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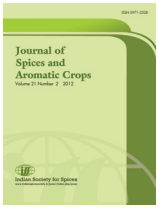

Keeping quality of betel leaves (*Piper betle* L.) as influenced by different methods and seasons

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Abstract

The objectives of the study were to assess the keeping quality under different seasons and methods of storage to suggest the best method and season for betel leaves storage. In all the treatments, leaves in two forms *i.e*, petiolated and depetiolated were included. The result showed that December–January *i.e*, winter season was the best for longer storage of betel leaves in any form and method. Among method of storage, zero energy cool chamber was the best for longest period of storage followed by packing with banana leaves in bamboo basket. Depetiolated condition was always better than petiolated condition for enhancing storage life. Chlorophyll degradation was minimum in petiolated condition either in packing with banana leaves or in treatment with Benzylaminopurine (BA) @ 30 ppm compared to depetiolated condition. Ascorbic acid content was more in sterilized paddy straw packing and in hessian cloth lined with mustard seed and ice pieces compared to other treatments.

Keywords: betel leaf, storage, quality, *Piper betle*

Introduction

The loss due to spoilage in Betelvine (*Piper betle* L.) ranges between 35–70 percent during storage and transport (Venkata Rao & Narasimhan 1977), which can be effectively minimized with proper packing and other treatments. Farmers use various types of packaging techniques to prolong the colour and freshness of betel leaves for achieving good market price. The objective of the present study was to compare some of selected methods and to identify the most suitable one in relation to the season of the year.

Materials and methods

The experiment was conducted in the Faculty of Horticulture, Bidhan Chandra Krishi Viswa Vidyalaya, West Bengal during 2005–2007. It was designed in two factorial RBD with 3 replications. Leaves of uniform size and age (eighth from the terminal apex) of cv. Simurali Deshi produced with 100% organic manure (mustard oil cake) were collected and used for the study. Both (i) petiolated and (ii) depetiolated leaves were included for the study. In each set there were nine treatments with two replications consisting of 100 leaves per replication. The leaves were washed with distilled water and blotted to remove the water adhering to the surface. The petioles of second set of leaves were removed carefully with a pair of sharp scissors from the base of the leaf

lamina. Then the leaves of each set were arranged as per treatment as follows T_1–leaves packed in sterilized moist paddy straw lining (5 cm thickness) in a bamboo basket ; T_2–leaves packed in banana leaves and kept in a bamboo basket ; T_3–leaves wrapped in moist Hessian cloth lined with mustard seeds and ice pieces and kept in a bamboo basket ; T_4–leaves kept in a bamboo basket and stored in zero energy cool chamber; T_5, T_6, T_7–leaves treated in three different plastic trays containing 15, 30 and 45 ppm of Benzylaminopurine (BA) respectively for 6 hours. After 6 hours leaves were taken out and washed with distilled water and blotted. Then the leaves were packed in vented polythene bags (45 ´ 30 cm) of 200 gauge and kept at room temperature; T_8–leaves packed in vented polythene bags and kept under refrigeration (6–8°C); T_9–leaves kept in bamboo basket only and stored at room temperature. The leaves were sprinkled with water regularly and observations were recorded at regular intervals.

The experiment was conducted in 3 seasons *i.e.*, during (i) April–May (ii) July–August and (iii) December–January and observation on number of marketable leaves were recorded at 4 days interval. Besides, chlorophyll content was estimated following the method suggested by Arnon (1959). Ascorbic acid content was also estimated as an indicator of chemical quality. The data was analysed statistically by analysis of variance method as suggested by Gomez & Gomez (1984).

Results and discussion

Number of fresh marketable leaves

Data presented in Table 1 clearly indicated that number of marketable leaves significantly varied due to storage conditions, petiole regulation and their interaction. From the data recorded on 5th day during April–May, it was observed that all the leaves remained in marketable condition in the treatments T_4, T_6, T_7 and T_8, but marketable leaves were least when

Table 1. Number of marketable leaves remaining /100 leaves in different system of storage during April–May

