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Impact of thermal and chemical treatments on ascorbic acid of fresh cut mangoes fruit

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Abstract

Quality attribute, viz., ascorbic acid (vitamin C) of minimally processed mangoes (cv. Dashehari and Langra) were studied at different level of thermal and chemical treatments. Thermal treatment (hot water temperature: 40, 45 and 50°C and water dipping time: 30, 40 and 50 minute) and chemical treatments (calcium chloride solution at different concentration of 2.5 and 3.5%) was applied on whole mangoes followed by another factor of chemical treatment i.e. malic acid solution at different concentrations (0.5 and 1.0%) were subjected to slice (cube) of mangoes. The effect of thermal treatments on vitamin C was decreased in sample of both mango verities. Whereas chemical treatments improve the value of ascorbic acid. The quality attributes were found higher in sample of Langra mango than Dashehari during whole given treatments. The highest ascorbic acid (17.59 and 142.99mg/100 gm for Dashehari and Langra respectively) was observed at 40°C/30min/3.5%$CaCl_2$/1%malic acid treatment.

***Key words**: Mango variety, minimal processing, thermal and chemical treatment, ascorbic acid*

1. INTRODUCTION

Mango fruit(*Mangiferaindica* Linn)belongs to the family Anacardiaceae and reported to have originated in Southeast Asia in general and Indo-Malaysian region in particular. Mango is regarded as “national fruit” of India, Pakistan and the Philippines (Anonymous, 2007).Mango is the most chief crop occupying about 43% of the total area under fruit in India, and this fruit accounts for 28% of the total production of fruits.Mango is a vital fruit crop in India and popularly called the 'king of fruits'. India rank first among world’s mango producing countries contributing nearly 50 per cent of world’s production.In India major mango varieties are Alphonso, Amrapali, Dashehari, Langra, Neelum, Mallika, Totapuri, Chaunsa, Himsagar and Bombay.Mango is most economically tropical fruit in the world due to their unique taste, aroma and nutritional content. Mango is commercially grown in more than 80 countries. India, China and Thailand are top three mango producing nations in the world. India and Pakistan are prized for their unique aroma and flavor all over the world. In case of productivity, Brazil ranks first i.e. 15.83 MT/ha (Patil, Deshmukh,Bhjaskar&Jahagirdar, 2018).

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Mango is an excellent source of vitamins A and C both important antioxidant nutrients. Vitamin C promotes healthy immune function and collagen formation. Vitamin A is important for vision and bone growth.Mango is a good source of dietary fiber, therefore, it is associated with a reduced risk of some types of cancer, protecting against heart disease and cholesterol build up mango (Vinci, Botre, Mele & Ruggieri, 1995; Shieber, Ulrich & Carle, 2000).

The nature of mango is climactericand after harvestripen rapidly. Mango fruit sensitivity to low storage temperatures and perishability due to ripening and softening are serious causes of post-harvest losses in mango, limiting its handling, transport potential and storage.25-40 percent post-harvestlosses have been estimated (Rekha & Goswami, 2007).This wastage can be reduced to some extent through proper and scientific methods (Anon 2013).The two major postharvest diseases that cause extensive losses in all mangos producing area of the world are anthracnose caused by Colletotrichum gloeosporioides and stem-end rot caused by Botryosphaeria types. In recent years, mangoes have become well recognized as fresh fruit in the global market but due to convenience it suffers (Djioua et al., 2009).Hot water dips are operative in controlling post-harvest anthracnose and stem-end rot diseases. However specific control of temperature and time is critical, otherwise fruit can be simplyinjuredthrough overexposure to heat (Swart, Serfontein&Kalinnowski, 2002).

