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Biopreservative effect of plant extracts on the shelf life of mango cv Raspuri

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Abstract
An investigation was undertaken to study effect of medicinal plant extracts/bulb extracts *viz* bael (50 and 70%), tulsi (50 and 100%), Garlic (5 and 10%) on shelf life of mango. The physiological loss of weight in mango fruits showed an increasing trend in all the treatments. Contrary to this acidity decreased with storage. However, there was an increase in pH with extension of storage period. The total soluble solids of fruits first increased upto a certain period and there after decreased. Bulb extracts of garlic @ 10 per cent were most effective of all the treatments with minimum spoilage percentage followed by garlic extracts @ 5 per cent concentration and tulsi extracts at 100 per cent concentration. In the present study bael extracts (50 and 100 per cent concentrations) were not effective in extending the shelf life of mango (Raspuri). The investigation concludes that the shelf life of mango fruits can be extended from 3 to 7 days by treating with 10 per cent garlic extract.

Keywords: Biopreservation, mango, tulsi extract, garlic extract, bael extract

Introduction
In India, Mango is known as the king of fruits and has unique state, prominent flavor with strong aroma and contains high amount of vitamin A and C, beta-carotenoids and trace amount of minerals [1]. In addition to this they are also very tasty and refreshing. Large varieties of fruits are grown in India, India accounts for about 10 per cent of the production of fruits in the world.

Mango (*Mangifera indica* L.) is an important tropical fruit however, it is susceptible to a number of biotic and abiotic stresses that leads to rapid deterioration and large postharvest losses, estimated to be over 50% in some developing countries. Fungal disease is one of the most important causes of postharvest losses [2].

To prevent the postharvest losses, these susceptible foods are treated with synthetic chemicals which have toxicity effect, some are carcinogenic and cause environmental pollution so to find an alternative way for synthetic chemicals, biological compounds are being used which are nontoxic, specific in their action and safe to environment and for the living beings [3]. To overcome this rapid loss of fruits or other foods, Biopreservation is a novel food preserving method which helps in extending the shelf life and enhanced food safety by using natural or controlled microbiota or antimicrobial compounds [4]. These compounds do not have side effects and also due to presence of antimicrobial compounds, increases the fruit quality and storage period [5]. Bioactive products of plant are less persistent in environment and are safe for humans and other non-targeted organisms.

In the present study, Biopreservation of mango fruits by using different concentration of Bael extract, garlic extract and tulsi extract was carried out *in vivo* to evaluate the effect of plant extract on preserving the mango fruits.

Material and Methods
Selection of Efficient Medicinal Plant Extracts
Aqueous extracts of bael, garlic and tulsi found to be effective against selected postharvest pathogens of mango fruit from our previous study were used.

Matured, uniform sized, undamaged healthy fruits of mango (Cv Raspuri) were randomly selected after harvest and subjected to various treatments. There were seven treatments and three replications in each treatment. The post-harvest treatments imposed were as follows:

Treatments	
T1	Control
T2	Bael Extract @50%
T3	Bael Extract @75%
T4	Garlic Extract @5%
T5	Garlic Extract @10%
T6	Tulsi Extract @50%
T7	Tulsi Extract @100%

The fruits were dipped in the extracts for five minutes and then air dried. The untreated and treated fruits were bagged in new ventilated polythene covers and kept at room temperature. Observations were taken on the 3rd, 6th, 9th, 12th and 15th day.

The following observations were recorded for shelf life studies:

Spoilage Percent

The number of spoiled fruits was counted in each treatment. They were expressed as per cent of spoiled fruits.

$$\textbf{Spoilage per cent} = \frac{\text{Number of fruits spoiled}}{\text{Total number of fruits}} \text{ x } 100$$

Physiological Loss of Weight (PLW)

The fruits were weighed at regular intervals i, e, 3rd, 6th, 9th, 12th and 15th day after treatment for mango. The loss in weight of fruits due to spoilage was calculated as per cent loss of weight.

Titratable Acidity (Citric Acid %)

Total titratable acidity was determined by the method, described by Ranganna [6]. Five g of pulp was blended with 40 ml water and volume was made upto 50ml with distilled water. Five ml of this was taken and titrated against 0.1N NaOH solution using phenolphthalein. The acidity was expressed as citric acid per cent.

