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Addition of Calcium Chloride as a Preservative Agent to Store Apple (*Pyrus domestica* L.)

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ABSTRACT

This experiment was conducted at food science laboratory technology, The University of Agriculture Peshawar Khyber Pakhtunkhwa, during 2018 to evaluate the "effect of Calcium Chloride ($CaCl_2$) on the quality of apple (*Pyrus domestica* L.) during storage" The experiment was performed by two factorial Complete Randomize Design (CRD) *i.e.* dipping time in calcium chloride solution (3, 6 and 9 minutes) and storage intervals (0, 5, 10, 15 and 20 days). The quality characteristics of apple fruit were significantly influenced by dipping time during storage. The obtained results concluded that different time dipping in calcium chloride solution retained the physiochemical properties of apple fruit during storage period. The minimum increase in pH (4.86), total soluble solid (12.98 obrix) were recorded in T_3, minimum decrease in moisture contents (87.72%) and minimum decrease in the weight loss (1.00%) were recorded in T_2, while the maximum increase in ash contents (1.31%) and maximum decrease in titrable acidity (0.31) were shown in T_2 and T_3. From the data it is concluded that apple fruits dipped for 9 minutes in calcium chloride solution maintained the quality of fruits sample and also increase the shelf life of fruit at room temperature.

Keywords: Calcium chloride; Physiochemical properties; Dipping time; Storage period

INTRODUCTION

Apple (*Pyrus domestic* L.) is the most consumable fruit belong to the family *Rosacea* and the sub family *Pomoideae*. It is native to eastern Turkey. The major producers are China (39.7 million tons), United State (4.1 million tons), Turkey (3.1 million tons), Poland (3.1 million tons) and Italy (2.2 million tons).

In Pakistan it is cultivated in northern hilly region of Punjab, Khyber Pakhtun Khwa and Baluchistan. The cultivated area was 100.246 thousand hectares with total production of 616.74 thousand tons while in Khyber Pakhtun khwa the cultivated area is 7.921 thousand hectare and produce 90.513 thousand tons apple. Post-harvest quality apple fruit play important role in national and international market in term of consumption and competition. On the other hand commodity quality maintenance of fresh fruits is very important because of utility and consumer preferences.

Nutritionally 100 grams of apple give 218 KJ calories, 0.17 grams of fat, 0.26 grams proteins, 13.81 grams of carbohydrate (10.39 grams of sugar and 2.4 grams of dietary fiber) and 4.6 mg of vitamin C.

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Medicinally the fibers in the apple fruit helps to minimize the chance of heart diseases, weight lose colon cancer and balancing cholesterol level by avoiding reabsorption [1].

Apple is widely used throughout the world. Apple is consume fresh as well as processed in squash, juice, apple slice canned, toffees and jams. These all products are made to make it available during off season. Apple is also used to make apple juice and crushed to make apple cider. Some alcoholic beverages are manufacture from apple fruit like apple wine, calvados and apple jack by the process of distillation. They are also used to apple jelly and apple butter. Apple are also used in many sweet dishes, like apple cake, apple pie and apple crumble.

Apple highly perishable fruit is subjected to post harvest losses which is 25%-40%. In store apple beside of losses in quantity, the loss of chemical quality and texture is also occurred. Apple is a climacteric so the quality is also reduced after harvest due to respiration and ethylene production. During the post-harvest storage, the softening of apple is another most important problem all the over the world. Enhancing the store temperature reduce the quality and increase the storage losses Shah, et al.

Calcium was found in the middle lamella and primary cell wall of plant tissues in the form of pectic substances. It is known as cementing material, acts in cell binding and stability of the cell wall structure particularly during the storage of fruits. Calcium infiltrates gradually to cell wall resulting an increased level of calcium ion which stabilizes the cell wall and inhibits the fungal and other microbial deterioration in fruits. By treating the apple fruit with $CaCl_2$ solution (2%) combined with the cold storage (20°C and 90% RH) prevents the degradation of cell wall and membrane, decreased the production of ethylene hence a delay in the ripening process occur. Calcium concentration plays an important role in the firmness of apple in post harvest hydro cooling treatment.

