Evaluation of the Effects of Drying Methods on the Nutritional Composition of Jute Mallow (*Corchorus olitorius*) Fruits

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ABSTRACT

Background: *There are huge on-farm losses of Corchorus olitorius fruit due to poor awareness of its nutritional potentials. Postharvest losses of Corchorus fruit occur in Nigerian communities due to poor postharvest handling and lack of effective processing methods. There is need for a sustainable processing method that extends the shelf-life of Corchorus fruit without reducing its nutritional qualities.*

Objective: *This study investigated the effects of various drying methods on the nutritional composition of Corchorus fruit.*

Materials and methods: *Tender and fresh Corchorus fruits from a Corchorus evaluation field located at Ikole-Ekiti, Nigeria were collected. The fibrous points of attachment of the fruits to the plants were cut off. The oven dried, sundried, air dried and fresh Corchorus fruit samples were analyzed using standard laboratory procedures. The data from the laboratory analyses were subjected to analysis of variance using the R Statistical software.*

Results: *The vitamins, minerals and proximate composition of the Corchorus fruits were significantly ($P<0.05$) affected by the various drying methods. Sun drying resulted in the highest concentrations of vitamins B_3, B_5, B_6, C, and E and crude protein. Oven-dried samples had the highest concentrations of minerals (potassium, magnesium, calcium, zinc, iron, manganese and phosphorus) evaluated except sodium. Air dried Corchorus fruits had the highest concentration of ash and fibre. Fresh Corchorus fruits had the lowest concentration of all the nutritional parameters evaluated except vitamin B_1.*

Conclusion: *Sun-drying, air-drying and oven-drying can be used in extending the shelf-life of fresh Corchorus fruits without negatively affecting its nutritional qualities.*

Keywords: *Corchorus olitorius*, jute mallow, fruits, micronutrients, proximate

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INTRODUCTION

Corchorus olitorius popularly known as jute mallow, Jew's mallow or molokhia is an important green leafy vegetable with numerous dietary, nutritional, nutraceutical and economic advantages. Although, *Corchorus* is believed to have originated from Africa and Asia, the vegetable is cultivated and its edible parts are consumed in a number of countries in the continents of South America, Europe and Australia (1, 2). *Corchorus* has numerous phytochemicals in its leaf, flower and fruits. Ahmed et al. (3) noted that these phytochemicals include: micronutrients, macronutrients, and numerous bioactive compounds such as flavonoids, phenolic compounds, fatty acid, sterols, glycosides, tannins and saponins. These phytonutrients and especially the bioactive compounds present in the vegetable have been reported to have anticonvulsant, antihistamin, neuromodulatory, analgesic, antipyuretic, antibacterial, atopic dermatitis, wound healing, antioxidant, antidiabetic, gastro-protective effect, antitumor, anticancer and cardio-protective effects (4, 5, 2).

Earlier studies on *Corchorus olitorius* were mostly on the leaf. The fruits are rich in micronutrients, protein, fibre and its antinutrients are within safe levels (6, 7). Most people that consume its leaf do not know that

its tender fruits are edible (6). There are huge on-farm losses of *Corchorus olitorius* fruits due to poor awareness of its nutritional potentials, hence large quantities of its fruits are left to rot in the field (6). Postharvest losses of *Corchorus* fruits occur in some of the communities in Nigeria where they are known and consumed and this is due to poor postharvest handling and lack of effective processing methods. Chibuzo et al (8) noted that storing fresh fruits is the most preferred way of preserving their nutritional qualities but most of these storage methods require low temperatures which are quite difficult to come by along their supply chains. Drying is therefore, an effective postharvest management method in Nigeria and other sub-Saharan African countries where fuel prices and power outages make low temperature storage and distribution facilities scarce (9). About one-half of the global fresh produce is dried in order to improve their shelf-life thereby enhancing food security (10).

