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Effect of processing and preservation on L-ascorbic acid content in commercially cultivated jute leaves

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Abstract

Vitamin C, also known as ascorbic acid is essential nutrients that cannot produce in human body and meet up through diet. Jute leaves contain L-ascorbic acid. The amount of L-ascorbic is unknown in different varieties developed by Bangladesh Jute Research Institute. L-ascorbic acid content is affected by cooking or processing and preservation. Therefore, the experiment was conducted to investigate the content of vitamin C in the fresh jute leaves as well as the effect of cooking and preservation methods on L-ascorbic acid content in jute leaves. Fresh jute leaves of different varieties contain different amount of L-ascorbic acid 0.39g/10g to 0.64g/10g in *Corchorus olitorius* and 0.64g/10g to 0.92g/10g in *Corchorus capsularis*. *C. capsularis* contain more amount of L-ascorbic acid than the *C. olitorius*. Jute leaves of *C. olitorius* retain 95% L-ascorbic acid and *C. capsularis* retain 62% L-ascorbic acid after 15 min of boiling. Vinegar soaking leaves release more L- ascorbic acid by 5 min than the fresh leaves and then the L-ascorbic acid content was reduced by 15 min in both the species. Spraying vinegar treatment releases more L-ascorbic acid and increasing up-to 30 min treatment. Both oven dried and cold dried leaves retain small amount of L-ascorbic acid. L-ascorbic acid content was reduced in preserved jute leaf tea and soup powder also in both species. Usually, leafy vegetables are cooked before consumption and sometimes preserved vegetables are consumed when fresh vegetables may not available. So, this study may be useful to know the actual intake of L-ascorbic acid from the processed or preserved jute leaves.

Keywords: L-ascorbic acid; Jute leaves; Processing; Preservation; *Corchorus capsularis*; *Corchorus olitorius*

1. Introduction

Jute (*Corchorus* sp.) leaves are consumed as vegetables in many tropical countries. It has more than 100 species [1], among them only two species namely, *Corchorus olitorius* and *Corchorus capsularis* are commercially cultivated for fibre production. Along with fibre production, jute is cultivated as vegetables which commonly called *'pat shak'* in Bangladesh. Jute leaves are rich source of vitamins, antioxidants and phenolic compounds [2, 3]. It contains L-ascorbic acid [4, 5] as well. L-ascorbic acid is known as Vitamin-C, found in variable quantities in fruits and vegetables [6]. L-ascorbic acid or vitamin C provide numerous health benefit such as prevention of scurvy, functions in collagen, reduction in plasma cholesterol level, enhancement of immune system and reaction with singlet oxygen and other free radicals. As an important antioxidant, L-ascorbic reduces risk of cardiovascular diseases and some form of cancers [7, 8].The human body cannot synthesize vitamin C endogenously, and it must intake through dietary component [9].

Like other leafy vegetables jute leaves are to cook. During cooking ascorbic acids are destroyed at high temperature, since it easily leaches into cooking water being a water-soluble vitamin. Losses of ascorbic acid depend upon cooking methods and periods [10]. The actual amount of vitamin C exists in the fresh condition is reduced through cooking. Therefore, it is important to investigate L-ascorbic status in cooked jute leaves. Jute leaves are dried and preserved for off season use. Drying is the technique of preservation for off season consumption as well as for year-round availability

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to commercialization. Drying and cooking process affect the L-ascorbic content. Therefore, this experiment has been carried out to investigate the L-ascorbic acid status in i) fresh jute leaves of different varieties of *Corchorus olitorius* and *Corchorus capsularis* ii) cooked and processed jute leaves and iii) preserved jute leaves.

2. Material and methods

Jute leaves (*C. olitorius* and *C. capsularis*) of different varieties were collected from the experimental field of Breeding Division of Bangladesh Jute Research Institute, Dhaka, Bangladesh. The site belongs to the Agro Ecological Zone-8 namely, young Brahmaputra and Jamuna Floodplain. Cultural activities were performed following recommended procedure [11].

Fresh jute leaves of different varieties were harvested from 50 days old jute plant for estimation of L-ascorbic acid content. The varieties of *C. olitorius* are O-9897, O-72, O-3820, O-795, MG-1 and Robi-1 and *C. capsularis* are CVL-1, D-154, CC-45, CVE-3, BJC-83 and *deshi pat shak*-1. Healthy leaves were collected randomly from plants. Three replications were used for each sample.

