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Evaluation of the Minerals, Proximate, Viscosity and Antinutrients of the Fruits of *Corchorus olitorius* Accessions

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ABSTRACT— In spite of the huge nutritional benefits *of Corchorus olitorius* leaves, documented knowledge and information on the food value, viscosity, nutritional and anti-nutritional contents of its fruits are scarce in the literature. Fresh and tender fruits of five *Corchorus olitorius* accessions were analysed for their minerals, proximate composition, viscosity and antinutrients in order to unravel their nutritional and anti-nutritional compositions thereby creating awareness about their dietary potentials. Results showed that the proximate, minerals, viscosity and antinutrients in the fruits were significantly ($p<0.05$) affected by accessions. The potassium was in the range of 485.0-647.5 mg/100 g, iron 4.62-7.22 mg/100 g, calcium 738.2-1187.5 mg/100 g, zinc 4.06-4.14 mg/100 g, copper 0.20-0.23 mg/100 g, magnesium 105.75-113.85 mg/100 g, manganese 1.74-4.48 mg/100 g and phosphorus 46.25-73.60 mg/100 g. The fresh *Corchorus* fruits were comparably lower in antinutrients than what has been found in most of the commonly consumed vegetables. Pearson's correlations among proximate qualities and minerals showed that crude protein showed a positive and significant ($p<0.01$) correlation with zinc (0.92**). Dry matter had a very strong significant and positive correlations with carbohydrate (0.95***) and manganese (0.79*). Calcium showed significantly positive correlations with zinc (0.68*), iron (0.76*) and potassium (0.62*). Magnesium showed a very strong and significantly positive correlations with zinc (0.77***) and phosphorus (0.93***). Results revealed fresh *Corchorus olitorious* fruits are more nutrient-dense than the leaves and seeds. The results have revealed *Corchorus olitorius* fruits are low in fat, calories and antinutrients are nutrient-dense and could help in combating malnutrition, especially micronutrient deficiencies.

KEYWORDS: *Corchorus olitorious*, fruits, viscosity, nutrient-dense, micronutrients

1. INTRODUCTION

Corchorus olitorius is a nutrient-dense and multipurpose leafy green vegetable that is grown and consumed in the tropical and sub-tropical regions of the world. *Corchorus olitorius* is cherished for its huge food, nutritional and nutraceuticals and economic and especially its high adaptation to varying climatic and edaphic conditions. Its leaves have been found to have high micronutrients, antioxidants, vitamins, phenolic compounds and protein [8], [17], [1], [10] and low in anti-nutrients [4]. The leaves of *Corchorus olitorius* are consumed in Japan, India, Malaysia, the Philipines, Sudan, Egypt, Bangladesh [15], Nigeria and most of the Central, West and Southern African Countries.

This vegetable has been reported to have numerous medicinal values that include its anti-diabetic, anti-bacterial and anti-pyretic activities [29], [20], [14], [11]. In ethno-medicine, *Corchorus olitorius* leaf is recommended in the treatment of anaemia possibly because of its high iron content. Its fibre is referred to as

jute fibre and used as raw materials in the manufacture of absorptive fibre for surgical dressings [5]; and the production of textiles, nets and sacks [23].

In spite of its numerous uses of *Corchorus olitorius*, [16] referred to it as a neglected and underutilized leafy green vegetable in Nigeria. Due to the potential benefits they offer, formerly underutilized and neglected crops are now being researched for use in nutrition and medicine [9]. The large quantities of *Corchorus olitorius* fruits produced as the crop reaches maturity are left to dry while the seeds burst open from the dry pods. Consumers of this vegetable in many parts of the world including some parts of Nigeria are not aware of that the tender fruits of *Corchorus olitorius* are edible and have food food value. Its fresh and tender fruits is used as an ingredient in the preparation of viscous soups; prepared especially by the Bunu and Ijumu people of Nigeria. In some parts Kwara State Nigeria, *Corchorus olitorius* leaf is cooked with its tender fruits to give a very viscous local delicious soup. Information on the nutritional and anti-nutritional composition of *Corchorus olitorius* fruits are scanty in the literature. There is currently no published information on the viscosity of the fruits. The earlier nutritional studies on *Corchorus olitorius* fruits used one cultivar in their studies [17], [22]. The inference that would have been drawn on the variability with respect to the nutritional and anti-nutritional contents of the fruits would have been limited with the analysis of fruits from one cultivar. The biochemical analysis of *Corchorius olitorius* fruits from a number of cultivars has the potentials of unraveling the variation (diversity) in the analyzed cultivars with respect to its nutritional quality and anti-nutrients. This study was therefore initiated to investigate the proximate, minerals, viscosity and anti-nutrients in the fruits of five *Corchorus olitorius* cultivars in order to ascertain their potentials for food and nutrition. The findings from this research will be useful in creating awareness about the nutritional potentials of *Corchorus olitorius* fruits, which could enhance its utilization.