Corchorus olitorius fruits are used as soup ingredients either in their fresh or dry forms in Nigerian communities where they are commonly consumed. Documented researches on drying methods for enhanced nutritional qualities of *Corchorus fruits* are still scarce in literature. There is, therefore, need for efficient, low-cost and sustainable processing methods that can help to extend the shelf life of *Corchorus fruits* without negatively affecting their nutritional qualities. This could enhance the nutrition and livelihoods of the farming families especially the women that grow and sell them. Extending the shelf life of *Corchorus* fruits could in some way contribute to food and nutrition security among its consumers. This study was, therefore, carried out to investigate the effects of various drying methods on the nutritional composition of *Corchorus fruits*.

MATERIALS AND METHODS

Sample Collection and Preparation

The fresh *Corchorus* fruits used for the study were harvested from agronomic evaluation of *Corchorus olitorius* cultivars in 2023 using organic fertilizer. The trial was located at about two kilometers away from the Ikole Campus of the Federal University, Oye-Ekiti, Nigeria. Tender fresh fruits were sorted out from the harvested fruits and the fibrous point of attachment of the fruits to the *Corchorus* plants were trimmed off. The fruits were divided into four parts. Three parts were subjected to various drying methods (air drying, oven drying and sun drying) while the fresh fruit was analysed fresh. The air-dried sample was dried under a shade. Sun-dried sample was dried in an open sun. The oven-dried sample was dried in a forced air oven at 60^0C. The fresh and dried samples were analyzed using standard laboratory procedures.

Proximate analysis of the fresh and dried *Corchorus* fruits

The finely ground fresh and dried *Corchorus* fruits samples were analysed for some of the proximate qualities using the AOAC (16). Kjeldahl AOAC (955.04) technique was used to analyse the crude protein content of the samples. The dry ashing AOAC (920.117) method was used to determine the ash content of fresh and dried *Corchorus olitorius* fruits. The AOAC (978.10) method was employed in the determination of the crude fibre content of the fresh and dried *Corchorus fruit* samples.

Minerals analyses of the fresh and dried *Corchorus fruits*

The AOAC (16) (method 968.08) was used to analyze the minerals contents of the fresh and dried *Corchorus* samples. Using a Buck Scientific Atomic Absorption Spectrophotometer (Model: 210VGP) and particular cathode lamps for each of the minerals, the mineral concentrations of the digested dried and fresh *Corchorus* fruit samples were calculated. Sodium and potassium were measured using of a flame photometer (Model: FP10). Based on calibration curves of minerals standard solutions, the minerals were quantified. Each batch of analysis had blanks, and verified reference standards were used to evaluate the analytical method's precision.

Determination of the vitamin content of the fresh and dried Corchorus fruits

Finely ground samples of the *Corchorus* and were analyzed for vitamins. Vitamins A and E were analyzed using Pearson's method (11). Vitamin B_1 and B_3 were determined using Okwu and Josiah's method (12). Vitamin B_6 was assayed in the samples using Asma method (13). The vitamin C content was determined using the Benderitter's method (14). The vitamin K content of the sample was determined using Menotti's method (15).

Statistical analysis

Data were obtained on a dry weight basis for the dried fruit samples while data were obtained on fresh weight basis for the fresh fruit samples. The data obtained from the laboratory analyses were subjected to statistical analysis using the R software, version 4.1.1. The library Agricolae was used to perform the analysis of variance. The significance of

Table 1: The effect of drying methods on the proximate composition (%) of *Corchorus olitorius* fruits

Drying Methods	Crude Protein	Ash	Fibre
Fresh	6.160 [d]	1.46[d]	1.22 [d]
Air drying	8.38[c]	14.63[a]	7.15 [a]
Oven drying	12.38 [b]	12.66[b]	6.14 [b]
Sun drying	16.54[a]	12.50[c]	5.925[c]

Means followed by different letters are significantly different by a Tukey's HSD test at $\alpha = 0.05$.