Jute leaves of variety O-9897 and CVL-1 were collected from 56 days old jute plant from the same experimental field for the processing experiment. Ten grams of 56-day-old fresh leaves were processed by (i) boiling with de-ionized water for 5, 10 and 15 min, (ii) soaked in vinegar for 5, 15and 30min, (iii) spraying vinegar for 5, 15and 30min, (iv), dried in convection oven (Memmert GmbH, Schwabach, Germany) in brown paper envelop at 60°C for 2h and (v) dried in refrigerator in brown paper envelop at 1-8°C for one month.

Leaves of O-9897 and CVL-1 variety of 56 days old jute plant were also prepared as tea and soup and preserved. The drying and preservation methods were as follows (i) Tea were prepared by washing, chopping the leaves and then immersion in boiling water for 3min following drying in oven at 60°C afterwards preserved in glass bottle at room temperature, (ii) Soup were prepared by drying leaves in oven at 100°C overnight, then ground by mortar and pestle, kept in plastic bottle and preserved in freezer (-20°C) (iii) soup were prepared by drying of leaves in refrigerator at 4°C for 10 days and ground with mortar and pestle, kept in plastic bottle and preserved in freezer at -20°C.

L-ascorbic acid content in jute leaves samples was estimated according to the method of Riemschneider et al., (1976) [12]. Ten gm leaves were chopped and homogenized with 50 ml acetic acid (10%) and transferred to a 100 ml volumetric flask and was diluted up to the mark by 10% acetic acid. Then filter through Whatman-no. 1 filter paper. Filtrations were performed in cold at 4°C. Filtrate sample were collected, and two/three drops of Bromine water were added for oxidation of ascorbic acid to dehydroascorbic acid. Then two or three drops of thiourea solution (10%) were added to it to remove excess Bromine water. Then two/three drops of 2, 4 Dinitrophenyle Hydrazine solution were added and kept the sample at 37°C for 3h. Afterwards two or three drops 85% H_2SO_4 was added to form red colour complex. Then absorbance was measured at 280 nm using spectrophotometer (UV-6300 PC, VWR, Radnor, PA).

2.1. Preparation of standard ascorbic acid solution

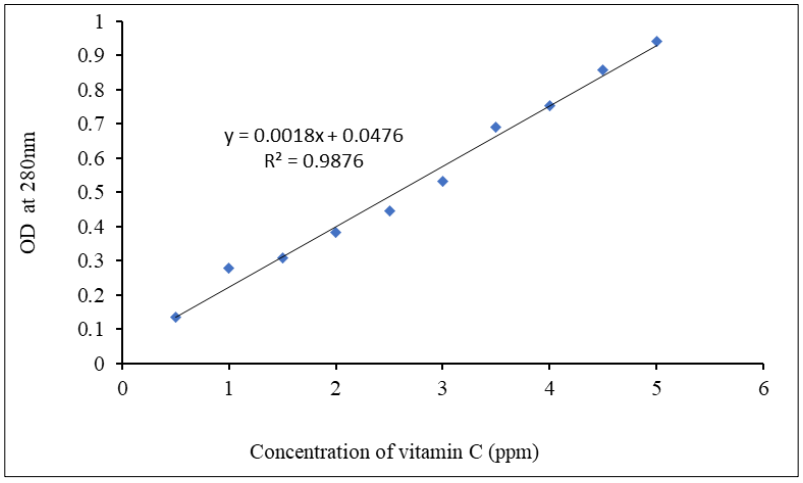

Figure 1 Calibration curve of standard L-ascorbic acid at 280 nm

50 mg standard crystalline L ascorbic acid was dissolved in 100 ml of 5% metaphosphoric acid and 10% acetic acid solution. This solution was used for calibration curve preparation. The calibration curve was constructed by plotting the concentration versus the corresponding absorbance (Figure 1).

2.2. Statistical analysis

Statistical analysis of variance (ANOVA) was carried out using statistical package Minitab to determine variation between treatments. The Least Significant Difference (LSD) test was used for comparison of mean.

