Accession and amino acid composition and protein quality of jute (*Corchorus olitorius L.*) Seed

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ABSTRACT

Background: *Corchorus olitorius is a leafy vegetable with high nutritional qualities. The leaves and immature fruits are used in making soup. However, there is limited information on the utilization of the dry seed. Assessing the amino acid composition and protein quality of the seed could unravel its potential use in formulating functional foods for human and animal feed.*

Objective: *The study examined the amino acid composition and protein quality of eight accessions of C. olitorius dry seed.*

Methods: *Dry seed of eight accessions of C. olitorius were harvested from the Department of Crop Science Garden, University of Nigeria, Nsukka and analyzed for essential, non-essential amino acids and protein content using standard analytical procedures. The study was a completely randomized design (CRD) with three replicates. Data were subjected to ANOVA in CRD using GENSTAT statistical software.*

Results: *Accession had positive effect on all the essential, non-essential amino acids and protein content. Accession Ib-1 had the highest concentration of alanine, arginine, asparagine, glycine and norvaline with respective values of 20.63, 18.89, 21.08, 20.71 and 20.07 g/100g protein. However, highest protein content of 14.88 g/100g was attributed to accession Ik-3. Isoleucine (18.92 g/100g protein), leucine (21.07 g/100g protein), lysine (18.52 g/100g protein), methionine (20.46 g/100g protein), phenylalanine (17.14 g/100g protein), threonine (19.93g/100g protein), tryptophan (20.23 g/100g protein) and valine (18.91 g/100g protein) were more pronounced in the seed from Ib-1 accession.*

Conclusion: *Accessional variability inessential, non-essential amino acids and protein content could guide the utility of the crop and be useful for selection and breeding purposes.*

Keywords: *Corchorus olitorius* seed, accession, amino acid profile, protein

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INTRODUCTION

Jute mallow (*Corchorus olitorius*) is an indigenous plant species belonging to the *Tiliaceae* Family. It is an annual herb that is commonly cultivated and very popular among people of all classes in West Africa especially in Nigeria (1). The plant is known for it leaves, it also produces numerous fruits which are capsule like, cylindrical, straight or slightly curved in shape and can be 3 to 7 cm long and 2 – 4 cm in girth with many seeds(2). The fruit is usually green when fresh and dark brown when fully matured (2). *Corchorus olitorius* leaf and fruit have been a major component in the traditional diets of the rural dwellers (3, 4). According to Samuel *et al.* (5), the fresh fruits are used in making sauce known as Tànkèlèkàn among the Okun people of Kogi State, North central Nigeria. The slimy nature of the soup makes it suitable for easy consumption of starchy balls (6).

Protein content and amino acid composition depend on genotype and growing conditions (7).

Natural vegetable proteins are useful owing to their safety, high biocompatibility, nutritional value and low cost. Finding new vegetable proteins that are rich in essential amino acids is important for food and pharmaceutical industries (8). Different parts of this important vegetable crop are reported to be used for several medicinal purposes such as tonic, remedy for aches, stomach pains, diuretic, stimulation of appetite, laxatives, including anti-bacterial activities and in the management of diabetes mellitus (9, 10, 11, 12, 13, 14). Seeds of C. *olitorius* are utilized as demulcent, diuretic, purgative and are also used to treat chronic cystitis, fever and tumor (15). Fibres from the bark are used for weaving bags, net and textile production (16).

An accession is a group of related plant material from a single species that is collected at one time from a specific location (17).Dube *et al.* (18) reported accessional variation in chemical composition of C. *olitorius* leaves. Previous study by Isuosuo *et al.* (19)found sufficient genetic variability in the nutritional properties of 14 accessions of C. *olitorius* seed from Oyo State. According to Opabode and Adebooye (20), few germplasms of jute have been collected and evaluated.

Despite the nutritional and economic importance of C. *olitorius*, it has been neglected by scientific research and development in most regions. Although all parts of C. *olitorius* have been reported to be useful and in Nigeria, more attention seemed to be focused on the leaves for consumption. The seed of C. *olitorius* have generally been neglected and wasted, however, it is used mainly for propagating the plant(1). Seed serve as a major source of food for the populations due to their caloric and nutritive values (21). Matsufuji *et al.* (22) stated that seed could serve as raw materials for industries. Information from this study will be useful for food product developers and nutritionists for better utilization of C. *olitorius* seed. Thus, this study was conducted to evaluate the amino acid profile of C. *olitorius* as influenced by accession.