2. MATERIAL AND METHODS

2.1 Sample Collection

The fresh and tender fruits (pods) of *Corchorus olitorius* used for this study were collected from a field trial on the evaluation of *Corchorus olitorius* accessions using N:P:K 15:15:15 fertilizer. The trial was located at the Faculty of Agriculture, Federal University, Oye-Ekiti, (FUOYE), Nigeria in 2021. The collected samples were immediately taken to the laboratory where the biochemical analyses were carried out.

2.2 Proximate analysis

Proximate analysis was carried out using the AOAC [7] method. Crude protein was determined using Kjeldahl AOAC method (955.04). Moisture contents of fresh *Corchorus olitorius* fruits were determined using the oven drying AOAC method (930.15). Crude fat content of the fresh fruits was analysed using the acid hydrolysis AOAC method (954.02). The ash contents of the fresh fruits were determined the dry ashing AOAC method (920.117). Crude fibre analysis was carried out using AOAC method (978.10). The carbohydrate concentration in the fresh *Corchorus olitorius* fruits was calculated as follows: Carbohydrate in the *Corchorus* fresh fruits = 100% - (%moisture + % protein + % fat + % ash + fiber)

2.3 Mineral analysis

Mineral analysis was done using AOAC [7] method 968.08. Metal concentrations in the digested fresh *Corchorus* fruit samples were determined using a Buck Scientific Atomic Absorption Spectrophotometer (Model: 210VGP) at various wavelengths of the metals and using specific cathode lamps of each metals. Sodium and Potassium were determined with flame photometer (Model: FP10) Quantification of the metals was based upon calibration curves of standard solutions of metals. Blanks were included in each batch of analysis and certified reference standards were used to assess the accuracy of the analytical method.

2.4 Determination of the Viscosity of fresh Corchorus fruits

Five grams (5 g) of the blended fresh fruits were added to 100 ml of the distilled water and thoroughly stirred in a beaker. The viscosity of each of the samples was determined using viscometer machine.

2.5 Anti-nutrient determination

Pyhtic acid contents of the fresh *Corchorus* fruit were determined by the method of Davis and Reld as modified by Abulude [2]. Tannin was determined using Amorim [6] method. Saponin was determined using the Obdoni and Ochuko (2001) analytical method. Oxalate content was determined in the fresh fruits using AOAC [7] method 915.03.

2.6 Statistical analysis

All data collected were analyzed using the R statistical analysis package version 4.1.1. The analysis of variance (ANOVA) was done using the library Agricolae, the significance of the treatment means (determined by the Fisher's least significant difference (F-LSD)) at 5% probability level) and the Pearson's correlation analysis using the library; Hmisc (was done to understand the strength of relationships that existed among the proximate qualities and minerals studied in the fresh fruits of the Corchorus olitorius accessions were carried out using R package.

3. RESULTS AND DISCUSSION

3.1 The proximate composition of the fresh fruits of Corchorus olitorius accessions

The results of the proximate composition of *Corchorus olitorius* accessions are found on Table 1. All the proximate parameters were significantly ($p<0.05$) influenced by accession except crude fibre. The crude protein contents of the fruits analysed in the accessions varied from Co-Ekiti (2.63%) to Co-Osun (3.45%). Fruits of Co-Osun were significantly ($p<0.05$) higher in their crude protein contents than the fruits in the rest of the accessions. The fruits in the accessions were generally low in their crude fat contents. Fruits of Co-Oyo (0.12%) recorded the least crude fat while fruits of Co-Osun (0.19%) was significantly (($p<0.05$) higher than the fruits in the rest of the accessions. *Corchorius olitorius* fruits in Co-Ekiti (2.43%) and Co-Oyo (1.93%) were significantly higher in their ash contents than the rest of the accessions. Fruits of Co-Osun (1.23%) were the least in their ash content. The moisture and dry matter of the fresh fruits analysed in the accessions showed inverse relationship. Fruits of Co-Ondo (89.30%) that recorded the highest moisture content had the least dry matter content (10.70%) while Co-Lagos (84.89%) with the least moisture content had the highest dry matter content (15.11%). The carbohydrate content of the fruits ranged from Co-Lagos (9.26%) to Co-Osun (4.52%). Co-Osun was significantly ($p<0.05$) lower in their carbohydrate content than the rest of the accessions. The crude fibre contents of the *Corchorus olitorius* fruits ranged from Co-Ondo (1.76%), followed closely by Co-Oyo (1.71%) to Co-Ekiti (1.44%). The results of the proximate composition in the fruits of the *Corchorus* accessions analysed in this study fell within the range of what has been reported for fruit vegetables by Titchenal [25] and similar to the findings of Samuel [22]; although the protein contents of the fruits analysed in this study were higher than the 1.58% they have reported in their study. The crude protein content of the fruits of Co-Osun almost doubled what they have reported in the fruits of the accession they analysed. These results are comparable with the proximate composition of okra fruits (pods) reported by Varmudy [28], although the crude protein recorded in the *Corchorus olitorius* fruits in this study is higher than what he has reported. The Crude protein contents of the fruits in this study were comparable to what has been reported in *Corchorus olitorius* leaves by Choudhary [10].