Proper maturity of harvested fruit is essential both for fresh fruit sale and for processing. These immature fruits often appear on the market early in the season and are thought to have contributed to the poor rating of early season mangoes by consumers (Young &Sauls, 1980). The marketable value and value of mango fruits depends on the phase of maturity. Maturity is based on the measurement of several qualitative and quantitative aspects. Such as physical characteristics like color, size, shape, shoulder growth and specific gravity. Some workers have associated it with chemical parameters such as total soluble solids, starch, acidity, caroteneids (Rao, Giridhar, Prasas& Rao, 1972).

Changes in consumer life styles together with the increasing desire for fresh quality in food products, has lead to the development of a new category of fruit, minimally processed fruit. Minimally processed fruits (peeled, cored and sliced) are a growing segment among food products due to the convenience and fresh like quality of the products (Pittia, Nicoli. Comi&Massini, 1999; Charles, Sanchez &Gontard, 2003) Minimally processed (MP) mangoes are fresh mango processed to increase their functionality without greatly changing their fresh properties. The product should have a shelf life sufficient for its distribution within the region of consumption. However, minimally processed fruits are good media for the growth of micro-organisms and represent a potential health risk. Because of their physio-chemical properties and composition, fresh cut fruits are considered to be highly perishable when they are not subjected to preservative processes (Shah & Nath, 2006). Chemical additives are used primarily as an aid to preservation and not as primary mode of preservation (Huxsoll, Bolin & King, 1989). Several chemicals (acidulants, enzyme inhibitors,

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reducing agents, complexing agent and chelating agent) have been used in the control of browning (Garcia & Barrett, 2002).

In this study chemical treatment related to different concentration of calcium chloride and malic acid to help in making cube in proper size of mangoes and inhibited enzymatic and non-enzymatic changes respectively during minimal process of mango fruit.However, reports on the combined effects of thermal treatment and chemical treatments on the physiology and quality of different varieties of minimal processed mangoes are limited. Therefore, the aim of this study was investigated the effect at different treatments level of thermal and chemical quarantine on ascorbic acid in minimally processed mangoes (cv. Dashehari and Langra).

2. MATERIALS AND METHODS

2.1 Plant material

Physiologically mature Dashehari and Langra mangoes were purchased from orchard from orchard of Punjab Agricultural University, Ludhiana, between June to July 2017. Mango fruits of uniform size, weight and maturity stage with absence of visible wounds were selected. The fruits were transported for further processing to the Food Engineering Lab, Department of Processing of Food Engineering, COAE&T, PAU, Ludhiana.

2.2 Process:

2.2.1 Thermal treatments

The thermal treatment was performed by hot water bath at temperature of 40, 45 and 50°C for water dipping time of 30, 40 and 50 minutes. After hot water bath, whole mangoes were cooled under the ambient for 15 minutes.

2.2.2 Use of calcium chloride

Different concentrations ofcalcium chloride (2.5 and 3.5%, w/w) were applied to whole heat-treated mango for 25 minutes to help for proper minimal processing of mangoes.

2.2.3 Minimal processing

Heat and calcium treated whole mangoes were peeled off and sliced into same size of cubesby stainless steel knife.

2.2.4 Use of malic acid

After minimal process of mangos, slices (cube) were dipped in solution of malic acid at different concentration of 0.5 and 1.0% for 1 minute to inhibit enzymatic and non-enzymatic changes during processing and storage.

2.3 Quality analysis

Samples of minimally processed (MP) mangoes were taken instant for quality analysis (ascorbic acid) after whole process done. Average twelve cubes were made from one mango. For one observation 108 mangoes used (approx. 27 Kg) per each variety of mango. Three hot water temperature (40, 45 and 50°C), three water dipping time (30, 40 and 50 minute), and two level of

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concentration of chemical used i.e. calcium chloride (2.5 and 3.5%) and malic acid (0.5 and 1.0%) with three replication level. Non-treated fruits were used as a control.