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 ^{0}29' N, 06 ^{0}51' E and 400 m above sea level), Enugu State, Nigeria from August - November 2021. The experimental site is characterized by sub-humid tropical conditions with bimodal annual rainfall distribution that ranges from 1155mm to 1955mm with a shift in the second peak of rainfall from September to October, a mean annual temperature of 29 and a relative humidity that ranges from 69% to 79% (23).

Collection of C. *olitorius* germplasm:Dry fruits of C. *olitorius* were sourced from three Local Government Areas (LGAs), namely Kabba/Bunu, Ikole, and Yewa South of Kogi, Ekiti, and Ogun States, respectively. The seeds were sourced from these locations owing to their availability at the time of collection. Eight accessions were collected from these LGAs, and were named according to the location of collection (Table 1).

Seed Extraction and Experimental Layout

Corchorus olitorius accessions were evaluated at the Department of Crop Science, University of Nigeria, Nsukka. The field experiment was laid out in a randomized complete block design (RCBD) with three replications. The dry fruits from the above experiment were harvested and broken manually to obtain the triplicate samples of the seeds used for the analysis. The seeds were packed in paper envelops and were labelled accordingly. The envelops were sealed, arranged in a carton and transported to Simuch Scientic Analytical Laboratory, Nsukka for amino acid profile analysis. The study was carried out as a completely randomized design (CRD).

Table 1: List of accessions and collection centres

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

Amino Acid Determination

The official method of AOAC (24) was adopted for the amino acid analysis of the samples. Five gram of the ground sample was weighed and dissolved with 50ml (50%) ethanol. Five ml of the resulting solution was taken into a test tube and 5 ml of Isobutanol and ninhydrin solution was added. The test tube was put in a beaker containing water and it was boiled for three minutes, allowed to cool to room temperature. Concentration of amino acid contents was determined by using Spectrophotometer (Labomed Spectronic 21D) and absorbance of samples was read at a wavelength of 545 nm for lysine, 530 nm for phenylalanine, 550 nm for threonine, tryptophan, alanine and asparagine. Similarly, absorbance for leucine and glycine were taken at 555 nm and methionine, valine, arginine, norvaline and Isoleucine were read at 560 nm.

Statistical Analysis

Following the procedure for completely randomized design (CRD), analysis of variance (ANOVA) was performed on triplicate data collected using GENSTAT (25) statistical software. Comparison of treatment means was conducted using LSD at 5% probability level where applicable.

RESULTS

The amino acid contents of the eight accessions of C. *olitorius* seeds in Table 2 showed a wide variability in the composition of non-essential amino acid (NEAA). It is pertinent to know that alanine, arginine, asparagine, glycine, norvaline were highest in accession Ib-1 with respective values of 20.63, 18.89, 21.08, 20.71 and 20.07 g/100g protein. However, protein was more concentrated in accession Ik-3 with 14.88 g/100g than others. The lowest alanine value (1.47 g/100g protein) was recorded in Ib-3. Accession Ik-1 gave the least arginine (1.21 g/100g protein) while Ik-3 yielded the lowest value (0.00 g/100g protein) for asparagine. Seed from accession Ik-1 had the least glycine, norvaline and protein.

Accessions significantly differed in isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan and valine ($P<0.05$) (Table 3). The most abundant essential amino acids in the C *olitorius* seed is leucine of 21.07g/100g protein, followed by methionine and tryptophan. Thelb-1 accession had the highest value of isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan and valine, while their least values was obtained in Ik-1. Similarly, Ib-3 accession had the least phenylalanine (0.00 g/100g protein).

The essential amino acids concentration in C. *olitorius* seed were compared with those recommended by FAO/WHO (25) as shown in Table 4. It was evident that the essential amino acid compositions of Ik-2, Ik-3, Ka-1, Ka-2, Ib-1, Ib-2 were relatively higher in all the traits assessed than the reference standard except for isoleucine, leucine, lysine, methionine, phenylalanine, threonine and valine in accession Ik-1. Furthermore, phenylalanine and valine contents were lower in accession Ib-3 in comparison with those recommended by FAO/WHO (26). The high content of essential amino acids in C. *olitorius* seed is favourable for its use as a substitution for meat-and-bone food/feed complementary weaning food.