Table 1. Proximate composition (%) of the fresh fruits of *Corchorus olitorius* accessions

Accession	CP	Fat	Ash	Moisture	Dry matter	Carbohydrate	Fibre

Co-Ekiti	2.63	0.16	2.43	86.18	13.83	7.57	1.44
Co-Lagos	2.64	0.14	1.45	84.89	15.11	9.26	1.63
Co-Ondo	2.22	0.17	1.38	89.30	10.70	5.54	1.76
Co-Osun	3.45	0.19	1.23	89.19	10.82	4.52	1.43
Co-Oyo	2.90	0.12	1.93	86.51	13.49	6.83	1.71
Mean	2.77	0.16	1.68	87.21	12.79	6.74	1.59
F-L $SD_{(0.05)}$	0.10	0.018	0.31	0.33	0.333	0.91	NS

NS= Non significant

3.2 The mineral composition of the fresh fruits of Corchorus olitorius accessions

The mineral composition of the fruits analysed in the accessions is shown in Table 2. Sodium varied from Co-Oyo (10.88 mg/100) to Co-Lagos (12.51 mg/100 g). Co-Osun (647.5 mg/100g) was significantly ($p<0.05$) higher than all the accessions in their potassium concentrations, followed closely by Co-Lagos (612 mg/100 g) while Co-Ekiti (485 mg/100 g) recorded the least potassium content. The iron contents analysed in the *Corchorus olitorius* fruits ranged from Co-Lagos (4.62 mg/100 g) to Co-Osun (7.22 mg/100 g). Calcium concentration was highest in the fruits of Co-Oyo (1187.5 mg/100 g) followed closely by Co-Osun (1087.5 mg/100 g) while Co-Ekiti (738.2 mg/100 g) recorded the least calcium content. Zinc concentration analysed in the *Corchorus olitorius* fruits ranged from Co-Osun (4.14 mg/100 g), next to it was Co-Oyo (4.06 mg/100 g) while C0-Ondo (3.05 mg/100 g) had the least zinc content. Co-Osun (0.23 mg/100 g) also recorded the highest copper content while Co-Oyo (0.20 mg/100 g) had the copper concentration. Co-Oyo (113.85 mg/100 g) had the highest magnesium concentration, next to it were Co-Ekiti (113.00 mg/100 g) and Co-Osun (112.55 mg/100g). The manganese content analysed in fresh fruits of the *Corchorus olitorius* accessions ranged from Co-Ondo (1.74 mg/100 g) to Co-Ekiti (4.48 mg/100 g). The phosphorus concentration ranged from Co-Ondo (46.25 mg/100g) to Co-Osun (73.60 mg/100 g). The results of the minerals obtained in the analysis of the fresh fruits of the *Corchorus olitorius* accessions in this present study were higher than what has been reported for calcium, magnesium, potassium, manganese, iron and phosphorus [22]. Noteworthy are the very low sodium contents of the fruits analysed in this study which were lower than the 40.21 mg/100 g of sodium they reported.

The results of the minerals in our study were higher than that what have been reported for these minerals in dried *Corchorus olitorius* leaves and seeds [17], [16]. Suggesting, that fresh *Corchorus olitorious* fruits are more nutrient-dense than the leaves and seeds. Co-Osun fruits had the highest concentrations of iron, zinc, potassium, phosphorus and sodium. It ranked the second and third in calcium and manganese concentrations. This suggests Co-Osun could be an excellent parent for the improvement of these minerals in the fruits. One-half of the world's population suffers from extremely dangerous levels of micronutrient malnutrition, particularly children, women of reproductive age, pregnant women, and nursing mothers in underdeveloped nations [26]. The results have revealed that *Corchorus olitorius* fruits are loaded with various micronutrients and minerals that could help in combating micronutrient deficiencies.

