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Influence of tender coconut water on post-harvest quality and shelf life on jasmine flowers (*Jasminum sambac* L.)

R Kumaravel and S Ganesh

Abstract
Experiment on the effect of different concentration of tender coconut water on post harvest quality and shelf life of jasmine flowers was conducted under ambient conditions at Ayothiapattinam, Salem district of Tamil Nadu during July 2016 to April 2018. Early morning harvested flower buds were soaked for two minutes in different solutions *viz*., T_1 - tender coconut water 10% (v/v), T_2 – tender coconut water 20% (v/v), T_3 – tender coconut water 30% (v/v), T_4 – Tender coconut water 40% (v/v), T_5 – tender coconut water 50 (v/v), T_6 – tender coconut water 60% (v/v), T_7 – Sucrose solution 5% (w/v) and T_8 – distilled water. The treated flowers were kept under ambient conditions and observed for freshness index, flower opening index, colour retention index, fragrance index, relative water content, physiological loss in weight, membrane stability index and shelf life. From the results of this experiment, it was concluded that jasmine flowers soaked with 40% tender coconut water for two minutes improved the quality as well as shelf life of flowers.

Keywords: Jasmine flowers, tender coconut water quality, quality of flowers and shelf life of flowers

Introduction
Jasmine is one of the oldest fragrant flowers and is especially appreciated in India (Anburani *et al.*, 2008) [2]. The term jasmine is probably derived from the Persian word "Yasmin" meaning "fragrance". Jasmine belongs to the family Oleaceae. Jasmines are widely cultivated in warm parts of southern Asia, Europe, Africa and the Pacific regions. Jasmine can be grown in a variety of climate and soils. Generally, it prefers midtropical climate for growth and flowering. Commercially grown important *Jasminum* species are *J. sambac, J. auriculutum, J. grandiflorum* and *J. multiflorum*. In India, Jasmines are cultivated throughout the country. However, the largest area under Jasmine flower production is in Tamil Nadu followed by Karnataka. In India, Jasmine (*Jasminum sambac* L.) is cultivated in an area of about 255.02 million hectare with an annual production of 2167 million tonnes (Rajiv *et al.*, 2018) [14]. Tamil Nadu is the leading producer of jasmine (*Jasminum sambac*) in the country with an annual production of 92951 tonnes and productivity of 8.75 tonnes per hectare from the cultivated area of 10623 ha. The flowers produced in the state are being exported to the neighbouring countries such as Sri Lanka, Singapore, Malaysia and Middle East countries. The major jasmine producing districts of Tamil Nadu are Dindigul, Salem, Madurai, Tirunelveli, Virudhunagar and Trichy. Since the crop requires huge manpower for harvesting and other operations, only small farmers are cultivating the crop. Tirunelveli districts ranks first in area under jasmine cultivation with an area of 1267.25 ha (Janani *et al.*, 2016) [5]. These flowers are used for various purposes like religious offering, veni, making garland, extraction of essential oil in the form of absolute and concrete which are used in cosmetic and perfumery industry. These flowers have good demand for export due to its attractive fragrance. But one of the major problem faced by farmers are shelf of flowers and browning of petals on the second day of harvest with abrupt loss in fragrance. Keeping this in mind, a study was undertaken to enhance the shelf life of jasmine flower along with ecofriendly biochemicals (Yathindra *et al.*, 2018) [17].

Materials and Methods
The field experiment in *Jasminum sambac* (L) was conducted at farmer's field at Ayothipattinum, Salem district of Tamil Nadu during July 2016 to April 2018. The flower buds were harvested in the early morning and were soaked for two minutes in different

treatments *viz*., T_1 - tender coconut water 10% (v/v), T_2 – tender coconut water 20% (v/v), T_3 – tender coconut water 30% (v/v), T_4 – Tender coconut water 40% (v/v), T_5 – tender coconut water 50 (v/v), T_6 – tender coconut water 60% (v/v), T_7 – Sucrose solution 5% (w/v) and T_8 – distilled water. Approximately 6-7 months matured tender coconut was used to extract tender coconut water. The experiment was conducted in a completely randomized design with three replications. The treated flowers were kept under ambient conditions and observed freshness index (percent), flower opening index (percent), colour retention index (percent), fragrance index (percent), moisture content (percent), relative water content (percent), physiological loss in weight (PLW percent) and membrane stability index (percent) at one day after treatment, two days after treatment and three days after treatment. The shelf life of flowers was observed by recording the number of hours upto which 50 percent or more flowers were kept fresh. The formula for various observations are furnished below.