Total Soluble Solids (TSS)

Pulp from randomly selected fruit was taken and macerated for juice extraction and TSS of the juice was determined using hand refractometer (Erma Japan) of 0-30 per cent range. The values were expressed as per cent total soluble solids of the fruits.

Ph

Fifty grams of the pulp were macerated with fifty ml of distilled water. The pH was read using a Digital (Hanna) pH meter [6].

Statistical Analysis

The data was statistically analyzed by adopting the analysis of variance technique appropriate to the levels of treatment [7].

Results and discussion

Spoilage per cent

At 3 days of storage fruits did not show any spoilage in all treated and untreated fruits (Table 1). However at 6 days of storage untreated fruits showed maximum spoilage (26.6 %) compared to the fruits treated with garlic extracts (10 per cent concentration) which showed 0 % spoilage and tulsi extracts (100 per cent concentration) showed 16.67 per cent spoilage indicating that the plant extracts of garlic and tulsi control the spoilage of mango fruits upto 6 days.

Further at 9 days of storage period fruits showed more spoilage per cent in all treated and untreated fruits. However fruits treated with 10 per cent garlic extracts can control the spoilage upto 9 days. After 9 days of storage period all the fruits showed more spoilage per cent indicating no shelf life of fruits after 9 days. There was significant difference between treatments on the 12th day. The fruits that were treated with garlic @ 10 per cent concentration showed minimum mean spoilage percentage of 53.3 per cent which differed significantly with fruits treated with tulsi @ 100 per cent concentration (73.3 per cent) and garlic @ 5 per cent concentration (73.3 per cent). The rest of the treatments were on par with each other. By 15 th day all the fruits were spoilt and unfit for consumption.

Table 1: Post Harvest shelf life of mango fruits treated with medicinal plant extracts

Treatments	Spoilage days after harvest				
	3 Days	6 Days	9 Days	12 Days	15 days
T1 Control	0.00 (12.92)	26.67 (31.05)	53.33 (46.89)	100.00 (93.24)	100.00 (93.24)
T2 Bael Extract @50%	0.00 (12.92)	20.00 (26.56)	53.33 (46.89)	93.33 (75.00)	100.00 (93.24)
T3Bael extract @75%	0.00 (12.92)	13.33 (21.39)	33.33 (35.24)	93.33 (75.00)	100.00 (93.24)
T4 Garlic extract @5%	0.00 (12.92)	6.67 (14.89)	26.67 (31.05)	73.33 (58.89)	100.00 (93.24)
T5 Garlic extract 10%	0.00 (12.92)	0.00 (12.92)	6.67 (14.89)	53.33 (46.89)	100.00 (93.24)
T6 Tulsi Extract 50%	0.00(12.92)	13.33 (21.39)	46.67 (43.05)	86.67 (68.53)	100.00 (93.24)
T7 Tulsi Extract 100%	0.00 (12.92)	6.67 (14.89)	46.67 (43.05)	73.33 (58.89)	100.00 (93.24)
CD@5%	-	-	-	18.54	-

*Note: Spoilage is expressed as % of fruits spoiled

Figures in parenthesis indicate values after arc-sine transformation.

Fungicidal potentials of different plant extracts against postharvest fungi *Colletotrichum gloeosporioides* in Mango have been well demonstrated [8]; so also the effects of Plant Leaf Extract against *Colletotrichum gloeosporioides* (Penz) Sac. causing Post-Harvest Disease of Papaya by using different plant extracts such as Mango, lemon, papaya nut grass etc. [9]

Physiological loss of weight (PLW)

There was no significant difference in mean physiological loss of weight in the fruits subjected to all the six treatments and control after 3 days of treatment (Table 2). Highest mean weight loss (0.36 per cent) was observed in control fruits.

On the 6th day after treatment the mean physiological weight loss recorded ranged from 1.32 to 2.16.per cent. No significant difference in the weight loss was observed at 9 days after treatment. Maximum mean weight loss (5.71 per cent) was observed in control fruits followed by fruits treated with bael extracts @ 50 per cent concentration (5.18 per cent) and least PLW was recorded with fruits treated with 5 per cent garlic extracts (2.74 per cent).