Table 2. Mineral composition (mg/100 g) of fresh fruits of Corchorus olitorius accessions

Accession	Na	K	Fe	Ca	Zn	Cu	Mg	Mn	P
Co-Ekiti	10.89	485.0	4.62	738.2	3.41	0.21	113.00	4.48	65.20
Co-Lagos	12.51	612.0	4.36	891.9	3.53	0.24	105.75	3.92	52.40
Co-Ondo	12.32	575.0	6.58	961.4	3.05	0.21	106.13	1.74	46.25
Co-Osun	12.41	647.5	7.22	1087.5	4.14	0.23	112.55	3.00	73.60
Co-Oyo	10.88	573.0	6.36	1187.5	4.06	0.20	113.85	3.11	68.05
Mean	11.8	578.5	5.83	973.3	3.64	0.22	109.28	3.25	61.1
F-$LSD_{(0.05)}$	0.152	13.132	0.20	13.72	0.10	0.03	2.481	0.13	1.24

Na = sodium K = potassium Fe = iron Ca = calcium Zn = zinc Cu = Copper Mg = magnesium Mn = manganese P = phosphorus

3.3 The viscosity of the fresh fruits of Corchorus olitorius accessions

The viscosity analysed in the fresh fruits of *Corchorus olitorius* accessions is shown in Table 3. The viscosity of the fruits was significantly ($p<0.05$) affected by accession. Co-Oyo (60.73 Pa-s), followed closely by Co-Ekiti (60.57 Pa-s) and were both significantly ($p<0.05$) higher than the rest of the accessions. Co-Osun (42.48 Pa-s) was the least viscous among the accessions. *Corchorus olitorius* is referred to as wild okra has been found in our study to contain viscous component which is also found in okra *Abelmoschus esculentus*. Okra's viscosity is caused by the abundance of glycans it contains [19] with the stringy, gum-like texture that is especially appreciated in soups [12]. The viscous (sliminess) nature of the fresh *Corchorus olitorius* fruits should make them of great food value and acceptable to vegetable consumers that cherish soups made from ingredients that have some levels of viscosity. Viscous soups are enjoyed by consumers because they enhance the consumption of certain solid foods called (swallow).

Table 3. Effect of accession on the viscosity (Pa-s) of *Corchorus olitorus* fresh fruits

Accession	Viscosity (Pa-s)
Co-Ekiti	60.57
Co-Lagos	54.80
Co-Ondo	43.47
Co-Osun	42.48
Co-Oyo	60.73
Mean	52.41
F-L SD $_{(0.05)}$	1.21

3.4 The anti-nutrient composition of the fresh fruits of Corchorus olitorius accessions

The results of the antinutrient composition of the fruits of the *Corchorus olitorius* accessions are found on table 4. The phytate concentrations in fruits were significantly ($p<0.05$) influenced by accession. Co-Osun (48.65 mg/100 g), Co-Ondo (48.45 mg/100 g) and Co-Lagos (48.45 mg/100 g) were significantly higher than the rest of the accessions in their phytate contents while the Co-Ekiti (39.55 mg/100 g) had the least concentration. Oxalate was significantly affected by accession and ranged from Co-Osun (60.89 mg/100 g) to Co-Ondo (69.36 mg/100 g). The *Corchorus olitorius* fruits analysed significantly ($p<0.05$) varied in their tannin concentration. Co-Oyo (153.10 mg/100 g) recorded the highest value for tannin while Co-Osun (127.75 mg/100 g) had the least tannin content. Co-Osun (70.35 mg/100 g) also had the least saponin content, followed closely by Co-Ekiti (71.53 mg/100 g) while Co-Lagos (83.25 mg/100 g) recorded the highest saponin content. The phytate, oxalate and saponin contents of the fresh *Corchorus olitorius* fruits in the present study were similar to the levels reported for these anti-nutrients in the fresh fruits by Samuel [22]. The anti-nutrients evaluated in this study are comparably lower than the 0.46-1.88% for oxalate, phytate and tannin reported in raw *Solanecio biafrae* and *Solanium nigrum* [3]. These results imply that the oxalate, saponin, phytate and tannin in *Corchorus olitorius* fruits are low and should make it acceptable for consumption. The fresh fruits of *Corchorus olitorius* are therefore recommended for dietary preparation for human consumption. Ajala [3] and Shita [24] have reported lowering effects of processing methods like steaming on antinutrients. Antinutrients are now used for health purposes [24]. There is currently proof that dietary phytate has key roles in preventing cancer, managing hypocholestrolemia, and preventing atherosclerosis when consumed in low doses [21].