Freshness index (FI)

The number of flowers which retained freshness without exhibiting petal necrosis, wilting and browning was measured by visual observation using the following score and expressed as percent fresh flowers or freshness index (Madhu, 1999) [8].

Table 1: Show the Number of flower buds under this score

Condition of flowers	Score	Number of flower buds under this score
Almost all buds turgid	7	X_1
Partial to half open flowers, turgid	6	X_2
Half to full open flowers, turgid	5	X_3
Partial to half open flowers, slightly wilted	4	X_4
Half to full open flowers, slightly wilted	3	X_5
Partial to half open flowers, fully wilted	2	X_6
Half to full open flowers fully wilted	1	X_7

Freshness index (FI) was computed using the following formula,

$$FI = \frac{(7 \times X_1) + (6 \times X_2) + (5 \times X_3) + (4 \times X_4) + (3 \times X_5) + (2 \times X_6) + (1 \times X_7)}{(X_1 + X_2 + X_3 + X_4 + X_5 + X_6 + X_7) \times 7} \times 100$$

Flower opening index

The flower opening index (FOI) was computed using the following formula (Madhu, 1999) [8].

$$FOI = \frac{(0 \times X_1) + (1 \times X_2) + (2 \times X_3) + (3 \times X_4)}{(X_1 + X_2 + X_3 + X_4) \times 4} \times 100$$

Table 2: The flower opening index was measured by the following score.

Stage of flowers	Score	Number of flower buds under this score
Unopened buds	0	X_1
Slightly opened	1	X_2
Half opened	2	X_3
Full opened	3	X_4

Colour retention index

Colour retention index (CRI) was computed by using the following formula Madhu (1999) [8].

$$CRI = \frac{(9 \times X_1) + (8 \times X_2) + (7 \times X_3) + (6 \times X_4) + (5 \times X_5) + (4 \times X_6) + (3 \times X_7) + (2 \times X_8) + (1 \times X_9)}{(X_1 + X_2 + X_3 + X_4 + X_5 + X_6 + X_7 + X_8 + X_9) \times 9} \times 100$$

Table 3: The retention of white colour of *J. sambac* flowers was recorded based on the following score,

Flower colour development during storage	Score	Number of flower buds under this score
Bright white	9	X_1
Dull white	8	X_2
Cream or yellowish	7	X_3
1 to 10% brown	6	X_4
11 to 15% brown	5	X_5
16 to 50% brown	4	X_6
51 to 75% brown	3	X_7
76 to 90% brown	2	X_8
All brown (100%)	1	X_9

Fragrance index

The fragrance released by the flowers was computed based on the following score (Madhu, 1999) [8].

Table 4: Fragrance index

Fragrance level	Ranking
Least and undesirable	1
Mild	2
Strong	3
Very strong	4

Moisture content

The moisture content of the flower was estimated after recording fresh weight and dry weight of flower buds (Kept in hot air oven at 80 + 2 °C). Moisture content was expressed on fresh weight basis in percent.

$$\text{Moisture content (\%)} = \frac{\text{Fresh weight - dry weight}}{\text{Fresh weight}} \times 100$$

Relative water content

The relative water content of leaves was calculated as per the method of Barrs and Weatherly (1962) [3] to find out the percentage of water held by leaves relative to fully turgid tissue. Flowers were punched uniformly and the fresh weight of the punches (30 numbers) was taken. Then punches were made to float in water for 2 hours, after which the turgid weight was recorded after removing the excess water by blotting them thoroughly. The dry weight was found out after drying in an oven at 70 °C. The RWC was calculated using the formul at given below and expressed in percent.

$$\text{Relative water content per cent} = \frac{\text{Fresh weight – dry weight}}{\text{Turgid weight – dry weight}} \times 100$$

Physiological loss in weight (PLW)

The PLW of flowers was calculated by using the following formula and expressed in percent.

$$PLW = \frac{\text{Fresh weight (I day)} - \text{Fresh Weight (II day)}}{\text{Fresh weight (I day)}} \times 100$$

Membrane stability index (MSI)

