

Effect of Hot Water Treatment on the Chemical, Sensorial Properties and Ripening Quality of Chaunsa Mango (*Mangifera indica* L.)

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Abstract: The study was carried out to investigate the effects of hot water treatment on the chemical, sensorial properties and ripening quality of Chaunsa mango during the year 2010-11. Results showed that mangoes treated with hot water of 55°C and stored at room temperature (38± 4°C) were ripened in 3 days, whereas mangoes treated with hot water treatment of 45°C ripened in 4 days, without hot water treatment were ripened in 5 days. Chemical properties like total acidity, vitamin C content, TSS, total sugars, reducing sugar, non reducing sugar were determined in mangoes treated with hot water at 55°C for 20 minutes and stored at room temperature, followed by hot water treatment of 45°C at 30 minutes. Early ripening of mangoes and best sensorial properties were also observed as peel color, fruit softness, pulp color, taste/ flavor, texture and aroma. The study revealed that mangoes treated in hot water were ripened in better quality than control. Furthermore, the sensorial properties of the treated mangoes were scored higher and quality wise better than control.

Keywords: Chaunsa mango, hot water treatment, chemical compositions.

INTRODUCTION

Mango (*Mangifera indica* L Family *Anacardiaceae*) commonly known as "King of fruits". Mango is considered as fruit of excellence and thus has prominent position among commercial fruit grown in Pakistan. Mango plays an important role in the diet of human being by providing about 64-86 calories energy [1]. Asia is the main producer with 76.9% of the total world production, where Pakistan stands at 4th position among mango producing countries with production of 9,38,000 tones with a share of 7.6% in the world market [2]. Pakistan is blessed with many important leading commercial varieties of mango such as Sindhri, Langra, Anwar Ratol, Summer Bisht, Fajri, Fazli, Zafraan, Saroli, Dusheri, Ghulab Khas, Swarnarica, Bagan Pali, Chaunsa Black and White and Neelum [3].

Being a delicious fruit, mango is liked equally by all classes of people of all ages. The mango is mentioned as the "food of the gods" in the Hindu Vedas [4]. Mango industry in Pakistan is facing problem of fruit fly. Non-chemical quarantine treatments in mango industry are increasing and becoming important. However, various importing countries such as China and Japan are imposing restrictions on chemical treatments for disinfestations of the pest. International interest in hot water treatment

for quality maintenance and disease control has been reflected in a range of literature [5]. Among different heat treatments, use of hot water as a disinfestations treatment has been widely adopted because of its efficacy and low cost [6]. In 2005, protocols signed by Pakistan with Iran and China for export of mango requires hot water treatment (HWT) (Iran: 45°C for 75 minutes; China: 48°C for 60 minutes) but effects of such treatment on Pakistani mangoes shelf life and quality are yet to be investigated. Blading and Reeder reported that 80% of mango fruit treated with hot water at 55°C for 5 minutes had injuries [7]. Spalding *et al.* reported that the quality of 'Tommy Atkins' and 'Keitt' mangoes was not affected when fruits were treated with hot water at 46°C for 90 minutes and then stored for 3 days at 13°C and subsequently ripened at 24°C [8]. But, Becerra reported fruit injury in 'Tommy Atkin' mangoes treated with hot water at 46.1°C for 90 minutes [9].

Keeping in view the aforementioned facts and due to very limited work on hot water treatment, this study was designed to evaluate the effect of hot water treatment on the ripening quality of Chaunsa mango, assess the effect of hot water treatment on the ripening quality, storage life of mango, chemical and sensorial properties of mango.

MATERIAL AND METHODS

A total of 81 unripe fresh mango of Chaunsa variety were collected from Malir Farm Tandojam. The

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mangoes were initially washed with tap water to remove dust, dirt, pesticide residues and dried with muslin cloth. All the mangoes were divided into three groups A, B and C, labeled and weighed. Mangoes in group A were dipped in hot water at 45°C for 30 minutes and group B mangoes were dipped in hot water at 55°C for 20 minutes. Mangoes in group C were kept as control (without any hot water treatment). All the mangoes (treated and untreated) were kept in the paper made boxes having holes from all four sides at room temperature (38± 4°C). The mangoes were examined every day till ripening. Prior to treatment, the mangoes were taken for chemical analysis and considered as unripe at 0 day.

Preparation of Sample for Chemical Analysis

Mango fruit was peeled with knife and cut into small pieces and homogenous samples were prepared by blending the flesh in blender. The samples were thoroughly mixed and used as sample for each chemical analysis.