Increased level of calcium plays a crucial role in disease resistance, inhibition of ethylene production, ripening and senescence which improves the quality of fruits. Calcium in the fruit tissue is important for reducing many of the post harvest physiological disorders. Most of the disorders in plant tissue such as hollow heart in potato and pear, bitter pit and softening in apple are due to the less concentration of calcium which can be controlled by post harvest application of calcium.

Calcium (such as calcium chloride) maintains fruits quality and firmness, prevents physiological disorders and lowers the respiration rate, solubilization of pectic substance and ripening process. Calcium sprayed fruits having high concentration of calcium in the peel and cortex improved the shelf life (reduced incidence of cork spot, internal and external rots, scald and brown core) and quality (appearance and color) of fruit. In Pakistan about 20%-30% or even up to 40% fruit losses are faced due to the lack of post-harvest technical knowledge, mishandling and improper storage which accounts for about 3 billion rupees loss in the country.

In context to the above mentioned problems this research study was conducted to check the effect of calcium chloride on the quality of apple fruit at the University of Agriculture Peshawar [2].

MATERIALS AND METHODS

To study the "effect of calcium chloride ($CaCl_2$) on fruit quality of apple (*Pyrus domestica* L) during storage" an experiment was conducted in food science laboratory at The University of Agriculture Peshawar in October 2018.

Experimental Design

The experiment was laid out in Complete Randomized Design (CRD) with following two factors and replicated three times.

- Factor A: Dipping time in CaCl2 solution.
- Factor B: Storage durations 1, 5, 10, 15, and 20 days.

Fruit Collection and Storage

Fresh, healthy and physiologically mature apple fruits were procured from local market of Peshawar. Fruits were sorted manually in order to get fresh (free of diseases, injuries, bruises, etc.) fruits at food science laboratory, the University of Agriculture Peshawar and treated with $CaCl_2$ solution and stored at a temperature of 20°C and 65%-70% relative humidity for 20 days. The data were recorded on the following physiochemical attributes of apple fruits during storage duration.

Fruit Juice pH

The pH of the samples was determined by pH meter (Model No. INOLABpH 720). pH meter was first standardized by a standard buffer solution. Juice of the selected apple sample was taken in a beaker and pH meter was put into it simultaneously a temperature dial also set in order to carefully noted the pH reading [3].

Total Soluble Solids (^{0}Brix)

Hand refractometer was used to analyze the Total Soluble Solids (TSS) of the apple fruit. First clean and dry the prism of refracrometer and then put a drop of sample juice on it and carefully recorded the reading.

Percent Acidity

Percent acidity of the apple fruits was determined by the standard method as prescribed. For the determination of the apple fruits were randomly selected from all treatment.

Procedure

Apple fruit juice sample (10 ml) was taken in beaker and the volume was made up to 100 ml with water. 10 ml of this diluted sample was taken in conical flask with the help of pipette and 2-3 drops of phenolphthalein were added as indicator. Titrate it against 0.1 N NaOH till the appearance of the pink color persisted for few seconds.

The process was repeated three times and notes the burette reading. The data was calculated as following [4].

$$\text{Acidity (\%)} = \frac{\text{Titrate reading x 0.0 1 Na OH xO.067 Malic Acid x 100}}{\text{10 x 10}} \times 100$$

Moisture Contents

The moisture contents in the apple were determined with the help of electric oven of the randomly selected fruits from all treatment. Five gram sample of apple fruit weighted with the help of electric balance and taken in petri dish from each sample. Then the sample in pettri dish was placed in oven for 24 hrs at 70°C. For each sample clean and weighted pettri dish is used.

Ash Contents

Ash is the residue that remains after the complete oxidation of all the organic matter at a temperature ranging from 500°C to 600°C. Ash can be determined by straight ash method. Two gram sample weighted with electric balance were taken in crucible from each treatment. The crucible containing samples were placed in an electric furnace for 5 hrs at 550°C. For each sample clean and weighted crucible is used. After 5 hrs the ash contents is determined by the following formula [5].

$$\text{Ash (\%)} = \frac{\text{weight of ash}}{\text{Weight of sample X 100}}$$

Weight Loss

The weight of fruits is decreased during storage life due to the loss of moisture from the fruits.