Treatment	No. of fresh leaves /100 leaves								
	5th day			9th day			13th day		
	P_1	P_0	Mean	P_1	P_0	Mean	P_1	P_0	Mean
T_1	95.50	100	97.75	42.75	77.75	60.25	1.50	19.25	10.38
T_2	96.75	100	98.75	52.75	82.25	67.50	5.75	21.75	13.75
T_3	94.25	97.75	96.00	28.25	63.75	46.00	1.50	1.25	5.88
T_4	100	100	100	85.25	87.50	86.38	22.00	34.75	28.38
T_5	97.25	100	98.63	48.00	67.50	57.75	8.00	18.50	13.25
T_6	100	100	100	64.50	80.50	72.50	20.00	38.25	29.13
T_7	100	100	100	49.00	70.25	59.63	1.75	2.25	3.50
T_8	100	100	100	3.00	43.00	23.00	0	1.00	0.50
T_9	61.25	70.75	66.00	0	9.25	4.63	0	0	0
Mean	93.89	96.50		41.50	64.64		6.72	16.56	
	5th day			9th day			13th day		
	T	P	T ´ P	T	P	T ´ P	T	P	T ´ P
SEm±	0.26	0.12	0.36	1.41	0.67	1.99	0.76	0.36	1.07
C.D.(P=0.05)	0.76	0.36	1.08	4.19	1.97	5.92	2.24	1.06	3.17

T_1=Sterilized paddy straw lining (5 cm thickness) in bamboo basket; T_2=Banana leaves packing; T_3=Leaves wrapped with moist hessian cloth lined with mustard seeds and ice pieces; T_4=Leaves kept in zero energy cool chamber; T_5=Leaves dipped in BA @ 15 ppm for 6 hours; T_6=Leaves dipped in BA @ 30 ppm for 6 hours; T_7=Leaves dipped in BA @ 45 ppm for 6 hours; T_8=Leaves kept in refrigerated condition (6–8°C); T_9=Leaves kept in refrigerated condition (6–8°C); T_9=Leaves kept at room temperature; P_1=Petiolated; P_0=Depetiolated.

kept at room temperature. More number of leaves (96.50) remained marketable in depetiolated condition than petiolated leaves (93.89). When leaves were kept at room temperature with petiole, the lowest number (61.25) of leaves remained marketable on the same day.

At 9th day during April–May maximum number (86.38) of fresh leaves remained in marketable condition, when leaves were kept in zero energy cool chamber. The interaction effect also showed that maximum number of leaves remained fresh in zero energy cool chamber in depetiolated condition, though statistically at par with petiolated condition. No leaf remained fresh, when stored at room temperature in petiolated condition. The same trend was observed after 13 days of storage during April–May. During July–August storage (Table 2), number of marketable leaves was less compared to April–May storage on all observation days. Among the treatments, T_4 retained maximum marketable leaves on all observations days (98.13, 59.38 and 9.13 % on 5th, 9th and 13th days respectively) while T_7 retained the lowest.

During December-January (Table 3), shelf life of the leaves was the longest i.e., up to 21 days. T_4 retained maximum marketable leaves (100, 100, 91.63 & 58.38 % on 9th, 13th, 17th & 21th days respectively), while it was found to be lowest in T_9.

Chlorophyll content

Content of chlorophyll in leaves on the day of harvest was 2.20 mg/g of leaf tissue. After 5 days the chlorophyll content of leaves varied between 2.06–2.38 mg/g tissue. At 9th day of storage during April–May, the highest chlorophyll content (1.87 mg/g) was observed in T_6 and was at par with T_5 (1.86 mg/g) and was lowest (1.77 mg/g) in both the treatments T_3 and T_9. Petiolated leaves retained more chlorophyll (1.85 mg/g) than depetiolated leaves (1.81 mg/g). Leaves wrapped with moist hessian cloth lined with mustard seed and ice pieces (T_3) in depetiolated condition showed lowest (1.73 mg/

Table 2. Number of marketable leaves remaining /100 leaves in different systems of storage during July–August

Treatment	No. of fresh leaves /100 leaves								
	5th day			9th day			13th day		
	P_1	P_0	Mean	P_1	P_0	Mean	P_1	P_0	Mean
T_1	90.75	96.75	93.75	27.25	51.75	39.50	0	15.00	7.50
T_2	93.50	97.00	95.25	38.50	60.25	49.38	0	8.25	4.13
T_3	88.50	93.75	91.13	11.50	29.25	20.38	0	0	0
T_4	96.25	100.00	98.13	53.75	65.00	59.38	0	18.25	9.13
T_5	93.50	95.75	94.63	31.25	53.00	42.13	0	6.75	3.38
T_6	95.50	96.75	96.13	45.00	56.75	50.88	0	8.75	4.38
T_7	94.00	95.00	94.50	63.50	46.50	41.50	0	6.00	3.00
T_8	93.50	93.75	93.63	0	24.25	12.13	0	0	0
T_9	51.25	62.50	56.88	0	9.00	4.50	0	0	0
Mean	88.53	92.36		27.08	43.97		0	7.00	
	5th day			9th day			13th day		
	T	P	T ´ P	T	P	T ´ P	T	P	T ´ P
SEm±	0.25	0.12	0.35	0.80	0.38	1.12	1.26	0.59	1.78
C.D.(P=0.05)	0.74	0.35	1.05	2.36	1.11	3.34	3.73	1.76	5.28