Thirty flower discs of one cm diameter were cut using a punching machine and were added into a 100 ml flask and

washed three times with de-ionized distilled water (Blum and Ebercon, 1981) [4]. For the desiccation treatment, flower discs were submerged in 30 ml of 30% PEG 600 solution and were allowed to stand in the solution for 24 hrs at 10 °C. Discs were submerged in deionized distilled water for non-desiccated control. For both desiccated and controlled samples, 30 ml of deionized distilled water were added and flower discs kept again for 24 hr at 10ºC. The flask was then warmed to 25 °C, shaken well and the electrical conductivity was measured using the electric conductivity meter. Following cooled to 23 °C and the electrical conductivity was measured for the second time. Three replicates were measured for the desiccation treatment (T) and non-desiccated control (C).

$$\text{Percentage injury} = \frac{1 - (T_1/T_2)}{1 - (C_1/C_2)} \times 100$$

MS1 = 100 – percentage of injury
T_1 = first conductivity measured of desiccation treatment,
T_2 = second conductivity measured of desiccation treatment,
C_1 = first conductivity measured of control and
C_2 = second conductivity measurement of control

Shelf life of flowers

The shelf life of flowers was assessed by recording the number of hours upto which 50 percent or more flowers kept fresh (Kumaresan, 2023) [7].

Statistical Analysis

The data on various parameters observed during the course of investigation were statistically analysed by applying the technique of analysis of variance suggested by Panse and Sukhatme (1978) [12].

Results and Discussion

Freshness index is an important quality parameter in Jasmine flowers. In the present study, the post-harvest treatments significantly influenced the freshness index of the jasmine flowers in all the three days of observations (Table 5). Among the treatments, jasmine flowers soaked with 40% of the tender coconut water (T_4) recorded the highest freshness index of 92.16, 79.36 and 67.07 percent in one day after treatment, two day after treatment and three days after treatments respectively. It was followed by 5% sucrose solution (T_8) which recorded 90.84, 77.56 and 58.62 percent in one day, two day and three days after treatment respectively. The higher freshness index due to coconut water might be due to the presence of auxin, gibberellin and cytokinin (Mamaril *et al.*, 1986) [9]. Nair *et al*. 2000 [11] also obtained similar results coconut water in cut flowers.

The flower opening index increased progressively from one day after treatment to three days after post-harvest treatments (Table 5). Comparing the treatments, jasmine flowers soaked with 40% of the tender coconut water (T_4) for two minutes maintained lower flower opening index (23.28 percent) than the other treatments and control in one day two days (30.45 percent) and 39.63 (percent). The jasmine flowers soaked with distilled water (T_7) recorded higher flower opening index in all the three days observations *viz*. one day after treatment (31.15 percent) two days after treatment (37.14 percent) and three days after treatment (45.19 percent). Cytokinin being a natural hormone present in tender coconut water with antimicrobial and anti-senescence properly might be the probable season for the better performances of coconut water (Agampodi and Jayawardena, 2007) [1].

The post-harvest treatments with jasmine flowers with 40% of tender coconut water (T_4) for two minutes recorded the highest colour retention index in all the three days *viz*., one day after treatment (98.22 percent), two days after treatment (86.02 percent) and three days after treatment (69.02 percent) (Table 6). Similar increase in colour retention index of jasmine flower was also obtained with cow urine by Sobhana (2014) [16].

The fragrance index decreased progressively from one day after treatment to three days after treatment (Table 6). The post-harvest treatments significantly influenced the jasmine flower fragrance index. Among the treatments, 40% tender coconut water (T_4) recorded the highest fragrance index in all the three days of observations *viz*. 4.00 in one day, 3.00 in two days and 2.00 in three days after post-harvest treatment. This might be attributed presence of kinetin in tender coconut water which maintained the fragrance in jasmine flowers. These results are in accordance with the findings of Agampodi and Jayawardena, (2007) [1].

The higher moisture content in any flower is an index of freshness with lower senescence. Hence, water balance is a major factor that determines quality and longevity of flowers. The moisture content of the jasmine flowers decreased progressively from one day after treatment to three days after treatment. Data in the present study revealed that the jasmine flowers treated with 40% coconut water (T_4) registered the highest moisture content in all the three stages of observations *viz*., 63.15 percent in one day after treatment, 56.51 percent in two days after treatment and 39.32 percent in three days after treatment (Table 7). This may be due to the presence of cytokinin in the tender coconut water which reduced the ethylene content and retarded the senescence. Similar result was also obtained by Ratikanth (2005) [15]. The lowest moisture content of 59.29 percent, 43.35 percent and 30.74 percent were recorded in one day, two days and three days after post-harvest treatment respectively. The progressive decrease in water content on storage indicate the beginning of the senescence of the flower.