Percent weight loss at an interval of 5 days was determined by formula given below;

$$\text{Weight loss (\%)} = \frac{w1-w2}{W1} \text{ X } 100$$

Whereas

W1=Primary weight

W2=Concluding weight

RESULTS AND DISCUSSION

Data was recorded on pH of fruit juice, titrable acidity, total soluble solid, moisture contents, weight loss and percent ash. The result of the experiment are summarized in table from 1-6.

Fruit Juice pH

The data pertaining to the pH of pear fruit juice showed in the **Table 1**. The pH of fruit juice was signi icantly in luenced by the $CaCl_2$ solution and storage durations. Fruit pH was increased from (4.72) to (5.09) during storage duration from 1 to 20 days. The means of data show that highest pH (4.91) was recorded in T_0 while the lowest pH (4.86) was recorded in T_3.

Table 1: pH of apple fruit juice influenced by dipping time in $Cacl_2$ and storage duration.

Treatment	Storage period (days)					Means
	Initial	5	10	15	20	
T_0	4.70	4.83	4.91	4.94	5.16	4.916
T_1	4.73	4.81	4.90	4.96	5.10	4.9
T_2	4.72	4.80	4.85	4.94	5.12	4.88
T_3	4.75	4.81	4.87	4.95	5.00	4.86
Means	4.725	4.812	4.882	4.947	5.09	

The statistical analysis depicted that calcium chloride solution and storage intervals had significant effect on pH of the apple fruits. These results are strengthened by the fact that less concentration of calcium chloride and dipping times were less effective in preventing the acids conversion into sugars. However by increasing the level of calcium chloride a decrease in the acidity and biochemical changes can be prevented, hence increased in pH was reduced. pH of the apple fruit increased with the increase in storage time. Whereas treatment of calcium chloride concentration reduced the fruit pH significantly during storage [6].

Total Soluble Solid (^{0}Brix)

Total Soluble Solid (TSS) of the samples are showed in the **Table 2**. TSS increase from 12.35 to 14.52 with increase in storage duration. The highest value was observed in T_0 (13.96). While the least total soluble solid value (12.98) recorded in T_3.

Table 2: TSS (^{0}Brix) of apple juice as in luenced by dipping time and storage duration.

Treatment	Storage days (period)					Mean
	Initial	5	10	15	20	
T_0	12.4	13.3	14.1	14.8	15.2	13.96
T_1	12.5	13.1	13.8	14.2	14.5	13.62
T_2	12.3	12.9	13.6	14	14.6	13.48
T_3	12.2	12.4	13	13.5	13.8	12.98
Mean	12.35	12.92	13.625	14.125	14.525	

Results showed that the total soluble solids of apple fruit were influenced by calcium chloride solution dipping time and storage durations. The increase in TSS of the samples may be due to the presence starch in fruits which gradually converts into sugar with the passage of time. Application of high concentrated calcium chloride solution increased the metabolic activities which ultimately decreased the TSS of the apple fruits, on the other hand a highest level of TSS was recorded in untreated apple fruit during storage [7].

Moisture Contents (%)

The data concerning to percent moisture contents are showed in the **Table 3**. The percent moisture contents were decreased during increase in storage duration of apple from 1 to 20 days. The percent moisture decrease from (88.59%) to (83.26%) during storage of 20 days. However among different treatment maximum (87.72%) moisture content was recorded in T_2 while minimum (84.68%) was recorded in T_1 [8].

Table 3: Moisture contents (%) of apple juice during storage.

Treatment	Storage days (period)					Mean
	Initial	5	10	15	20	
T_0	88.45	87.83	87.55	84.75	82.94	86.3
T_1	87.95	87.31	84.33	82.95	80.88	84.68
T_2	89.01	88.54	87.17	86.131	84.75	87.72
T_3	88.59	87.5	86.99	85.45	84.49	86.67
Mean	88.59	87.79	86.51	84.82	83.26	

The analysis of the data showed that the moisture contents of apple fruit were signi icantly in luenced by different time of dipping in $CaCl_2$ solution and the storage durations. The possible reason for least decrease in moisture contents for higher concentration of calcium chloride is due the decrease in transpiration rate due to higher concentration of calcium in the cell wall and the high decrease in percent moisture of untreated sample or low calcium chloride concentration is due to high transpiration rate [9].