Table 2: Post-harvest physiological loss of weight (PLW) of mango fruits treated with medicinal plants extracts

Treatments	PLW%- days after harvest				
	3 Days	6 Days	9 Days	12 Days	15 days
T1 Control	0.36 (3.44)	1.86 (7.71)	5.71 (13.81)	8.86 (17.26)	13.37 (21.39)
T2 Bael Extract @50%	0.29 (3.09)	2.16 (8.33)	5.18 (13.05)	7.96 (16.32)	11.01 (19.37)
T3Bael extract @75%	0.31 (3.19)	1.86 (7.71)	4.28 (11.83)	7.94 (16.32)	12.14 (20.36)
T4 Garlic extract @5%	0.30 (3.14)	1.32 (6.55)	2.74 (9.46)	5.44 (13.44)	8.03 (16.43)
T5 Garlic extract 10%	0.31 (3.19)	1.86 (7.71)	3.30 (10.47)	5.85 (13.94)	8.02 (16.43)
T6 Tulsi Extract 50%	0.30 (3.14)	1.60 (7.27)	3.64 (10.94)	7.22 (15.56)	9.53 (17.95)
T7 Tulsi Extract 100%	0.30 (3.14)	1.60 (7.27)	3.94 (11.39)	6.08 (14.18)	9.95 (18.34)
CD@5%	-	-	-	-	2.98

*Note: Weight loss is expressed as % of weight loss
Figures in parenthesis indicate values after arc-sine transformation

At 12 days after treatment, the mean weight loss of control fruits was 8.86 percent which was maximum. All the treatments and control were on par with each other. Significant differences were observed in mean physiological loss of weight on 15 days after treatment. The fruits treated with garlic extracts at 10 per cent concentration showed minimum mean weight loss of 8.02 per cent followed by fruits treated with garlic 5 per cent with a mean weight loss of 8.03 per cent. These treatments were on par with fruits treated with tulsi extracts @ 50 per cent and 100 per cent concentration.

The results indicated that mango fruits treated with garlic (5 and 10 per cent concentration) will enhance shelf life of fruits by less PLW during the storage period.

Studies were also conducted on storage behavior of mango [10], showing that the physiological loss in weight was found to be very slow in fruits treated with 20 % neem leaf extract as compared to Pongamia, custard apple leaf and marigold flowers extracts.

Titratable Acidity

On 3rd day of storage, there was not much variation in the titratable acidity among the treatments. Maximum acidity (1.88 per cent) was recorded in fruits treated with garlic extract @ 5 per cent and control fruits. In rest of the treatments the acidity ranged from 1.70 to 1.83 percent (Table 3).

A decrease in acidity was observed in all treatments after 6 days. Fruits dipped in garlic extract @ 5 per cent concentration and tulsi extracts @ 100 per cent concentration recorded highest acidity (1.68) lowest acidity of 1.44 per cent was recorded in control fruits.

On day 9, fruits treated with tulsi extracts @ 100 per cent concentration showed maximum acidity (0.80 per cent). In rest of the treatments the acidity ranged from 0.54 to 0.70 per cent. On day 12, there was further decrease in acidity in all the treatments. The acidity content of fruits ranged from 0.27 to 0.37 per cent. The former was recorded in control fruits and latter was observed in fruits dipped with garlic extracts @ 10 per cent concentration.

Table 3: Post-harvest changes in titratable acidity (citric acid %) of mango fruits treated with medicinal plants extracts

Treatments	Titratable Acidity days after harvest				
	3 Days	6 Days	9 Days	12 Days	15 days
T1 Control	1.88	1.44	0.54	0.27	0.12
T2 Bael Extract @50%	1.83	1.45	0.57	0.36	0.12
T3Bael extract @75%	1.80	1.60	0.62	0.28	0.15
T4 Garlic extract @5%	1.88	1.68	0.67	0.35	0.12
T5 Garlic extract 10%	1.78	1.62	0.69	0.37	0.15
T6 Tulsi Extract 50%	1.70	1.64	0.70	0.35	0.15
T7 Tulsi Extract 100%	1.82	1.68	0.80	0.32	0.12

* Note: Titratable Acidity expressed as citric acid %

There was not much difference among the treatment in the acidity percent of fruits at 15 days after storage. The acidity content was low ranging from 0.12 to 0.15 per cent.

