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Full Length Research Paper

Effects of Age at Harvest on the Nutritional Compositions of (Jute) *Corchorus Oltorius L.* (Ewedu)

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Corchorus olitorius L. (Jute) is one of the leafy vegetables commonly consumed in Africa, it is a native plant of tropical Africa and Asia, and it is popularly used in soup preparation and folk medicine for the treatment of fever, chronic cystitis, cold and tumours. This research was conducted to determine the effects of maturity on the minerals, antioxidant, and anti-nutrient compositions of *Corchorus olitorius* leaves. The experiment was conducted at the Oke Ogun Polytechnic Saki by cultivating a garden for the leafy vegetables. It was planted in July and harvesting was done at three harvesting ages: 5, 7 and 9 weeks. Laboratory analysis was done on the air-dried edible portions using standard analytical methods. The highest values obtained for K, Na, Fe, Mg and Ca were 222.85mg/L at 5 WAS, 27.97mg/L at 5 WAS, 7.11mg/L at 9 WAS, 93.33mg/L at 9 WAS and 37.33mg/L at 9 WAS respectively. Only Na and K decreased with plant age at harvest while other minerals increased progressively. The antioxidant (total phenolic, flavonoid, vitamin A, E and B_2) level increased progressively with plant age (0.08 ± 1.0 - 4.09 ± 1.0mg/g) with flavonoid having the highest value (4.09mg/g at 7 WAS) and both vitamin E and B_2 possessed the lowest value (0.08mg/g at 5 WAS). The anti-nutrient concentrations of the leaves (mg/g) of dry matter shows the range of 0.19 ± 0.1 mg/g (as for tannin at 5WAS) – 5.25 ± 1.0 mg/g (as for phytate at 7WAS) with less significant differences anti-nutrient levels observed at different age at harvest. It was therefore concluded that plant age at harvest had a greater impact on the proximate, mineral and antioxidant compositions of *Corchorus olitorius* (jute) with no significant impact on the anti-nutrient levels.

Keyword: Maturation, minerals, antioxidant, anti-nutrient, concentration

INTRODUCTION

Jute (*Corchorus olitorius* L.) is an annual or biennial herb, erect, stout, branched, to 1.5 m high (Islam, 2013). Tossa and white jute varieties are thought to be native to Bangladesh and India, and are also the world's producer. It is used as an herb in Middle Eastern and African countries, where the leaves are used as an ingredient in a mucilaginous potherb called"molokhiya". It is very popular in some Arab countries such as Egypt, Jordan, and Syria as a soup-based dish. It is high in protein, vitamin C, beta-carotene, calcium, and iron. Along with white jute, tossa jute has also been cultivated in the soil of Bengal where it is known as paat from the start of the 19th century. Currently, Bangladesh is the only global producer of white jute variety, However the Bengal region (West Bengal in India, and Bangladesh) is the largest global producer of the tossa jute varieties (Anonymous, 2011).

Jute needs a plain alluvial soil and standing water. The suitable climate for growing jute (warm and wet) is offered by the monsoon climate, during the monsoon season. Temperatures from 20˚C to 40˚C and relative humidity of 70%–80% are favourable for successful cultivation. Jute requires 5–8 cm of rainfall weekly, and more during the sowing period (Islam, 2013).

Jute leaf is a unique plant part which is a rich source of many chemical compounds and plays an important role in the national and international market. Jute leaves now reported to contains as many as 17 active nutrients compounds including protein, fat, carbohydrate, fiber, ash, Calcium, Potassium, iron, sodium, phosphorous, beta-carotene, thiamine, riboflavin, niacin, ascorbic acid etc (Islam, 2010). Leaves contain oxydase and chlorogenic acid. The folic acid content is substantially higher than that of other folacin- rich vegetables, ca 800 micrograins per 100g (ca 75% moisture) or ca 3200 micrograms on a zero moisture basis (Chen and Saad, 1981). This green, leafy vegetable is rich in beta-carotene for good eyesight, iron for healthy red blood cells, calcium for strong bones and teeth, and vitamin C for smooth, clear skin, strong immune cells, and fast wound-healing. Vitamins A, C and E present in Saluyot “sponge-up” free radicals, scooping them up before they can commit cellular sabotage (Islam, 2013). While perhaps better known as a fiber crop, jute is also a medicinal "vegetable", eaten from Tanganyika to Egypt. Dried leaves were given me by an Egyptian friend who had brought them with him to this country. They are used in soups under the Arabic name "Molukhyia." In India the leaves and tender shoots are eaten. The dried material is there known as "nalita." Injections of olitoriside markedly improve cardiac insufficiencies and have no cumulative attributes; hence, it can serve as a substitute for strophanthin (Annonymous, 2011).