2.3.1 Vitamin C (Ascorbic acid content)

Taken 10 gm of the fruit sample in a wearing blender with 70 ml of Metaphosphoric acid-acetic acid extracting solutions and filtered after making the volume of 100 ml. Taken 10 ml filtered sample and titrated with Standard Indophenol solution (AOAC, 1995). Ascorbic acid (mg/100 gm of the sample) was estimated by using Equation 1.

$$\text{Ascorbic acid (mg per 100gm)} = \frac{\text{Dye factor} \times \text{Volume of dye used} \times \text{volume made}}{\text{volume of aliquot taken} \times \text{Weight of sample aliquot}} \times 100 \qquad (1)$$

2.4 Statistical analysis

The experimental design used a completely randomized design (CRD). Analysis of variance (ANOVA) and Tukey's post hoc test were used to determine statistically significant differences ($p \leq 0.05$) of the mean values. The software used was IBM SPSS Statistics 22 version. Three replications were carried, mean values were reported and graphs were plotted.

3. RESULTS AND DISCUSSION

Total 36 mean observations were made for each dependent variable for one variety of mangos during the whole pre-treatments process. The combined effect of thermal treatments (T1, T2 and T3: hot water temperature at 40, 45 and 50°C respectively and t1, t2 and t3: water dipping time of 30, 40 and 50 minute respectively) and chemical treatments (C1 and C2: Calcium chloride solution with concentration of 2.5 and 3.5% respectively and M1 and M2: Malic acid solution with different concentration of 0.5 and 1.0%respectively) were applied for both variety of mangoes.

3.1 Effect of varieties and pre-treatments on ascorbic acid content (Vitamin C)

Tropical fruit, particularly mangoes are rich in health promoting compound such as vitamin C which contribute to high antioxidant capacity of mangoes as compared with other fruits (Xianli et al., 2004). Changes invitamin C in samples of selected varieties of mangoes influenced by pre-treatments are given in Table 1. It was perceived that trend of vitamin C slowly declined with higher level of thermal treatments during experimentation. These results are corresponding with Yahia et al., (2007) who have reported that ascorbic acid content was higher in control tomatoes than in thermal treated fruit. It has also been observed that vitamin C was increased with respect to chemical treatments (Figure 1 and Figure 2 for Dashehari and Langra variety respectively). The results of this study are in agreement with earlier reported by Robles-Sanchez et al., 2009. Who expected, a 4-fold increase in vitamin C was observed in treated sample during the storage of mango. A tremendous difference was found in vitamin C while varieties of mango were taken into consideration. Vitamin C was found higher in sample of Langra variety than Dashehari variety of mango during whole process of pre-treatments. It has also been observed that the value of vitamin C in untreated sample was 17.04 and 142.25 mg/100gm for Dashehari and Langra variety of mangoes respectively. The minimum changes

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in vitamin C was found in sample number 13 i.e. sample code of T2t1C1M1 treatment (17.02 and 142.25 for Dashehari and Langra variety respectively) with respect to control sample. The maximum value of vitamin C was found in sample number 4 or sample code (T1t1C2M2) for both varieties i.e. 17.59 and 142.99 mg/100gm for Dashehari and Langra variety respectively.

ANOVA indicted that changes in vitamin C influenced by individually pre-treatments (Hot water temperature, water dipping time, calcium chloride and malic acid solutions) had non-significant effect at $P \leq 0.05$ for both verities samples. Further all eleven interactions with different treatments were also found non-significant effect. The highest F-value observed for non-significant effect was hot water dipping time (F-value: 1.98) for Dashehari samples and malic acid(F-value:2.47) for Langra mangoes samples.

4. CONCLUSIONS

From the present investigation it may be concludedthe effect of different combinations of heat treatments (water temperature and duration of application) and chemical treatments ($CaCl_2$ and malic acid) onascorbic acid of fresh cut mangoes. Selected attributes (vitamin C) of minimally processed mangoes were found to be non-significantly influenced by individually pre-treatments. The tremendous difference of vitamin C was observed between both varieties i.e. Langra has much higher vitamin C content than Dashehari mango during pre-treatment. The value of ascorbic acid of control sample were observed 17.04 and 142.25 mg/100 gm for Dashehari and Langra’s sample.