T_1=Sterilized paddy straw lining (5 cm thickness) in bamboo basket; T_2=Banana leaves packing; T_3=Leaves wrapped with moist hessian cloth lined with mustard seeds and ice pieces; T_4=Leaves kept in zero energy cool chamber; T_5=Leaves dipped in BA @ 15 ppm for 6 hours; T_6=Leaves dipped in BA @ 30 ppm for 6 hours; T_7=Leaves dipped in BA @ 45 ppm for 6 hours; T_8=Leaves kept in refrigerated condition (6–8°C); T_9=Leaves kept in refrigerated condition (6–8°C); T_9=Leaves kept at room temperature; P_1=Petiolated, P_0=Depetiolated.

Table 3. Number of marketable leaves remaining /100 leaves in different systems of storage during Dec–Jan

Treatment	No. of fresh leaves /100 leaves											
	9th day			13th day			17th day			21st day		
	P_1	P_0	Mean	P_1	P_0	Mean	P_1	P_0	Mean	P_1	P_0	Mean
T_1	96.25	100.00	98.13	86.25	100.00	93.13	28.75	54.75	41.75	0	23.50	11.75
T_2	97.75	100.00	98.88	88.00	100.00	94.00	50.25	62.75	56.50	17.75	32.75	25.25
T_3	97.00	100.00	98.50	87.00	100.00	93.00	24.00	37.00	30.50	0	0	0
T_4	100.00	100.00	100.00	100.00	100.00	100.00	90.00	93.25	91.63	51.00	65.75	58.38
T_5	100.00	100.00	100.00	100.00	100.00	100.00	61.50	61.50	61.50	15.00	27.50	21.25
T_6	100.00	100.00	100.00	100.00	100.00	100.00	68.25	6.25	67.25	14.00	36.00	25.00
T_7	100.00	100.00	100.00	100.00	100.00	100.00	65.00	55.50	60.25	21.75	28.50	25.13
T_8	100.00	100.00	100.00	100.00	100.00	100.00	45.50	49.00	47.25	0	9.75	4.88
T_9	94.75	100.00	97.38	75.75	85.00	80.38	0	10.25	5.13	0	0	0
Mean	98.42	100.00		93.00	98.33		48.13	54.47		13.27	24.86	
	9th day			13th day			17th day			21st day		
	T	P	T ´ P	T	P	T ´ P	T	P	T ´ P	T	P	T ´ P
SEm±	0.07	0.03	0.10	0.10	0.05	0.14	0.42	0.20	0.60	0.47	0.22	0.66
C.D.(P=0.05)	0.22	0.10	0.30	0.30	0.14	0.43	1.26	0.60	1.79	1.38	0.65	1.96

T_1=Sterilized paddy straw lining (5 cm thickness) in bamboo basket; T_2=Banana leaves packing; T_3=Leaves wrapped with moist hessian cloth lined with mustard seeds and ice pieces; T_4=Leaves kept in zero energy cool chamber; T_5=Leaves dipped in BA @ 15 ppm for 6 hours; T_6=Leaves dipped in BA @ 30 ppm for 6 hours; T_7=Leaves dipped in BA @ 45 ppm for 6 hours; T_8=Leaves kept in refrigerated condition (6–8°C); T_9=Leaves kept in refrigerated condition (6–8°C); T_9=Leaves kept at room temperature; P1=Petiolated; P_0=Depetiolated.

g) of chlorophyll at 9th day. Petiolated leaves treated with BA @ 30 ppm for 6 hours and stored at room temperature within vented polythene (T_6) showed maximum chlorophyll (1.89 mg/g) and was statistically at par with T_5 (1.88 mg/g) in petiolated leaves (Fig. 1).

At 13th day of storing during April–May, chlorophyll degradation was lowest (1.11 mg/g) in T_7 with petiolated leaves and highest (0.65 mg/g) in T_9 with and without petiole.

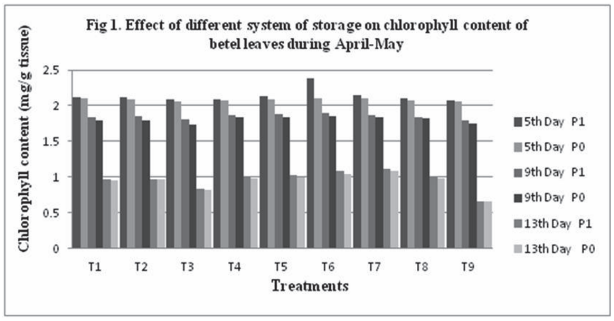
During July–August storage, chlorophyll content decreased in all treatments with duration of storage (Fig. 2). In the 5th day chlorophyll content was found to be higher in all the treatments compared to April–May, whereas, in the 9th day it showed a reverse trend. The highest amount of chlorophyll content (2.23 mg/g) was obtained with T_4 and T_6 at 5th day of storing.