Table 2. The effect of drying methods on the vitamin content (mg/100 g) of *Corchorus olitorius* fruits

Drying methods	Vitamin A	Vitamin B1	Vitamin B3	Vitamin B5	Vitamin B6	Vitamin C	Vitamin E	Vitamin K
Fresh	76.71[a]	91.055[a]	3.125[d]	76.34[d]	0.975[d]	444.72 [d]	168.640[d]	1.930[b]
Air drying	90.63[c]	87.695 [c]	6.250[c]	138.80[c]	1.245b[b]	805.00 [c]	590.240[b]	5.755[a]
Oven drying	88.07[b]	85.850 [d]	7.950 [b]	256.78[b]	1.225 [c]	906.33[b]	581.385[c]	1.625[c]
Sun drying	87.90[b]	89.210[b]	15.195[a]	305.36[a]	1.905[a]	1277.87[a]	610.900[a]	1.135[d]

Means followed by different letters are significantly different by a Tukey's HSD test at $\alpha = 0.05$

the treatment means was determined by the Tukey's HSD test at 5% probability level.

RESULTS

Proximate Composition

The proximate composition of the *Corchorus* fruits was significantly ($P<0.05$) influenced by the drying methods studied (Table 1). Air drying resulted in the highest concentration of ash and fibre in *Corchorus* fruits. Sun-dried fruits had the highest concentration of crude protein. The fresh *Corchorus* fruits consistently recorded the lowest ash, fibre and crude protein contents. Oven drying ranked second for the proximate composition of the Corchorus fruits. Crude protein was in the range of 6.16-16.54%, ash 1.46-12.5%, fibre 1.22-7.15% (Table 1)

All the vitamins analyzed in the fruits of *Corchorus olitorius* fruits were significantly ($p<0.05$) affected by drying methods (Table 2). Sun drying of the *Corchorus* fruits consistently resulted in the highest concentrations of vitamins B_3, B_5, B_6, C, and E. Air drying had the highest value for vitamins A. The highest vitamin B_1 content was obtained when the fruits were fresh. The fresh *Corchorus* fruits were significantly lowest in vitamins A, B_3, B_5, B_6, C, and E. Sun drying had the lowest vitamin K content while oven drying recorded lowest B_1 content. All vitamins analyzed were reported in in milligram per hundred grams (mg/ 100 g) of the samples. Vitamin A was in the range of 76.71-90.63, vitamin B_1 85.85-91.06, B_3 3.13-15.20, B_5 76.34-305.36, B_6 0.98-1.91, vitamin C 444.72-1277.87, vitamin E 168.40-610.90 and vitamin K 1.14-5.76 (Table 2).

Mineral Content

The micronutrients in the *Corchorus* fruits were significantly ($P<0.05$) influenced by the various drying methods evaluated in the study (Table 3). Oven drying consistently recorded the highest concentration of all the micronutrients (potassium, magnesium, calcium, zinc, iron, manganese and phosphorus) evaluated except sodium. Sodium concentration was highest in the sun-dried fruits. The fresh fruits recorded the lowest concentrations of all the minerals evaluated. Potassium in the fruit was in the range of 344-1675 mg/100 g, magnesium 124.30-521.100 mg/100 g, calcium 282-2425 mg/100 g, zinc 2.40-7.23 mg/100 g, copper 0.27-1.16 mg/100 g, iron 8.43-28.18 mg/100 g, manganese 6.09-18.75 mg/100 g, phosphorus 82.6-386.3 mg/100 g and sodium 12.80-66.61 mg/100 g

Table 3. The effect of drying methods on the mineral contents (mg/100 g) of *Corchorus olitorius*fruits

Drying Methods	Na	K	Mg	Ca	Zn	Cu	Fe	Mn	P
Fresh	12.80[d]	344 [d]	124.30[d]	282 [c]	2.40 [d]	0.27 [c]	8.430 [d]	6.09 [d]	82.6 [d]
Air drying	44.40 [c]	1244 [c]	344.85[c]	2152 [b]	6.39 [b]	1.13[a]	22.400 [c]	18.23[b]	284.1[c]
Oven drying	55.66[b]	1675[a]	521.10[a]	2425[a]	7.23[a]	1.16[a]	28.180 [a]	18.75[a]	386.3[a]
Sun drying	66.61[a]	1475 [b]	432.25 [b]	2150 [b]	5.55 [c]	0.96[b]	26.815 [b]	16.75[c]	325.3[b]