3. Results and discussion

L-ascorbic acid content in fresh jute leaves of different varieties of *C. olitorius* and *C. capsularis* are presented in Table 1. Different varieties show variation in L-ascorbic acid content in both species. O-9897, O-72 and Robi-1 varieties of *C. olitorius* contain highest L-ascorbic acid (0.61, 0.64 and 0.59 g/10g) than other *C. olitorius* varieties. There is no significant difference among these three varieties. Variety O-3820 and MG-1 contain the second highest L-ascorbic acid (0.49 and 0.51g/10g) and have no significant difference between these two varieties. Variety O-795 contain lowest amount of L-ascorbic acid 0.39g/10g among the six *C. olitorius* varieties. In *C. capsularis Deshi pat shak* -1 contain highest amount of L-ascorbic acid (0.92g/10g). Variety CVL-1 shows the second highest L-ascorbic acid content 0.72g/10g. Variety CVE-3 and CVL-1 did not show significant difference in L-ascorbic acid content. Variety D-154, BJC-83 and CC-45 have less amount of L-ascorbic acid than other *C. capsularis* varieties. Variety CC-45 shows lowest amount of L-ascorbic acid (0.64g/10g) among the six *C. capsularis* varieties. *C. capsularis* contain more L-ascorbic acid than the *C. olitorius*. Variability in L-ascorbic acid content is more in *C. capsularis* species than in *C. olitorius*.

Table 1 L-ascorbic acid content in fresh leaves of commercially cultivated jute species

Species	Variety	L-ascorbic acid content(g/10g)[a]
Corchorus olitorius	O-9897	0.61±0.020a
	O-72	0.64±0.021a
	O-3820	0.49±0.021b
	O-795	0.39±0.038c
	MG-1	0.51±0.020b
	Robi-1	0.59±0.010a
Corchorus capsularis	CVL-1	0.72±0.015b
	D-154	0.65±0.015cd
	CC-45	0.64±0.010d
	CVE-3	0.69±0.020bc
	BJC-83	0.65±0.15cd
	Deshi pat shak-1	0.92±0.017a

[a]Mean within a column for L-ascorbic acid content separated with LSD and Values in the column Followed by the same letter are not significantly different, P < 0.01

L-ascorbic acid content in different processed jute leaves is presented in Table 2. Very few amounts of L-ascorbic acid were lost in leaves of *C. olitorius* during 15 min boiling. Retention of L-ascorbic acid was about 98% during 5-10 min boiling and retention was about 95% by 15 min boiling. L-ascorbic acid was increased in leaves of *C. olitorius* while soaked in vinegar for 5 min but over time L-ascorbic content was decreased. L-ascorbic was increased 17% by 5 min and decreased 26% by 15 min and 43% by 30 min in vinegar-soaked leaves. Treatment with spraying vinegar on leaves increased L-ascorbic acid content over time during 5-30 min treatment. L-ascorbic acid content was increased about 9% by 5 min, 75% by 15 min and 97% by 30 min of vinegar spraying treatment. Oven dried leaves of *C. olitorius* losses L-ascorbic acid content about 62% at 60°C for 2h. Leaves left in refrigerator at 4°C for one month losses L-ascorbic acid 88%.

Table 2 Effect on L-ascorbic acid content in leaves of cultivated jute species subjected to 11 processing treatments

Species (variety)	Processing method	L-ascorbic acid content (g/10 g)
	Fresh leaves (control)	0.81±0.020d
C. olitorius (O-9897)	Boil with H_2O for 5min	0.80±0.026d
	Boil with H_2O for 10 min	0.80±0.017d
	Boil with H_2O for 15min	0.77±0.021d
	Soaked in vinegar for 5 min	0.95±0.029c
	Soaked in vinegar for 15 min	0.55±0.011e
	Soaked in vinegar for 30 min	0.46±0.026f
	Spraying with vinegar for 5 min	0.89±0.015c
	Spraying with vinegar for 15 min	1.42±0.030b
	Spraying with vinegar for 30 min	1.60±0.011a
	Dried at 60°C for 2hrs in oven	0.30±0.010g
	Dried at 4°C for 30 days	0.09±0.010h
	Fresh leaves (control)	1.27±0.020d
C. capsularis (CVL-1)	Boil with H_2O for 5min	0.98±0.010e
	Boil with H_2O for 10 min	0.92±0.010f
	Boil with H_2O for 15min	0.79±0.015g
	Soaked in vinegar for 5 min	1.61±0.020b
	Soaked in vinegar for 15 min	0.79±0.020g
	Soaked in vinegar for 30 min	0.74±0.010h
	Spraying with vinegar for 5 min	1.36±0.010c
	Spraying with vinegar for 15 min	1.59±0.015b
	Spraying with vinegar for 30 min	1.70±0.021a
	Dried at 60°C for 2hrs in oven	0.48±0.026i
	Dried at 4°C for 30 days	0.13±0.021j

[a] Mean within a column for L-ascorbic acid content separated with LSD and Values in the column followed by the same Letter are not significantly different, $P < 0.01$.