The different plant extract treatments had significant effect in slowing down ripening processes. Fruits treated with neem leaf extract showed higher retention of acidity during storage. This could be due to the influence of treatments in delaying physiological ageing and alteration in metabolism, which might owed to higher retention of acidity. Our results are in agreement with the results of other reports [10, 11, 12, 13].

Total Soluble Solids (TSS)

The TSS of fruits was measured using a hand refractometer. On the 3rd day after storage, there was not much variation in the TSS irrespective of the treatments. The TSS content of fruits ranged from 11.0 to 12.6 per cent **(**Table 4). There was an increase in TSS in all the treatments after 6 days of storage.

Maximum TSS (15.8 per cent) was observed in fruits treated with tulsi @ 100 per cent and fruits dipped in bael extract @ 50 per cent recorded lowest TSS (14.6 per cent). Fruits dipped in garlic extracts @ 10 per cent showed highest TSS (17.2 per cent) at 9 days after storage. In rest of the treatments the TSS varied from 16.0 per cent to 16.8 per cent. On day 12, the TSS contents of fruits increased to maximum in all the treatments.

The TSS content varied from 17.8 per cent to 18.4 per cent. The former was observed in fruits dipped in bael extract @ 50 per cent and control fruits. The latter was recorded in fruits treated with tulsi @ 50 per cent. A decrease in TSS was recorded in all the treatments at 15 days after storage.

Table 4: Post-Harvest changes in total soluble solids (TSS) of mango fruits treated with medicinal plants extracts

Treatments	Total soluble solids days after harvest				
	3 Days	6 Days	9 Days	12 Days	15 days
T1 Control	11.6	14.8	16.0	17.80	16.40
T2 Bael Extract @50%	12.40	14.60	16.2	17.8	16.0
T3Bael extract @75%	11.0	15.2	16.4	18.0	16.6
T4 Garlic extract @5%	12.6	14.8	16.8	18.2	17.0
T5 Garlic extract 10%	12.6	15.4	17.2	18.0	17.2
T6 Tulsi Extract 50%	11.8	15.6	16.8	18.4	17.0
T7 Tulsi Extract 100%	12.2	15.8	17.0	18.0	17.4

* Note: The values are expressed as per cent total soluble solids of the fruits

There was not much variation in TSS content among the treatments. The TSS content of fruits varied from 16.0 per cent to 17.4 per cent. Chauhan and Joshi (1990) [14] reported the efficacy of phytoextracts on the storage quality of mango cv. Ratna and found them significantly better in retaining total soluble solids and sugar contents and in reducing reduction in the possible incidence of anthracnose pathogen in comparison to untreated fruits where lower soluble solid and sugar content and higher incidence of anthracnose pathogen was reported. The increase in TSS and sugar content may be due to the hydrolysis of insoluble polysaccharides into simple sugars. Such changes are expected to be slower and more gradual when the metabolism of the commodity is slowed down by the application of various coating treatments, pre-cooling and under low temperature storage [14].

Initially, the total soluble solids content of fruits increased which may be due to the hydrolysis of insoluble polysaccharide into simple sugars. Afterwards it declined gradually may be due to decline in the amount of carbohydrates and pectin, partial hydrolysis of protein and decomposition of glycosides into sub-units during respiration. At the end of the storage study, the highest TSS content were recorded in fruits treated with 20 % neem leaf extract (Table 4), which might be because of reduced respiration rate and delayed ripening in this treatment whereas, the lowest was in control, probably due to higher respiratory losses in these fruits as there was no barrier to restrict the movement of gases in the fruit [15].

Plant extracts are important in order to reduce the environmental pollution by synthetic chemicals. In day to day life the world is facing the threat of global warming and pollution, in order to contribute in keeping the environment clean to some extent and reduce the residual effect of synthetic insecticide and pesticides. The extract of neem, marigold and other plant extracts increase the shelf life of the fruits and vegetables by reducing the fungal and bacterial spoilage during storage. Neem extracts was best in retaining most of biochemical characteristics such as TSS, acidity, pectin and ascorbic acid content [10].

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