Means followed by different letters are significantly different by a Tukey's HSD test at $\alpha = 0.05$

DISCUSSION

The results of the present study have revealed that the nutrient composition of *Corchorus* fruit is largely and significantly influenced by the various drying methods. Sun drying has been the major drying method used in drying farm produce by both male and female farmers in most rural and agrarian communities in Nigeria, and especially in Kogi and Kwara States, Nigeria where *Corchorus olitorius* is majorly grown for its fruits. It was interesting to note that sun drying had the highest concentration of most of the vitamins. This implies that people who consume soups made from dried *Corchorus* fruits will have better nutrients in their diets than those than that consume soups made from the fresh fruits. All the dried samples analysed in the study were higher in their proximate composition than the fresh samples, indicating they had better crude protein, ash and fibre contents than the fresh fruits. This result agrees with Eze and Akubor (19) that recorded better crude protein and ash contents in the dried okra than the fresh okra samples analysed in their study.

Similar trends that were observed for the proximate composition, have also been observed for the vitamins and minerals of the *Corchorus* fruits. This was obvious in the very low concentration of the vitamins in the fresh *Corchorus* fruits except vitamin B_1 that had the highest concentration in the fresh fruits. This finding agrees with (17) that opined that reducing the moisture contents of food increases its nutrient concentration. Earlier reports (6, 7 and 21) on the nutritional contents of *Corchorus* fruit have shown that high moisture contents (84.95-89.50% moisture) have been associated with fresh *Corchorus* fruits. The low level of the nutrients obtained in the fresh fruit sample in the present study could have been due to the high moisture contents of the fresh fruits, since moisture and dry matter are usually negatively correlated.

The minerals with the exception of sodium were significantly highest in the oven-dried samples and were followed closely by the other drying methods indicates that soups and dietary preparations made from dried *Corchorus* fruits will be rich sources of micronutrients that could be helpful in enhancing the micronutrient nutrition of those that consume them. Considering the nutrient density of the dried *Corchorus* fruits, they are recommended as ingredient for dietary preparations. The results obtained for the minerals in the fresh sample agreed with what have been reported earlier for fresh *Corchorus* fruits by (6, 7 and 20). Although the fresh *Corchorus* fruits were lower in the micronutrients evaluated, it is worth mentioning that the fresh *Corchorus* fruits were higher in calcium, phosphorus, iron, and vitamins than fresh okra fruits recorded by (18).

There is already a well-developed market for dried *Corchorus* fruits in Kogi and Kwara States, Nigeria (6) where this leafy green vegetable is largely sold for its leaf and fruit. This has been a source of livelihood for farmers (especially the women) that grow, harvest and market them. It is, therefore, necessary to create awareness about the nutritional density of both fresh and dried *Corchorus* fruits in other parts of Nigeria and the world where *Corchorus* is grown majorly for its leaf and fibre. This study and the previous studies (6, 7) have proven that Corchorus fruits are edible and nutrient-dense

and could contribute significantly to food and nutrition security

CONCLUSION

The results of the study have revealed that sun drying, oven drying and air drying of *Corchorus* fruits resulted in higher concentrations of the crude protein, ash, fibre, magnesium, calcium, zinc, copper, iron, manganese, vitamins A, B_3, B_5, B_6, C, E and K in the dried fruits than the fresh samples of *Corchorus* fruits. Oven drying was best for micronutrient concentrations. Sun drying of the *Corchorus* fruits resulted in the highest concentrations of vitamins B_3, B_5, B_6, C, and E and crude protein. Air dried *Corchorus* fruits had the highest concentration of ash and fibre. Since there is market for dried *Corchorus* fruits, it is nutrient-dense and used in preparing soups; awareness should therefore be created about its nutritional and economic potentials. Hence the large quantities of *Corchorus* fruits that get rotten and underutilized in communities where only its leaf is consumed should be maximized to the nutritional and economic advantages of the farmers and especially the women farmers that grow and consume *Corchorus olitorius*.

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