It was evident from the data (Table 7) that among the post-harvest treatments, the jasmine flowers soaked with (T_4) 40% tender coconut water recorded the highest relative water content (RWC) of 88.54 percent, 82.36 percent and 65.32 percent in one day, two days and three days of the post-harvest treatment respectively. The jasmine flowers treated with 5% sucrose solution (standard) was found to be the next best treatment and recorded 87.21 percent in one day after treatment, 79.83 percent in two days after treatment and 64.18 percent in three days after treatment. In contrast to the coconut water and sucrose solution treatments, the jasmine flowers with distilled water (T_8) recorded the lowest RWC of 81.65 percent in one day after treatment, 57.44 percent in two days after treatment and 54.65 percent in three days after treatment.

The Physiological Loss in Weight (PLW) decreased progressively from one day after treatment to three days after treatment (Table 8). The lowest PLW was recorded due to the treatment of jasmine flowers with (T_4) 40% tender coconut water in all the three stages of observations *viz*., 0.69 percent in one day after treatment, 1.15 percent in two days after

treatment and 2.38 percent in three days after treatment. The this treatment was closely followed by 5% sucrose treatment *viz*., 0.72 percent in one day, 1.171 percent in two days and 2.42 percent in three days after treatment. The distilled water treatment with jasmine flowers (T_7) continued to show poor performances and recorded the highest PLW of 1.25 percent in one day, 1.93 in two days and 3.28 in three days after treatment. The lowest PLW in best treatment (40% coconut water) may be due to the presence of plant hormones which slow down respiration and transpiration and ultimately reduced physiological loss of weight. This result was in line with the findings of Madhu (1999) [8].

Membrane stability index (MSI) is used to measure the membrane integrity of the flowers. In general, it was observed from the data that membrane stability index decreased as the storage life increased (Table 8). Higher the stability, lower will be the membrane leakage (integrity). Lower leakage associated with higher shelf life (Martin *et al.,* 1987) [10]. The jasmine flowers treated with 40% sucrose solution (T_4) continued to show best performance and maintained the highest MSI in all the three stages of observations *viz*., 93.59 percent in one day, 80.16 percent in two days, and 49.02 percent in three days after treatment. The results confirm the findings of Karuppaiah *et al.*, (2016) [6].

Data pertaining to the shelf life of jasmine flowers (hours) are presented in Table 9. Critical analysis of the data revealed that the highest shelf life of 76.45 hours was recorded in jasmine flowers soaked with (T_4) 40% tender coconut water for two minutes. It might be due to the presence of cytokinin in tender coconut water. In fact, cytokinin with a role in cell division, pertaining the degradation of chrlorophyll and causes delay in senescence. In addition, cytokinin have the antiethylene property and cause prolonged vase life of flowers by preventing ethylene activity (Penner and Wiely, 2008) [13].

Table 5: Effect of post-harvest treatments on freshness index (%) and flower opening index (%) in jasmine flowers

Treatment	Freshness index (%)			Flower opening index (%)		
	One day after treatment	Two days after treatment	Three days after treatment	One day after treatment	Two days after treatment	Three days after treatment
T_1 - Tender Coconut Water 10%	87.32	67.21	57.26	26.44	33.02	40.26
T_2 - Tender Coconut water 20%	89.44	69.44	63.58	24.25	32.38	41.49
T_3 - Tender Coconut water 30%	89.75	78.43	65.12	28.47	36.25	43.76
T_4 - Tender Coconut water 40%	92.16	79.36	67.07	23.38	30.45	39.63
T_5 - Tender Coconut water 50%	89.74	65.58	47.42	30.70	36.16	44.57
T_6 - Tender Coconut water 60%	88.62	69.43	48.98	28.66	35.73	41.21
T_7 - Distilled Water (Control)	86.21	66.82	55.86	31.15	37.14	45.19
T_8 - Sucrose 5%(Standard)	90.84	77.56	58.62	24.54	31.66	43.53
SE(d)	1.46	1.18	0.97	0.43	0.55	0.70
CD (P=0.05)	3.10	2.51	2.05	0.92	1.18	1.48

Table 6: Effect of post-harvest treatments on colour retention index (%) and fragrance index (%) in jasmine flowers