Jute leaves are consumed in various parts of the world. It is a popular vegetable in West Africa. The Yoruba of Nigeria call it "ewedu". The Hausa people of Nigeria and Fulani call it "rama." They use it to produce soup ("taushe") or boil the leaves and mix it with "Kuli-kuli" or groundnut cake and consume the mixture which they call "kwado" in Hausa. It has a mucilaginous (somewhat "slimy") texture, similar to okra, when cooked. The seeds are used as flavouring, and an herbal tea is made from the dried leaves. The leaves of Corchorus are rich in betacarotene, iron, calcium, and vitamin C. The plant has an antioxidant activity with a significant α-tocopherol equivalent vitamin E. (Islam, 2006). However, Barg et al. (2008) identified that maturity at harvest is one of the main factors determining quality and the rate of quality changes during postharvest handling and shelf life. Consequently, it is recommended to harvest leafy vegetables at optimal maturity stage, not only because of the economic benefits for producers but also because the physiological response of plants during refrigerated storage allows optimal quality maintenance with respect to other plants harvested earlier or later than the optimal maturity stage. Maturity at harvest can significantly impact product composition and the nutritive value of the crop (Gil et al., 2012). Moreover, maturity at harvest is critical not only to assure product quality and shelf life of intact leafy vegetables for the fresh market but also for the fresh-cut industry. It affects postharvest tolerance to handling and processing operations, and their post-cutting life (Kader, 2002). Harvest maturity indicators have been set to describe the right time to harvest for better quality and shelf life. The quality of leafy vegetables for fresh consumption is a complex issue as many characteristics comprise the full description. The set of characteristics important to consumer acceptance associated with leafy vegetables are visual characteristics such as colour, shape, size and freshness, as well as texture and flavour. The determination of horticultural maturity varies with commodity but in general for leafy vegetables, size is the principal criterion (Cantwell and Kasmire, 2002), although shape and surface areas are also used as common maturity indices (Barg et al., 2008). Other main harvest maturity indicators of leafy vegetables include diameter, head length, head width, colour, firmness and compactness. For non-heading lettuces, the number of leaves can be used as a harvest index (Cantwell and Kasmire, 2002). It is important to distinguish between the stage that represents optimal eating quality and the stage of full maturation biologically (Barg et al., 2008). This work is therefore aimed at evaluating the effects of age at harvest on the nutritional composition of jute with a view to compare the result obtained at different maturity stages with one and other.

MATERIALS AND METHODS

Study site

The experiment was carried out during the raining season of 2019 (for 63 days from July 4th, 2019 to September 4th, 2019.) at the experimental garden which was located at the back of the lecturers’ office department of science Laboratory Technology, The oke ogun polytechnics, Saki.

Plant material, sowing and harvest

The samples seeds were obtained from the seed seller at Gbawojo market in Saki. All the samples’ seeds were sprinkled onto the prepared plot, then, the soil was disturbed with hand to cover the seed and harvesting was done first at 5th week after sowing (5 WAS), followed by 7th week after sowing (7 WAS) and lastly 9th week after sowing (9 WAS).

Laboratory work

The fresh leaves were washed with well water to remove the unwanted matter and air dried until properly dried with continuous turning to avert fungal growth. The samples were crunched and sieved through a 2 mm sieve size to obtain fine form of it followed by laboratory analysis.

Mineral contents analysis

Digestion of samples

About 0.5g of the sample was weighed into 100ml beaker, nitric acid and perchloric acid was mixed in the ratio 1:2. The mixture in the sample was placed on a hot plate to undergo digestion at 150oc for 30 minutes; this depends on the nature of the sample until it changed to a colourless solution or a milky solution. The beaker was covered with already washed glass and allowed to cool, after which distilled water was added to make 25ml. the same thing was done for other samples.

