Potassium helps to synthesize protein and regulates blood pressure (46, 47). Consumption of *C. olitorious* species could address hidden hunger and micronutrient deficiencies (48).

Vitamins: The vvariability observed in vitamin contents in this work could be attributed solely to genetic differences since the accessions of C. olitorius were grown under the same agronomic condition. The findings supported earlier reports by Walker et al. (49) and Isuosuo et al. (12) with respect to vitamins in seeds of C. olitorius. The vitamin B9 obtained in this study varied from 1.89-3.44 mg/100 g, these values were comparatively higher than what was documented by Singh (50) (168.00 *µg/100 g) in cowpea seeds*. The appreciable amount of vitamin B9 in C. *olitorius* seeds could improve nutrition since humans depend on plant and animal sources (51). Vitamin B9 deficiency results to health issues like impaired cognitive function, neural tube defects, anaemia, cardiovascular diseases and cancer (52, 53). The values obtained for vitamin C and β-Carotene in this present study were relatively lower when compared to 0.88 and 2.83 mg/100 g, respectively reported by Isuosuo et al. (12) in C. *olitorius* seeds. Vitamin C value recorded in this work was relatively higher than 0.15% found by Stevens et al. (11) in Moringa seeds. β-Carotene value (0.96 µg/g) reported by Sahin et al. (54) in V. anatolica seeds was lower compared to the values obtained in this study. The accessions evaluated in this study exhibited high levels of vitamin C content. Interestingly, accession Ik-2 had the highest concentration of vitamin C (26.60 mg/100 g) effective to prevent scurvy. Humans and other species cannot produce vitamin C; they solely depend on vitamin C contained in diet. Daily intake of 6.50-10.00 mg of vitamin C can prevent scurvy (55). The lycopene content of the seed obtained in this study was lower compared to the range of 1.60-16.70 mg/100 g reported by Concha-Meyer et al. (56) in tomato seed. Kumar et al. (57) also reported higher lycopene values which varied from 0.75-1.20 mg/100 g in tomato seed. Lycopene has antioxidant property with the potential to sequester singlet oxygen and has the capacity to trap peroxyl radicals (58).

CONCLUSION

Distinct variations in chemical compositions of C. *olitorious* seeds across accessions suggested possibility of identification of high nutritional potential for selection and genetic improvement. Appreciable amount of carbohydrate, protein, fat, ash, calcium, potassium, vitamin B_9 and C were obtained in this study indicating that the seeds could be a potential source of nutritious food. Hence, the need for suggested inclusion of C. *olitorious* seeds in everyday meal thereby enhancing nutrition security. The seeds contained anti-nutritional factors except tannin which was within the tolerable limit but could be reduced to a minimal level during cooking.

Conflict of interest

The authors declare no conflict of interest.

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