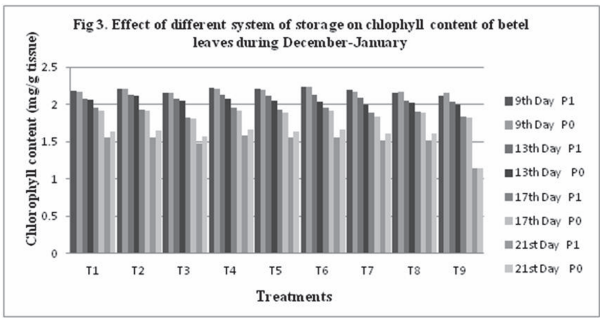
Fig. 3 showed that during December–January storage, leaves could be stored for more days, but chlorophyll content decreased gradually with duration of storing. Maximum chlorophyll (2.23 mg/g) was obtained in T_6 at 9th day, which decreased upto 1.61 mg/g at 21 st day of storing. With respect to chlorophyll content of the leaf, December–January was found to be the best among all the seasons.

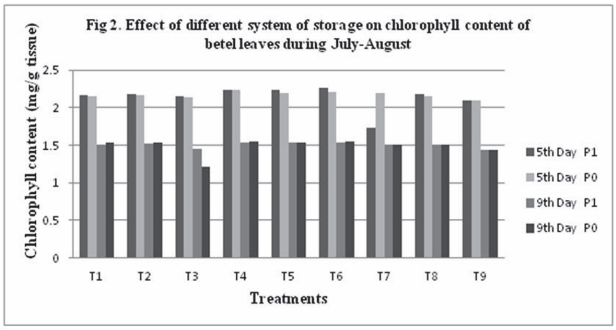
Ascorbic acid content

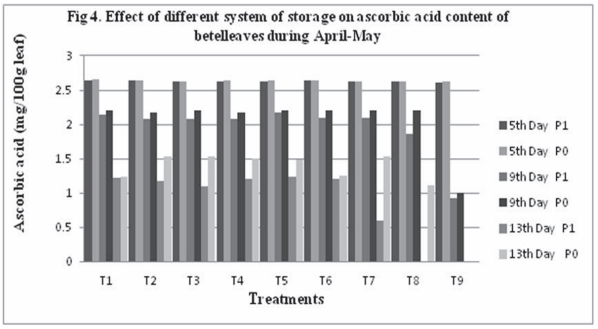
Ascorbic acid content was on par among treatments during 1st and 5th days of storage. The content ranged between 2.61–2.65 mg/100g leaves (Fig. 4) during 5th day of storage during April–May.

Highest ascorbic acid (2.18 mg/100g) was noted in T_5 and it was at par with T_1 (2.17 mg/100g). The lowest value (0.96 mg/100g) was recorded







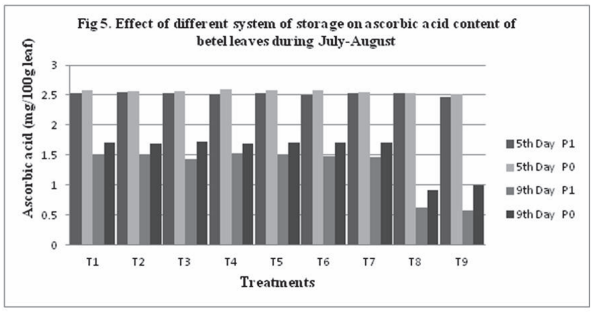


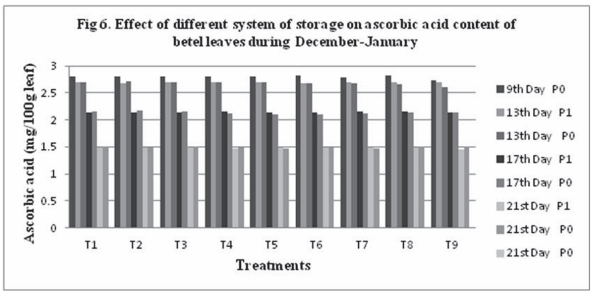
T_1=Sterilized paddy straw lining (5 cm thickness) in bamboo basket; T_2=Banana leaves packing; T_3=Leaves wrapped with moist hessian cloth lined with mustard seeds and ice pieces; T_4=Leaves kept in zero energy cool chamber; T_5=Leaves dipped in BA @ 15 ppm for 6 hours; T_6=Leaves dipped in BA @ 30 ppm for 6 hours; T_7=Leaves dipped in BA @ 45 ppm for 6 hours; T_8=Leaves kept in refrigerated condition (6–8°C); T_9=Leaves kept in refrigerated condition (6–8°C); T_9=Leaves kept at room temperature; P_1=Petiolated; P_0=Depetiolated.