Mineral contents instrumental analysis

752N uv-vis spectrophotometer (model: BOSCH) was used to analyze the metals (Na, Fe, K, Mg and Ca), their concentrations were determined as described by AOAC .

Antioxidant and anti-nutrient analysis

Determination of antioxidants and anti-nutrients were determined using standard analytical methods.

Data analysis

All the data collected were subjected to analysis of variance (ANOVA) using Microsoft Excel (version 2007) and IBM-SPSS (VERSION 21.0). Treatment mean were separated using the least significant difference where significant difference occurred at 5% level of probability.

RESULTS AND DISCUSSION

The result of the mineral compositions, antioxidant and anti-nutrient compsitions of C*orchorus olitorius* (Jute) obtained at different harvest age were presented in (Tables 1, 2 and 3).

Minerals

From (Table 1), the mean sodium contents firstly decreased as age 7WAS was approached and declined nearly up to the value obtained at age 5 WAS. However, sodium concentration was maximized at age 5 WAS for jute plant leaves (27.97mg/L) of dry weight. The amount of potassium (K) obtained for Jute plant leaves, a clear variation was observed between the harvest of 5 WAS (222.85mg/L) and 7 WAS (150.56mg/L) (decreased up to the 7th WAS) and a slight difference was seen when age 9 WAS that is, 165.11mg/L) was reached. This variation observed indicates that plant maturity contributes to potassium absorption and deterioration in leafy vegetables. For the concentration of Iron (Fe), a linear relationship was obtained for jute plant that is, the Fe contents increased as the plant age increased at harvest period (Table 2). Therefore, the plant harvested at 9th week after sowing had the highest concentration of Fe for Jute (7.11mg/L). However these values are very close to 11.6mg/g reported for jute by Islam, (2010, and 2013). Considering the daily requirements of 11mg/day for an adult male, the vegetables need to be consumed severally within a day before they can supply their requirement to an adult male. Regarding the mean Calcium content of jute, the Ca content increased with increase in plant maturity at harvest with the harvest of 9 WAS having the highest value (37.33mg/L). However, it is likely that older leaves may contain anti –nutrients (e.g oxalate and phylate) that decrease minerals bio-availability to humans. In plants, calcium is taken up in the ionized form (Ca^{2+}). The leafy parts are relatively high in calcium and low in Phosphorus, whereas, the reverse is true of the seeds (Clement, 2011). The trend of magnesium followed the same way as that of calcium. The magnesium content increased as the plant age increased. (37.33mg/L at 9th WAS). However, the result obtained for Mg in this study did not conform with the report of Adediran et al. (2015) that age at harvest did not contribute significantly to the variation in magnesium content of leaves.

Antioxidants

Table 2 shows the range of 0.24mg/g -1.85mg/g for total phenolic present in the jute samples, it was observed that the highest value was obtained at 7WAS and the lowest value was obtained at the age of 5WAS. The level of jute flavonoid obtained in this study ranged from 0.62mg/g at 5WAS to 4.09mg/g at 7WAS. A very significant difference was found between age 5WAS and other harvest ages but the value obtained at age 7WAS and 9WASwere very close.

The concentration of vitamin E (tocopherol) was generally low. Table 2 shows that the vitamin E values had the range of 0.08 -0.20mg/100g for Jute. The highest value obtained for Jute was at the 9th WAS (0.20mg/100g). There was no significant difference between the values obtained for jute at every harvest age. This goes along with the expression of Yi-Fang et al. (2002) that vitamin E level in leafy vegetables increases with plant age. Vitamin E is required in the human diet but its deficiency is rare except in pregnancy and the new born, where it is associated with hemolytic anaemia. The vitamin A (retinol) contents of Jute was highest at the 9th WAS (3.77mg/100g). This result suggests that more retinol would be found in the leaves of jute at older age. Vitamin B2 (riboflavin) also present in Jute plants

Table 1. Mineral concentrations of jute leaves at harvest age of 5, 7 and 9 WAS in mg/L. Mean value ± SD of triplicate result.