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TABLE 1: Effect of different pre-treatments on ascorbic acid of MP mangoes

Sample No.	Sample code	Process Variables				Vit. C (mg/100 gm)	
		Temp (°C)	Time (minute)	Concentrations (%)		Varieties of mangoes	
				$CaCl_2$	Malic acid	Dashehari	Langra
1	T1t1C1M1	40	30	2.5	0.5	17.28	142.52
2	T1t1C1M2				1	17.54	142.94
3	T1t1C2M1			3.5	0.5	17.32	142.60
4	T1t1C2M2				1	17.59	142.99
5	T1t2C1M1		40	2.5	0.5	17.12	142.30
6	T1t2C1M2				1	17.41	142.84
7	T1t2C2M1			3.5	0.5	17.15	142.34
8	T1t2C2M2				1	17.45	142.89
9	T1t3C1M1		50	2.5	0.5	16.82	142.05
10	T1t3C1M2				1	17.18	142.62
11	T1t3C2M1			3.5	0.5	16.88	142.13
12	T1t3C2M2				1	17.24	142.72
13	T2t1C1M1	45	30	2.5	0.5	17.02	142.25
14	T2t1C1M2				1	17.40	142.78
15	T2t1C2M1			3.5	0.5	17.07	142.31
16	T2t1C2M2				1	17.44	142.86
17	T2t2C1M1		40	2.5	0.5	16.80	142.02
18	T2t2C1M2				1	17.24	142.54
19	T2t2C2M1			3.5	0.5	16.83	142.12
20	T2t2C2M2				1	17.29	142.62
21	T2t3C1M1		50	2.5	0.5	16.50	141.74
22	T2t3C1M2				1	17.01	142.24
23	T2t3C2M1			3.5	0.5	16.54	141.79
24	T2t3C2M2				1	17.03	142.32
25	T3t1C1M1	50	30	2.5	0.5	16.60	141.94
26	T3t1C1M2				1	16.95	142.52
27	T3t1C2M1			3.5	0.5	16.64	141.98
28	T3t1C2M2				1	16.98	142.60
29	T3t2C1M1		40	2.5	0.5	16.40	141.75
30	T3t2C1M2				1	16.80	142.28
31	T3t2C2M1			3.5	0.5	16.43	141.78
32	T3t2C2M2				1	16.86	142.34
33	T3t3C1M1		50	2.5	0.5	16.10	141.54
34	T3t3C1M2				1	16.47	141.96
35	T3t3C2M1			3.5	0.5	16.14	141.58
36	T3t3C2M2				1	16.52	141.99
Control sample						17.04	142.25

Where,

T1, T2 and T3=hot water temperature at 40, 45 and 50°C respectively

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t1, t2 and t3= water dipping time of 30, 40 and 50 minutes respectively