In *C. capsularis* leaves L-ascorbic content was reduced during boiling. The amount of L-ascorbic acid was lost due to boiling about 22%, 27% and 37% by 5, 10 and 15 min respectively. That means retention of L-ascorbic acid was 77%, 72% and 62% by 5, 10 and 15 min boiling. Vinegar-soaked leaves of *C. capsularis* showed increasing L-ascorbic acid 26% by 5 min but decreasing trend was observed over time. Ascorbic content was lost 37% and 41% while leaves soaked in vinegar for15 and 30 min. Leaves treated with spraying vinegar increased availability of L-ascorbic acid 7%, 25% and 33% after 5, 15 and 30 min spraying of vinegar, respectively. L-ascorbic acid content was lost 62% in oven dried leaves for 2h at 60°C and about 89% lost in cold dried leaves at 4°C for one month in Refrigerator.

During 15 min cooking/boiling leaves of *C. olitorius* showed comparatively less reduction than leaves of *C. capsularis.* Leaves of *C. olitorius* variety O-9897 retain L-ascorbic acid 95% (0.77g/10g) of its fresh condition and *C. capsularis* variety CVL-1 retains 62% (0.79g/10g) of its fresh condition. Therefore, after 15 min cooking nearly similar amount of L-ascorbic is available from the leaves of both species. Highest L-ascorbic content was obtained in vinegar spraying treated *C. capsularis* variety CVL-1 (1.7g/10g). The lowest amount of L-ascorbic acid was obtained in one month old cold dried leaves of *C. olitorius* variety O-9897(0.09g/10g).

Jute leaves were dried as tea and soup following preservation. Tea prepared from Jute leaves retains very few amounts of L-ascorbic acid. Tea made by leaves of *C. capsularis* contains more amount of L-ascorbic acid than *C. olitorius*. Soup made by cold drying leaves (4°C) retain more L-ascorbic acid than oven drying (60°C) leaves in *C. olitorius* variety O-9897. In leaves of *C. capsularis* variety CVL-1, soup made by oven drying shows more L-ascorbic acid than drying leaves at 4°C in refrigerator.

Table 3 Effect on L-ascorbic acid content in leaves of cultivated jute species subjected to drying and preservation methods

Product	Processing & preservation	Time (Year)	L-ascorbic acid content (g/10g)	
			C. olitorius (O-9897)	*C. capsularis* (CVL-1)
Used as tea	Immersed in boiled water for 3min then cool and then dried at 60°C afterwards preserved in glass bottle in room temperature	1	0.05±0.005	0.07±0.001
Used as soup	Drying in 60°C & preserved in plastic bottle in -20°C	3	0.07±0.001	0.22±0.005
	Drying in 4°C for 10 days & preserved in plastic bottle in -20°C	3	0.14±0.005	0.17±0.008

4. Discussion

Jute leaves contain good amount of L-ascorbic acid. There is difference among the varieties of two species and between the two species as well. Leaves of *C. capsularis* contain more L-ascorbic acid than leaves of *C. olitorius*. Taste of leaves is different between species. *C. capsularis* taste is bitter and genetic makeup also different [13]. All the varieties of both species showed higher amount of L-ascorbic acid than the previous report (Table-4) except one [14]. The present research reports are like the report of Shaker, (2021)[14].Vitamin C levels may vary considerably due to different factors, which include species, maturity, portion, soil, climate, season, handling, method of preparation and consumption [15].

Table 4 Previous report of L-ascorbic acid content in *Corchorus* sp.