Table 4. The antinutrient concentrations (mg/100 g) of the fresh fruits of *Corchorus olitorius* accessions

Accession	Phytate	Oxalate	Tannin	Saponin
Co-Ekiti	39.55	61.41	128.47	71.53
Co-Lagos	48.45	66.64	145.45	83.25
Co-Ondo	48.45	69.36	128.47	75.50

Co-Osun	48.65	60.89	127.75	70.35
Co-Oyo	46.20	64.27	153.10	72.39
Mean	46.26	64.51	136.65	74.60
$FLSD_{(0.05)}$	0.9075	0.2903	1.9214	1.5006

Table 5 shows the results of the Pearson's correlations among the proximate and minerals analysed in the fruits of *Corchorus olitorius* accession. Crude protein showed a positive and significant ($p<0.01$) correlation with zinc (0.92**), crude fat showed a significant ($p<0.05$) and negative relationship with dry matter (-0.68*) and carbohydrate (-0.64*). Ash showed a significant and negative relationship with sodium (-0.90**) and potassium (-0.89*). Dry matter showed a very strong significant and positive relationships with carbohydrate (0.95***), manganese (0.79*) but had a significantly negative correlation with iron (-0.87*). Carbohydrate showed a significant relationship with iron (-0.92**) and manganese (0.66*). Sodium was significantly correlated with potassium (0.75*) and magnesium (-0.66*). Calcium showed significantly positive relationships with zinc (0.68*), iron (0.76*) and potassium (0.62*). Magnesium showed a very strong and significantly positive relationship with zinc (0.77***) and phosphorus (0.93***). The significant and high positive relationships between the pair of the proximate qualities and the minerals suggest the possibility of their simultaneous improvements in *Corchorus olitorius* fruits. Appropriate crop management practices can simultaneously enhance any of the pairs of the nutritional parameters that were significantly and positively correlated. Falconer [13] noted that the extent of correlated response is a function of the heritability of the correlated traits. The correlation results have provided useful information that could influence the selection strategies and breeding plans for enhanced nutritional quality in *Corchorus olitorius* fruits.

Table 5. Pearson's Correlation coefficients among proximate qualities and minerals in the fresh fruits of *Corchorus oloitorus* accessions

CP	Fat	Ash	Moi	DM	CB	Fib	Na	K	Fe	Ca	Zn	Cu	Mg	Mn
1														
0.31	1													
-0.21	-0.38	1.00												
0.15	0.68*	-0.49	1.00											
-0.15	-0.68*	0.49	-1.00***	1										
-0.38	-0.64*	0.37	-0.95**	0.95***	1.00									
-0.49	-0.48	-0.14	0.04	-0.04	0.03	1.00								
0.03	0.48	-0.90	0.34	-0.34	-0.16	0.06	1.00							
0.52	0.24	-0.89*	0.32	-0.32	-0.32	0.07	0.75*	1						
0.42	0.39	-0.51	0.87*	- 0.87*	-0.92**	0.09	0.19	0.50	1					
0.49	-0.19	-0.43	0.35	-0.35	-0.48	0.30	0.04	0.62*	0.76*	1.00				
0.92 *	-0.05	-0.10	-0.01	0.01	-0.24	-0.28	-0.17	0.47	0.39	0.68*	1.00			
0.26	0.22	-0.51	-0.14	0.14	0.21	-0.13	0.66	0.52	-0.24	-0.17	0.08	1.		
0.72*	-0.09	-0.21	0.51	-0.08	-0.46	0.21	-0.66*	-0.18	0.06	0.22	0.77**	-0.17	1	
0.20	-0.20	0.61*	-0.79**	0.79*	0.66*	-0.53	-0.41	-0.41 -	0.76*	-0.53	0.18	0.20	0.55	1
0.88 *	0.16	0.24	0.05	-0.05	-0.33	-0.56	-0.43	0.07	0.31	0.36	0.86	-0.11	0.93**	0.37

CP = crude protein Fat = crude fat Ash= ash Moi = Moisture DM = dry matter CB = carbohydrate Fib = crude fibre Na = sodium K = potassium Fe = iron Ca = calcium Zn = zinc Cu = Copper Mg = magnesium Mn = manganese P = phosphorus

4. CONCLUSION

The results of this study have shown that fresh *Corchorus olitorious* fruits are more nutrient-dense than the leaves and seeds. The results have revealed that *Corchorus olitorius* fruits are low in fat, calories and antinutrients but loaded with various nutrients and minerals that could help in combating malnutrition and especially micronutrient deficiencies.

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