Table 2: Accession and non-essential amino acid and protein content of *C. olitorius* seed(g/100g)

Accessions	Ala	Arg	Asp	Gly	Nov	Pro
Ik-1	15.70	1.21	1.75	6.33	1.28	6.13
Ik-2	16.72	15.43	15.27	15.23	14.33	11.39
Ik-3	9.75	10.14	0.00	9.96	10.24	14.88
Ka-1	17.15	17.14	17.57	14.46	15.84	11.38
Ka-2	1.47	14.15	11.95	13.95	14.28	11.40
Ib-1	20.63	18.89	21.08	20.71	20.07	10.51
Ib-2	14.51	10.15	13.42	14.36	10.63	13.14
Ib-3	8.28	3.79	8.17	7.43	4.45	7.02
F-lsd$_{(0.05)}$	0.03	0.04	0.06	5.96	0.05	0.02

Ala= Alanine; Arg = Arginine; Asp = Asparagine; Gly = Glycine; Norv= Norvaline; Pro = Protein.
Accessions: see Table 1 for full meaning of the acronyms used.

Table 3: Accession and essential amino acid profile of *C. olitorius*seed (g/100g protein)

Accessions	Iso	Leu	Lys	Met	Phe	Thr	Try	Val
Ik-1	1.27	1.91	1.27	0.00	0.00	1.24	1.17	1.27
Ik-2	15.52	16.91	14.46	16.13	12.25	15.61	16.01	15.45
Ik-3	10.04	10.46	10.22	10.61	8.19	9.51	9.60	10.14
Ka-1	15.67	15.04	15.56	15.67	13.07	15.46	15.84	17.13
Ka-2	14.27	14.81	14.18	14.03	12.18	11.69	11.67	14.17
Ib-1	18.92	21.07	18.52	20.46	17.14	19.93	20.23	18.91
Ib-2	9.25	13.20	10.68	14.48	10.97	14.77	14.22	10.17
Ib-3	3.11	8.87	6.81	3.75	0.00	7.75	7.66	3.79
F-lsd$_{(0.05)}$	0.04	0.01	0.06	0.03	0.02	0.03	0.18	0.032

Iso = Isoleucine; Leu = Leucine; Lys = Lysine; Met = Methionine; Phe= Phenylalanine; Thr = Threonine; Try = Tryptophan; Val = Valine. Accessions: see Table 1 for full meaning of the acronyms used.

Table 4. Comparison of amino acids in eight accessions of *C. olitorius*seed with FAO/WHOamino acids

EAA	FAO/WHO	Ik-1	Ik-2	Ik-3	Ka-1	Ka-2	Ib-1	Ib-2	Ib-3
Iso	3.00	1.27	15.52	10.04	15.67	14.27	18.92	9.25	3.11
Leu	5.90	1.91	16.91	10.46	15.04	14.81	21.07	13.20	8.87
Lys	4.50	1.27	14.46	10.22	15.56	14.18	18.52	10.68	6.81
Met	1.60	0.00	16.13	10.61	15.67	14.03	20.46	14.48	3.75
Phe	NR	0.00	12.25	8.19	13.07	12.18	17.14	10.97	0.00
Thr	2.30	1.24	15.61	9.51	15.46	11.69	19.93	14.77	7.75
Try	0.60	1.17	16.01	9.60	15.84	11.67	20.23	14.22	7.66
Val	3.90	1.27	15.45	10.14	17.13	14.17	18.91	10.17	3.79

Source: FAO/WHO (25), EAA-Essential amino acids, Iso = Isoleucine; Leu = Leucine; Lys = Lysine; Met = Methionine; Phe= Phenylalanine;Thr = Threonine; Try = Tryptophan; Val = Valine. NR- Not reported. Accessions: see Table 1 for full meaning of the acronyms used.