1. Titratable Acidity

Titrate acidity (malic acid mg/100g) was determined according to the method of AOAC [10]. Five gram Mango sample was mixed with 25 ml distilled water in a beaker and filtered through Whatman filter paper No 4. 10 ml filtrated sample containing phenolphthalein (3-5 drops) as an indicator was titrated against NaOH 0.1 N using titration kit.

2. Vitamin C (Ascorbic Acid)

Vitamin C (ascorbic acid) was determined by titrimetric method as described by Rangamma [10]. An amount of 10 ml was taken and made volume up to 100 ml with 3% HPO₃ and filtered. Pipette 10 ml of filtrate into a conical flask and titrated with the standard dye till pink color appeared.

Dye Standardization

05 ml standard ascorbic acid solution with 5 ml of 3% of metaphosphoric acid was diluted. Titrated with dye solution till pink color persists for 10 seconds. Dye factor was calculated (mg of ascorbic acid per ml of dye) as follow;

$$\text{Dye Factor (D.F)} = 0.5/\text{titration}$$

3. Total Soluble Solids (%)

The total soluble solids (TSS) were determined according to the method by AOAC [11] using digital

refractometer. After cleaning the prism of the refractometer was adjusted to zero using distilled water. Then few drops of prepared solution of mango pulp were placed on the prism-plate of the refractometer and lid was placed over to cover it. The reading on digital refractometer in Brix^o was noted as total soluble solids of mango.

4. Reducing Sugar (%)

Reducing sugar was analyzed according to the method by James [12]. 10g mango sample was mixed with 100ml warm distilled water. The mixture was filtered through Whatman filter paper No: 4 and then distilled water was added up to final volume of 250 ml in volumetric flask. The solution was transferred to burette and titrated against the 10ml Fehling's solution containing 4 to 5 drops of methylene blue indicator till brick red color appeared.

5. Total Sugars (%)

Took 5 g of sample into a beaker and added 100 ml of warm water. The solution was stirred until all the soluble matters were dissolved and filtered through whatman filter paper into a 250 volumetric flask. Pipetted 100 ml of the solution prepared into a conical flask, added 10 ml diluted HCl and boiled for 5 minutes. On cooling, neutralize the solution to phenolphthalein with 10% NaOH and make up to volume in a 250 volumetric flask.

6. Sensory Evaluation

Sensory evaluations of mango samples (at the stage of ripening) were performed according to the method as reported by Anjum and Ali [13]. 10 members panel of judges were selected from the teaching staff and technical staff that were familiar with organoleptic attributes. Whole and sliced mango samples were served to a panel of ten Judges to score sensory attributes (i.e. peel color, flavor, taste, texture, flesh color) using 9 point Hedonic scale, where 9 being most acceptable and zero the least.

7. Statistical Analysis

The collected data was analyzed for analysis of variance and other comparison by the method of Gomez and Gomez [14].

RESULTS AND DISCUSSIONS

The present research was conducted to find out the effect of hot water treatment on the chemical, sensorial properties and ripening quality of mango during 2010-

11. In this study, unripe mangoes of Chaunsa variety were given hot water treatment at two temperatures such as 55°C for 20 minutes and 45°C for 30 minutes as compared with untreated control. After treatment, the mangoes were stored at ambient temperature (38±4°C). The treated and untreated mangoes samples were also analyzed for chemical compositions such as Total Acidity, vitamin C, total soluble solids, reducing sugar, total sugar, non reducing sugar, peel color, fruit softness, pulp color, taste, flavor, texture and aroma. Study revealed that the shelf life of mangoes could not be extended through hot water treatment rather reduce the shelf life of mango from 5 days to 3 days however it improved the ripening qualities of mangoes.

Results indicate that total acidity of mango increased from 0 days till ripening in all treatment (Table 1). It was also observed that increase in total acidity of ripened mangoes (after 3 days) with hot water treatment of 55°C, stored at room temperature was higher than control stored at room temperature. This may be due to the degradation of biochemical constituents of the un-ripened fruits during respiration resulting in certain acids, which are then reduced after three days. Our findings are in agreement with Anwar and Malik [15] and Malundo *et al.* [16], observed the pattern of changes in acidity percentage and there was an increase in titratable acidity percentage during first three days of storage. Whereas, hot water treatment at 55°C and 45°C has reduced the vitamin C content of mango as compared to control (Table 1). This attributed to susceptibility of ascorbic acid to oxidative destructions particularly slow in hot water treatment as compared to ambient temperature. The present results are in conformity with Pudmini and Prabha [17] and

Thomas and Oke [18], who also reported reduction in vitamin C content of fruit during ripening. Furthermore, total soluble solids of mango fruit was significantly affected by both hot water treatments. The highest TSS (Brix°) was recorded in mangoes treated at 55°C stored at room temperature as compared to 45°C and control stored at room temperature (Table 1). The results are in agreement with the findings of Aina [19], Rathore, *et al.* [20] and Rajwana *et al.* [21] who reported that the increase in total soluble solids might be due to the alteration in the cell wall structure and break down of complex carbohydrates into simple sugar and this hydrolytic changes in starch is may be due to hot water treatment whereas slow changes in TSS was also observed in control samples.