Name	L ascorbic acid content	Reference
Corchorus olitorius L.	316.80 mg/100gm (dw)	[16]
Corchorus olitorius L.	153.63 mg/100ml	[4]
Corchorus olitorius (Serrated edge)	89.94 mg/100gm 101.91 mg/100gm	[17]
Corchorus olitorius (Smooth edge)	40.21 mg/100gm (CV) 44.74 mg/100gm (NBS)	[17]
Corchorus olitorius	7.5mg/gm	[14]
Corchorus capsularis	135.60 mg/100gm	[5]

L-ascorbic acid is water soluble and heat labile. So due to boiling L-ascorbic acid content was reduced. Loss of L-ascorbic acid content differs during boiling of leaves in different species. Leaves of CVL-1 of *C. capsularis* show more loss of L-ascorbic acid than leaves of O-9897 of *C. olitorius*. Leaves of O-9897 retain L-ascorbic acid 95% and CVL-1 retains 62% by 15 min boiling. Musa and Obgadoyi (2012) revealed that vitamin C concentration decreased significantly in the cooked *C. olitorius* leaves [18]. They reported percentage loss of vitamin-C in leaves of *C. olitorius* cooked for 5 and 10 min were 79.86% and 85.30%, respectively. The extent of loss of ascorbic acid depends upon variation in cooking methods and periods [10].Shorter cooking time results in greater retention of vitamin during cooking [19,20].Fifty percent ascorbic acid retention was achieved in spinach(*Spinacia oleracea*L.) cooked for 7 min[21]. Whereas boiling for 6 min caused 64.45% decrease in broccoli (*Brassica oleracea*.var. *italica*), 70.74% in white cabbage (*Brassica oleracea*. var .*Caplitata*) and 66.82% in cauliflower(*Brassica oleracea*,var. *Botrytis*) [22] which indicates retention of varying ascorbic acid after cooking from species to species.

Vinegar may use for pickling vegetables, dressing on salad, preparing for sauce, sanitizing vegetables and help for removal of pesticide residue. Present experimental results showed that vinegar had effect on L-ascorbic acid in leaves. While leaves soaked in vinegar initially L-ascorbic acid was released and then it decreased. When vinegar gets contact with leaf, the leaf tissue may be disintegrated immediately which causes releasing L-ascorbic acid. Afterwards vinegar

reacts with L-ascorbic acid and break down it. Therefore, in 5 min vinegar-soaked leaves released more L-ascorbic acid than its fresh one and then by 15 to 30 min L-ascorbic acid were reduced. Similar trend was observed in both species. Spraying treatment of vinegar had different effect, it releases L-ascorbic acid from leaves gradually and continue to release during 5 to 30 min treatment. Spraying treatment given with less amount of vinegar compared to leaf which may act slowly on leaves for releasing L-ascorbic acid and over time more L-ascorbic acid was released. Similar trend was observed in both species by spraying vinegar treatment.

Depending on the composition of food, the material is prone to nutrient degradation during drying [23,24]. Oven dried leaves of *C. olitorius* and *C. capsularis* lost about 62% L-ascorbic acid and cold drying for one-month leaves losses 88-89% L-ascorbic acid.

Making tea and soup from jute leaves were subjected to drying and preservation. Tea made from jute leaves showed lower L-ascorbic acid in both species. Soup prepared from jute leaves showed slightly higher L-ascorbic acid than tea. Tea was preserved in room temperature which may cause deterioration of vitamin content quickly. Soup preserved in freezer. So, it retains slightly more L-ascorbic acid content. Temperature, moisture content and interaction with water all influence the chemistry and biochemistry of the food product during drying and storage [25]. The presence of water in dehydrated foods is important because it affects deterioration reactions and vitamin degradation [26].

5. Conclusion

Jute leaves contain good amount of L-ascorbic acid. Vitamin C or L-ascorbic acid content differ in varieties as well as in between species. *C. capsularis* leaves have more L-ascorbic acid than leaves of *C. olitorius*. Retention of L-ascorbic acid in boiled leaves for 15 min was 95% in *C. olitorius* and 62% in *C. capsularis*. Soaking in vinegar for 5 min enhance to release more L-ascorbic acid. Spraying treatment of vinegar released maximum L-ascorbic acid from leaves up to 30 min. Both cold dried and oven dried leaves showed loss of L-ascorbic acid content. Preserved tea and soup made from jute leaves also lost maximum L-ascorbic acid.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declare that they have no competing interest.

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