Treatment	Colour retention index (%)			Fragrance index (%)		
	One day after treatment	Two days after treatment	Three days after treatment	One day after treatment	Two days after treatment	Three days after treatment
T_1 - Tender Coconut Water 10%	90.89	78.99	61.99	3.00	2.00	1.00
T_2 - Tender Coconut water 20%	95.89	83.14	65.14	3.00	2.00	1.00
T_3 - Tender Coconut water 30%	96.89	85.16	66.16	3.00	2.00	1.00
T_4 - Tender Coconut water 40%	98.22	86.02	69.02	4.00	3.00	2.00
T_5 - Tender Coconut water 50%	92.11	79.57	53.57	3.00	2.00	1.00
T_6 - Tender Coconut water 60%	93.78	82.76	64.76	3.00	2.00	1.00
T_7 - Distilled Water (Control)	90.89	74.69	52.14	3.00	2.00	1.00
T_8 - Sucrose 5% (Standard)	97.16	86.27	68.36	4.00	3.00	2.00
SE(d)	1.53	1.33	1.04	0.04	0.03	0.01
CD (P=0.05)	3.24	2.83	2.21	0.10	0.06	0.03

Table 7: Effect of post-harvest treatments on moisture content (%) and relative water content (%) in jasmine flowers

Treatment	Moisture content (%)			Relative water content (%)		
	One day after treatment	Two days after treatment	Three days after treatment	One day after treatment	Two days after treatment	Three days after treatment
T_1 - Tender Coconut Water 10%	60.19	47.63	32.25	83.24	65.45	55.41
T_2 - Tender Coconut water 20%	61.12	49.47	36.85	87.21	78.29	63.25
T_3 - Tender Coconut water 30%	60.04	51.77	37.23	87.48	82.36	65.32
T_4 - Tender Coconut water 40%	63.15	56.51	39.32	88.54	82.36	65.32
T_5 - Tender Coconut water 50%	60.05	48.10	35.25	85.43	70.16	60.25
T_6 - Tender Coconut water 60%	61.98	44.19	32.15	85.54	66.25	59.36
T_7 - Distilled Water (Control)	59.29	43.35	30.74	81.65	57.44	54.65
T_8 - Sucrose 5% (Standard)	62.56	53.40	38.25	87.21	79.83	64.18
SE(d)	1.00	0.80	0.58	1.41	1.12	0.91
CD (P=0.05)	2.12	1.70	1.23	3.00	2.38	1.94

Table 8: Effect of post-harvest treatments on physiological loss in weight (%) and membrane stability index (%) in jasmine flowers

Treatment	Physiological loss in weight (%)			Membrane stability index (%)		
	One day after treatment	Two days after treatment	Three days after treatment	One day after treatment	Two days after treatment	Three days after treatment
T_1 - Tender Coconut Water 10%	0.82	1.38	2.72	92.43	74.78	45.19
T_2 - Tender Coconut water 20%	0.87	1.42	2.60	91.82	71.67	43.05
T_3 - Tender Coconut water 30%	0.85	1.62	2.48	85.67	65.82	42.63
T_4 - Tender Coconut water 40%	0.69	1.15	2.38	93.59	80.16	49.02
T_5 - Tender Coconut water 50%	1.15	1.72	2.85	92.81	79.31	47.22
T_6 - Tender Coconut water 60%	1.20	1.85	2.92	93.15	79.67	48.13
T_7 - Distilled Water (Control)	1.25	1.93	3.28	70.43	48.17	35.41
T_8 - Sucrose 5%(Standard)	0.72	1.17	2.42	72.58	49.64	36.39
SE(d)	0.016	0.025	0.044	1.421	1.138	0.717
CD (P=0.05)	0.034	0.054	0.094	3.012	2.414	1.521

Table 9: Effect of post-harvest treatments on shelf life (hr) in jasmine flowers

Treatment	Shelf life (hr)
T_1 - Tender Coconut Water 10%	68.53
T_2 - Tender Coconut water 20%	73.56
T_3 - Tender Coconut water 30%	72.96
T_4 - Tender Coconut water 40%	76.45
T_5 - Tender Coconut water 50%	69.47
T_6 - Tender Coconut water 60%	71.78
T_7 - Distilled Water (Control)	55.38
T_8 - Sucrose 5%(Standard)	75.21
SE(d)	1.12
CD (P=0.05)	2.39

Conclusion

The present study led to the inference that freshly harvested jasmine flowers soaked in 40 percent 6-7 months matured tender water for 2 minutes enhanced the freshness index, colour retention index, fragrance index, relative water coconut, lowest physiological loss in weight and hence resulted in higher, shelf life. Hence, soaking jasmine flower in 40 percent tender coconut water for two minutes can be recommended to enhance the shelf life of jasmine flowers.

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