There was a gradual increase of total sugars in mangoes treated with hot water treatment at 55°C and stored at room temperature as compared to 45°C and control stored at room temperature (Table 1). The increase in total sugar level could be attributed mainly due to breakdown of starch into simple sugars during ripening along with a proportional increase in total sugars which was attributed to the increased activity of amylase and other enzymes converted into sucrose, glucose and fructose during storage. These results can be correlated with the findings of Srinivasa *et al.* [1] and Kudachikar *et al.* [22] who reported that maximum total sugar percent in late Chaunsa white mango was observed in hot water treatments and less changes in control. Increase of reducing sugar was also observed in mango fruit treated with hot water treatment at 55°C and stored at room temperature as compared to 45°C and control stored at room (Table 1). This increase in reducing sugar could be attributed mainly due to

Table 1: Effect of Hot Water Treatment on the Physico-Chemical Characteristics of Mango, Variety Chaunsa at Various Temperatures

| Treatments | Titratable acidity (%) | vitamin C content (mg/100g) | TSS (Brix°) | Total sugar (%) | Reducing sugar (%) | Non reducing sugar (%) |
|---|------------------------|-----------------------------|-------------|-----------------|--------------------|------------------------|
| Initial (0days) | 0.09 | 13.81c | 5.67 | 4.68 | 3.14 | 1.36 |
| Control (Without treatment) (After 5days) | 0.10 b | 20.66 a | 5.89 c | 4.66 c | 3.27 c | 1.41 b |
| Hot Water Treatment (45°C) (After 4days) | 0.12 a | 18.64 b | 6.85 b | 5.83 b | 3.90 b | 1.92 a |
| Hot Water Treatment (55°C) (After 3days) | 0.13 a | 14.99 c | 8.86 a | 6.98 a | 4.95a | 2.03 a |
| SE | 0.1258 | 0.2494 | 0.0278 | 0.0679 | 0.0508 | 0.0508 |
| LSD at 1 % | 0.5972 | 1.1835 | 0.1321 | 0.3221 | 0.2404 | 0.2412 |
| LSD at 5 % | 0.4104 | 0.1658 | 0.0908 | 0.2214 | 0.1652 | 0.1658 |

breakdown of starch into water soluble sugars, sucrose and glucose during ripening along with a proportional increase in reducing sugar level and further hydrolysis decreased the reducing sugar during storage. Our results are in agreement with the finding of Medicott *et al.* [23] and Selvaraj [24] who observed an increase in reducing sugar content in mango after hot water treatment. Likewise, non-reducing sugar in mango treated with hot water treatment of 55°C stored at room temperature was higher than 45°C and control stored at room temperature (Table 1). This increase may be due to acidity by physiological changes during storage [15]. Other treatments indicated significant differences and the lowest percent of non-reducing sugar were observed in control. The results are in line with the finding of Aina [19] Jabbar *et al.* [25] who found that when fruits were given hot water treatment, reducing sugar remained higher than non-reducing sugar throughout ripening process and ambient temperature and relationship was statically significant.

In the present study during sensory evaluation peel color of mango fruit was evaluated by a panel of judges who were familiar with organoleptic attributes using 9 point hedonic scale (Table 2). The highest score for

peel color was observed in mango fruit treated with hot water treatment of 55°C and stored at room temperature as compared to 45°C and control. Change in peel color from green to yellow might be due to the breakdown of chlorophyll leading to disappearance of green color. These results are in agreement with the findings of Gowda and Huddar [26] who reported that the concentration of carotenoids were increased due to a series of physicochemical changes in green mature Alphaso and other varieties of mango stored at 18-34°C during ripening and peel color turned from green to pale yellow. Besides, pulp color in mangoes treated with hot water treatment of 55°C stored at room temperature received highest score as compared to control. The pulp color which was white to pale yellow due to development of carotenoid pigments in fruit. Our results are comparable with findings of Carillo *et al.* [27] and Malik *et al.* [28] who observed that fruit pulp color turned in pale yellow due to hot water treatment that increased enzymatic oxidation and photo discoloration as compared to control. The highest score for fruit softness was observed in mangoes treated with hot water treatment at 45°C and 55°C, stored at room temperature whereas minimum score was observed in