DISCUSSION

Non-essential amino acid and protein

The values for alanine, arginine and protein detected in this work were comparable to the values (4.22 g/100 g protein, 9.69 g/100 g protein and 10.24g, respectively) reported by Ijarotimi *et al*. (27) in C. *olitorius* seed flour. However, glycine value obtained in this present study was lower when compared with their value (3.70 g/100g protein). Alanine and glycine found in this current work were higher than those reported by Osunbade *et al*. (28) (2.89 and 0.39 g/100g protein, respectively) in the seed of African walnut flour, but arginine (7.08 g/100 g protein) falls within the range reported in this work. Similar to our finding, Udeonyia *et al*. (29) found an asparagine value of 1.90 g/100g protein in the seed of African walnut which is comparable to those recorded in this present study but alanine (0.88 g/100g protein) and glycine (2.28 g/100g protein) were relatively lower than what was found in this study. The alanine, arginine and protein obtained in this work were comparable to those documented by Esan *et al*. (30) in *Amaranthus cruentus* seed flour. Glycine value recorded in this work was higher compared with theirs (3.37 g/100g) in *Amaranthus cruentus*. However, the protein content recorded in this work was lower in comparison to their protein value (16.107%). Protein concentration in C. *olitorius* was lower compared with 35.96% in *D. microcarpum* and 33.09% in *B. monandra* seed as reported by Anhwange *et al*. (31). However, appreciable amounts of protein obtained in this work can be used as a blending food source to increase the

biological value of processed foods. This may impart health benefits or desirable physiological effects and can be used to develop new food products with beneficial components. These accessions showed crude protein contents that ranged between 6.13– 14.88g, which are higher than what is obtainable in most cereal crops. The values are higher than those recorded for buckwheat (12%) (32). This indicated that *C. olitorius* is a good source of protein to meet recommended daily requirement for humans. The high protein contents of the *C. olitorius* seed revealed their potential as protein supplements to improve protein quality in composite flour.

Essential amino acid

It has been established that variability existed in amino acid contents in the seed of *C. olitorius* accessions. Similar result was reported by Esan *et al.* (30) in Moringa seed. Contrarily, previous report of Udeonyia *et al.* (29) found minute variation in amino acid among accessions of African walnut. The differences in amino acid contents of the accessions could be linked to genetic and environmental factors. In the report of Bell *et al.* (33), environment rather than genetics, was more highly implicated in observed differences in amino acid composition of tested species. It is evident that *C. olitorius* contained high essential amino acids required to support infants and children growth. An appreciable amount of essential amino acid content was found in *C olitorius* seed with accession Ib-1 yielding more in comparison to others. All the essential amino acid values obtained herein appeared comparable to those of Ijarotimi *et al.* (27) and Esan *et al.* (30)in *C. olitorius* and *Amaranthus cruentus* seed flour. Similarly, lysine, phenylalamine, leucine, isoleucine, methionine, valine, threonine and tyrosine found in this present work were comparable to what was reported by Anhwange *et al.* (31) (3.21, 4.24, 5.74 4.01, 1.00, 3.05, 3.03 and 2.37 g/100g protein) in the seed of *Moringa oleifera*. The amino acid composition of *C. olitorius* seed confirmed that, the plant is a good source of amino acids. The relatively high content of essential amino acids in *C. olitorius* seed is favourable for its use as a substitution for meat-and-bone food/feed complementary weaning food. The amino acid analysis is a method that can be used to determine the quality and content of proteins contained in a food component. Isoleucine helps in development and repair of muscles, development of hemoglobin and acts as energy regulator. Its deficiency results in ailments like leucine deficiency (34). Lysine ensures the adequate absorption of calcium, help the formation of collagen, in addition it aids the production of antibodies, hormones and enzymes. Lysine deficiency may result in tiredness, inability to concentrate, irritability, bloodshot eyes, retarded growth, hair loss, anemia and reproductive problems (35). Leucine is responsible for regulating the blood sugar concentrations, growth and repairs of muscles/tissues, hormone production, wound healing and energy production. Its deficiency causes dizziness, headaches, fatigue, depression, confusion, irritability and hypoglycemia in infants (31). Phenylalanine is another essential amino acid that is used by the brain to produce norepinephrine (a chemical that transmits signals between the nerve cells and the brain). It keeps the body alert and reduces hunger pains. It is an antidepressant and helps in improving memory and its deficiency could result in slow growth, liver damage, and skin lesions (36). Threonine concentrations are considered to be high when compared to the World Health Organization protein standard (37). Threonine is necessary in the body because, it produces antibodies, prevent fat buildup in liver and assist metabolism and assimilation (31). It is an important constituent of collagen, elastin and enamel protein. Its deficiency has been associated with skin disorders and weakness (36). Methionine as a supplier of sulphur, which prevents disorders of hair, skin and nails. It prevents arterial fat buildup, regulate ammonia formation and creates ammonia free urine which reduces bladder.

CONCLUSION

The study indicated variability in the eight accessions of *C. olitorius* seed with respect to amino acid profile and protein content. This suggests that selection is possible and the differences could guide the utility of the crop.

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