Age	K	Na	Fe	Mg	Ca
5	222.85^{d}±1.00	27.97^{c}±1.00	5.14^{d}±1.00	58.52^{f}±1.00	23.41^{fg}±1.00
7	150.56^{e}±1.00	22.32^{e}±1.00	6.06^{cd}±1.00	72.04^{d}±1.00	28.81^{c}±1.00
9	165.11^{e}±1.00	25.36^{d}±1.00	7.11^{c}±1.00	93.33^{b}±1.00	37.33^{ab}±1.00

SD= Standard Deviation

WAS= Weeks after Sowing

Means with the same superscript are not significantly different.

Table 2. Antioxidant composition measurements of jute leaves at different ages of harvest; 5, 7 and 9 WAS in mg/g. Mean value ± SD of triplicate result.

Age	Total phenolic	Flavanoid	Vitamin E	Vitamin A	Vitamin B_2
5WAS	0.24^{b}±0.01	0.62^{b}±0.01	0.08^{a}±0.00	0.56^{b}±0.01	0.08^{a}±0.00
7WAS	1.85^{a}±1.00	4.09^{b}±1.00	0.16^{a}±0.01	1.99^{b}±1.00	0.09^{a}±0.00
9WAS	1.68^{a}±1.00	4.08^{a}±1.00	0.20^{a}±0.01	3.77^{a}±1.00	0.16^{a}±0.01

SD= Standard Deviation

WAS= Weeks after Sowing

Means with the same superscript are not significantly different.

Table 3. Anti-nutrient concentrations (mg/g) of dry matter of jute. Mean value ± SD of triplicate result.

Age	Saponin	Tannin	Oxalate	Phytate
5WAS	0.25^{cd}±0.01	0.19^{b}±0.01	0.18^{a}±0.01	1.05^{de}±1.00
7WAS	0.54^{a}±0.01	1.43^{a}±1.00	0.12^{a}±0.01	5.25^{a}±1.00
9WAS	0.54^{a}±0.01	1.41^{a}±1.00	0.12^{a}±0.01	*4.18^{ab}±1.00*

SD= Standard Deviation

WAS= Weeks after Sowing

Means with the same superscript are not significantly different.

(Table 2) but its concentrations were generally low at every harvest maturity stage. No significant difference was observed in the result but still the highest value obtained for Jute was at 9th WAS (0.16mg/100g).

Anti-nutrient

Table 3 shows the result for anti-nutritional components of jute in mg/g of mean value. The result shows that the plants contain low level of anti-nutritional factors ≤5.25 mg/g (mean value). The saponin contents of jute were highest at 7WAS also (0.539 mg/g). The difference observed was not much. The result for tannins shows that the concentration of tannin in jute was maximized at the 7WAS (1.43 mg/g). However, tannin in these plants will be lethal if it is ≥ 5% (Tolulope *et al*., 2010). This value is the agreed value that can complex with other nutrients. The phytate contents of jute leaves ranged from 1.05 mg/g – 5.25 mg/g mean values. This range is higher than that of other anti-nutrients. However, the effect of age at harvest was a bit significant. It is likely that older leaves may contain anti-nutrients that decrease minerals through the formation of complexes, thereby hindering the nutrient bio-availability to humans and animals (Albert, 2007). For oxalate contents, the levels are generally less than 1.0mg/g. The influence of age at harvest was not clearly seen. However, the maximum value recorded for jute was 0.18mg/g at the 5WAS and no any difference was seen in the values obtained at 7 and 9WAS.

Conclusion and recommendation

In establishing the optimum time for harvesting of jute, consideration has to be given to optimum eating quality based on appearance, and biochemical changes of leaves; the results of this study indicate that: the mineral elements; K, and Na of jute decreases as the plant age increases but not in every case. Jute leaves should be delayed till 7WAS if the minerals are to be maximized. The effect of age at harvest on the anti-nutrient contents is less significant and their concentrations were generally low (≤5.3mg/g dry weight of jute). The antioxidant composition measurements of jute indicate that the flavonoid and total phenolic were increased at the 7WAS while Vitamin A and E increases as the plant age progressed. The vitamin B_2 contents of jute increased progressively with plant age. Therefore, the optimum time of harvesting jute is anytime from the 7th WAS. This research recommends that the government and non-governmental organization that are working in human nutrition should continue to organize seminars so as to educate people on the effects of age at harvest on the nutritional compositions of leafy vegetables and also individuals should try to engage in self vegetable cultivation so as to optimize and target the best nutritious value of intended vegetables.

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