Table 2: Effect of Hot Water Treatment on Sensorial Properties of Mango Variety Chaunsa Stored at Room Temperature

| Treatments | Temperature | R1 | R2 | R3 | Mean |
|----------------|------------------------------|------|------|------|-------|
| Peel color | Control at 38± 4°C | 7.0 | 8.5 | 7.5 | 7.66c |
| | Hot water treatment at 45°C | 8.5 | 9.0 | 9.0 | 8.83b |
| | Hot water treatment at 55 °C | 9.5 | 9.75 | 9.5 | 9.58a |
| Fruit softness | Control at 38± 4°C | 3.0 | 3.5 | 3.5 | 3.33c |
| | Hot water treatment at 45°C | 4.5 | 4.3 | 4.6 | 4.46b |
| | Hot water treatment at 55°C | 5.5 | 5.3 | 4.6 | 5.13a |
| Pulp color | Control at 38± 4°C | 6.5 | 7.6 | 7.4 | 5.46c |
| | Hot water treatment at 45°C | 8.5 | 8.0 | 8.75 | 8.41b |
| | Hot water treatment at 55 °C | 9.5 | 9.0 | 9.75 | 9.41a |
| Taste/flavor | Control at 38± 4°C | 6.0 | 6.75 | 7.0 | 6.58c |
| | Hot water treatment at 45°C | 7.25 | 7.5 | 7.5 | 7.41b |
| | Hot water treatment at 55°C | 8.25 | 8.5 | 8.5 | 8.41a |
| Texture | Control at 38± 4°C | 4.0 | 4.8 | 3.9 | 4.23c |
| | Hot water treatment at 45°C | 5.0 | 5.75 | 5.75 | 5.50b |
| | Hot water treatment at 55°C | 6.0 | 6.75 | 7.25 | 7.25a |
| Aroma | Control at 38± 4°C | 6.5 | 7.5 | 6.0 | 6.66c |
| | Hot water treatment at 45°C | 6.5 | 6.75 | 6.25 | 6.50c |
| | Hot water treatment at 55°C | 7.5 | 7.75 | 7.25 | 7.50a |

SE = 0.2083; LSD (1%) = 0.8768; LSD (5%) = 0.6317; CV (%) = 4.69S.

control. These results are resembled with the finding of Weichman [29], who reported that the fruit treated with hot water treatment at 48°C to 60°C for 35 minutes took minimum time period of 3 days to reach optimum eatable ripening quality while fruits which were given no treatment or only wash delayed the ripening process.

Texture is the important quality parameters in sensory evaluation, which play an important role at the time of selection of fruit by consumer. The highest score for texture was observed in mangoes treated with hot water treatment at 55°C stored at room temperature as compared to the control (Table 2). These finding are authenticated by the findings of Manzano *et al.* [30] and Kittur *et al.* [31] who observed that in green mature Dusheri, Chaunsa and other 5 varieties of mango, the firmness decreased from 28.94 to 15lbs/sq.inch, in 18-34 days and decreased to a series of other physicochemical changes. The highest score of taste/flavor goes to hot water treated at 55°C and stored at room temperature as compared to control. Sweetness due to sugar and sourness from organic acids are dominant components in the taste of many fruits. These results are similar with the findings of Opera [32] who reported that pleasant flavor may be due to the reduction in total acidity as well as increase in extractable flavor resulting from polyphenole compounds. The highest scored for aroma was observed in mangoes treated with hot water treatment in 45°C and 55°C stored at room temperature and minimum in control. These results are in agreement with the finding of [29], who reported that the biochemical changes were faster and conservation of complex compound into ester, aldehydes and acid by hot water treatment contributed better as compared to control.

The present experiment study provides substantial evidences including the sensory evaluation that mangoes treated with hot water treatment of 55°C stored at room temperature resulted in better retention of peel color, fruit softness, pulp color, texture taste/flavor and aroma. The mangoes stored without treatment (control) showed low scores for quality parameters like peel color, fruit softness, pulp color, texture taste/flavor and aroma. The study further concludes that storage life of mangoes treated with hot water is not increased at room temperature because of fast ripening of fruit but maintained the ripening quality, physical appearance and sensorial properties [33] concludes the same remarks that hot water treatment

increase ripening without impairing taste and flavor of fruit.

CONCLUSIONS

It is concluded that the chemical and sensorial properties of mango fruit were best observed when fruits were given hot water treatment at 55°C and stored at room temperature in terms of ripening quality, physical appearance, peel color, pulp color, taste, firmness and texture as compared to mango fruit treated at 45°C as well as control stored at room temperature. The shelf life of mango fruit was not extended by hot water treatments rather reduced.

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