C1 and C2= Calcium chloride concentrations at 2.5 and 3.5% respectively

M1 and M2= Malic acid concentrations of 0.5 and 1.0% respectively

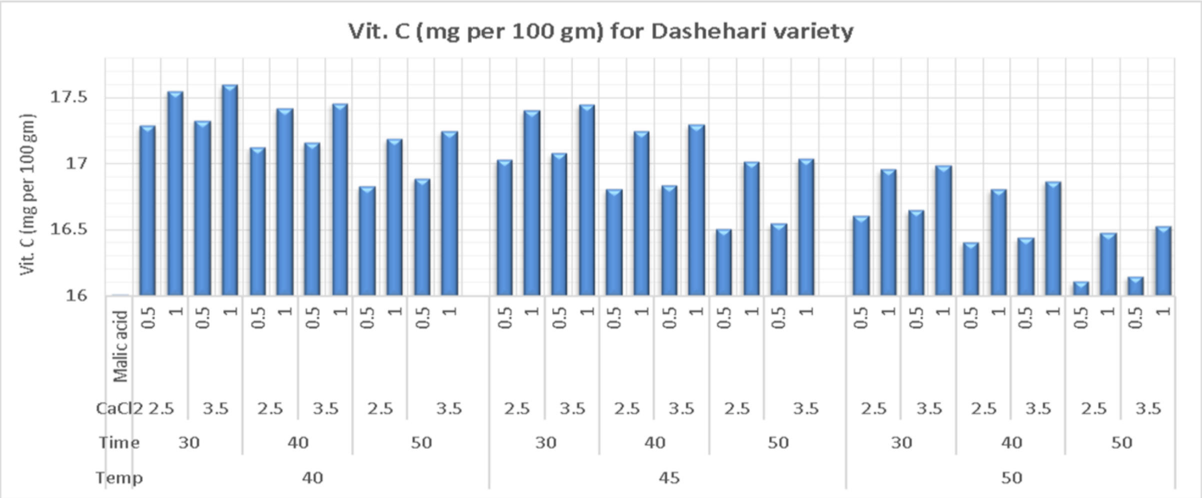

FIGURE 1: Changes in ascorbic acid of MP mangoes (cv. Dashehari) with different pre-treatments

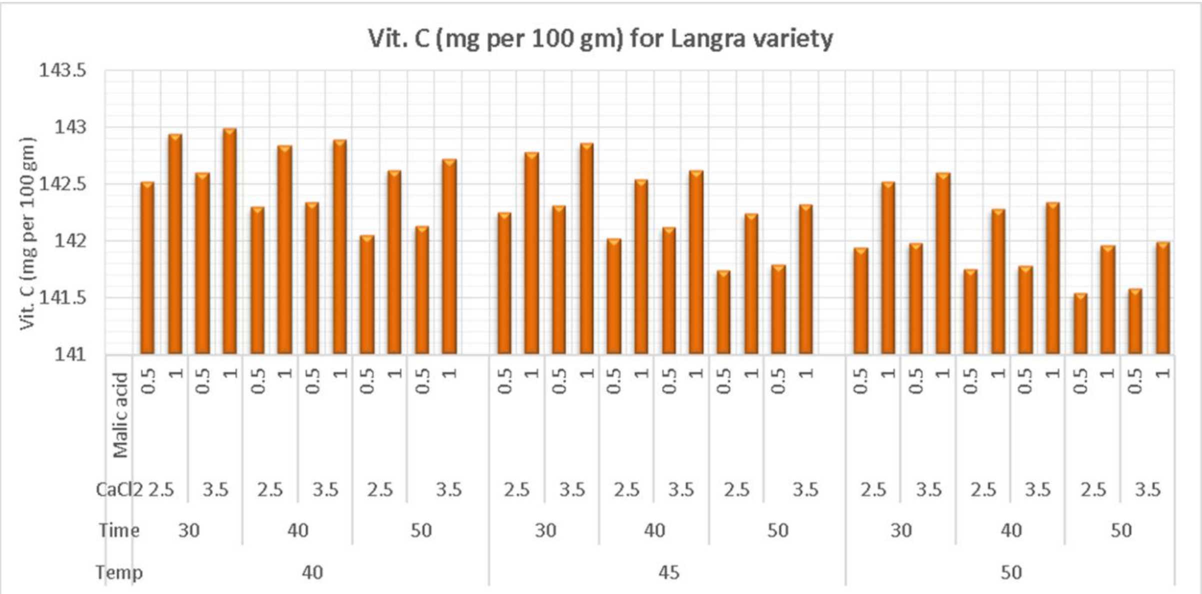

FIGURE 2: Changes in ascorbic acid of MP mangoes (cv. Langra) with different pre-treatments

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