in T_9 at 9th day (Fig. 4). Depetiolated leaves stored with sterilized paddy straw lining in bamboo basket (T_1) showed highest (2.21 mg/100g) ascorbic acid concentration in the leaves. Like 9th day on 13th day also the highest (1.36 mg/100g) ascorbic acid content was recorded in T_5 and it was at par with T_4. In case of interaction effect the maximum value (1.54 mg/100g) was recorded in T_7 (in depetiolated leaves).

During July–August storage, ascorbic acid content in leaf was found to be lower in all the treatments compared to April May both at 5th and 9th day of storing (Fig. 5). Maximum ascorbic acid content (2.56 mg/100g) was found in T_1 and T_5 closely followed by T_2 T_3 and T_4 (2.55 mg/100g), which gradually decreased at 9th day of storing.

During December–January storage (Fig. 6) the highest amount of ascorbic acid was found in





T_1=Sterilized paddy straw lining (5 cm thickness) in bamboo basket; T_2=Banana leaves packing; T_3=Leaves wrapped with moist hessian cloth lined with mustard seeds and ice pieces; T_4=Leaves kept in zero energy cool chamber; T_5=Leaves dipped in BA @ 15 ppm for 6 hours; T_6=Leaves dipped in BA @ 30 ppm for 6 hours; T_7=Leaves dipped in BA @ 45 ppm for 6 hours; T_8=Leaves kept in refrigerated condition (6–8°C); T_9=Leaves kept in refrigerated condition (6–8°C); T_9=Leaves kept at room temperature; P_1=Petiolated; P_0=Depetiolated.

all the treatments compared to other two seasons. At 9th day the maximum amount (2.81 mg/100g) was recorded in T_6 and T_8 and the lowest (2.77 mg/100g) was obtained with T_9. The amount gradually decreased up to 21st day of storing.

The experiment showed that storage life of betel leaves depends on presence or absence of petiole with the leaves. It was very clear from the result of the experiment that irrespective of season, depetiolated leaves had better shelf life than leaves with petioles. Presence of some senescence factor in the petiole may hasten the senescence processes during storage. Similar result was reported by Sandhya & Chauhan (1979) and Saikia *et al.* (1995).

This experiment also clearly demonstrated that shelf life of leaves was enhanced during December–January than April–May or July–August due to low temperature and less atmospheric humidity. Similar observation was reported by Saikia *et al.* (1993). Quick loss of shelf life during July–August and in April–May was mainly due to higher temperature and relative humidity. Among many factors responsible for senescence, low temperature was found to play a promising role in slow down action of degradative enzymes and denaturation of micro-molecules (Misra & Gaur 1980). This helps in enhancing shelf life during winter. On the other hand, high humidity with high temperature increased incidence of diseases specially the fungal one, due to congenial condition for their growth and resulted in early spoilage.

Among methods of storage, zero energy cool chamber showed its superiority over all other methods, irrespective of seasons and petiole regulation. Banana leaves packing was on par to the leaves treated with BA @ 30 ppm for 6 hours. Maximum spoilage of leaves was found during storage under room condition without any packaging. Wet straw lined bamboo basket was superior over storage under room condition but inferior to all other methods of storage. In general, banana leaves packing was found to be superior to wet straw packing. It might be due to low temperature in banana

leaves and high temperature due to heat trapping by wet straw and creation of congenial microclimate for spoilage.

Regarding quality parameters of the leaves during storage, data was recorded at three days interval. It was observed that irrespective of season, petiole regulation and methods of storage, ascorbic acid and chlorophyll content in leaves gradually decreased with increasing storage period. It is may be mainly due to continuous enzymatic reaction resulting in oxidation, thus decreasing the chlorophyll and ascorbic acid content of leaves. Pandey *et al*. (1998) also reported marked changes in chlorophyll, total protein and water soluble sugar content and total dehydrogenases activity up to 30 days. They also noticed that all the quality parameters showed decreasing trend during storage. The respiration rate as expressed by total dehydrogenases activity, though varied with the cultivars, became faster and the rate of senescence increased during storage.

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