Weight Loss (%)

The data concerning to the weight loss are showed in the **Table 4**.

The percent weight loss were decreased during thestorage duration of apple from 1 to 20 days. The percent weight decrease from (1.78) to (0.53) during storage of 20 days. Among different treatment maximum (1.13%) weight loss were recorded in T_1 while minimum (1.00%) were recorded in T_2. The analysis of the data showed that the weight loss of apple fruit was in luenced by time of dipping in $CaCl_2$ solution and the storage durations [10].

Table 4: Weight loss (%) of apple juice during storage.

Treatments	Storage period (days)					Means
	1	5	10	15	20	
T_0	1.56	1.49	1.31	0.89	0.72	1.1
T_1	1.93	1.73	1.21	0.98	0.62	1.13
T_2	1.81	1.72	0.88	0.85	0.56	1
T_3	1.82	1.72	1.37	0.88	0.24	1.05
Means	1.78	1.61	1.16	0.9	0.53	

Ash Contents (%)

The data concerning to percent ash contents are showed in the **Table 5.** The percent ash contents were increased from (0.79) to (1.54) during the storage period from 1 to 20 days. In case of various treatments maximum (1.31%) ash content was recorded in T_2 while minimum (0.86%) ash content was recorded in T_0 [11].

Table 5: Ash contents (%) of apple juice during storage.

Treatments	Storage period (days)					Means
	1	5	10	15	20	
T_0	0.88	0.66	0.92	1.25	1.54	0.86
T_1	0.59	0.39	0.47	1.27	1.58	1.05
T_2	0.98	0.89	1.36	1.62	1.72	1.31
T_3	0.74	0.62	0.92	1.09	1.35	0.94
Means	0.79	0.64	0.91	1.3	1.54	

The analysis of the data showed that the percent ash contents of apple fruit were significantly influenced by different time of dipping in $CaCl_2$ solution and the storage durations. Total ash for all cultivators decreased slowly during the initial growing period followed by a sudden increase in the latter stage of maturation and ripening, with maximum level varying from 5.2% to 7.9%. Minerals: Ca, Mg, Na, K and P, for all cultivars decreased slowly during all stages of development. The total mineral content (ash content) of plant tissue varies from not less than 0.1% to 0.5% of the fresh weight. Potassium single most abundant element occurs mainly in plants (spinach). Minerals occur in salts of organic acids if calcium is increased by agronomic practices or by post-harvest treatment it can improve storage life and product quality [12].

Percent Acidity (%)

The data concerning percent acidity (%) are presented in the **Table 6**. The percent acidity decreases from 0.53% to 0.23% with storage duration from 1 to 20 days. The mean value of the data showed that high acidity (0.43%) was recorded in the untreated apple fruit, while minimum acidity (0.31%) was recorded in T_2 and T_3. The analysis of data showed that $CaCl_2$ solution, dipping time and storage durations significantly influenced the acidity (%) of apple fruit. A gradually declined was recorded in percent acidity of reel delicious apple during storage at 10°C. Similarly, Wills, et al. also found that acidity decreased as storage period increased. The application of $CaCl_2$ solution retained the maximum titrable acidity as compare to untreated apple fruit [13].

Table 6: Percent acidity of apple juice during storage.

Treatments	Storage duration (days)					Means
	Initial	5	10	15	20	
T_0	0.6	0.53	0.4	0.33	0.33	0.43
T_1	0.53	0.46	0.4	0.33	0.26	0.39
T_2	0.53	0.4	0.26	0.2	0.2	0.31
T_3	0.46	0.4	0.33	0.28	0.23	0.31
Means	0.53	0.44	0.34	0.28	0.23	

CONCLUSION

From the present study we concluded that apple fruits dipped in $Cacl_2$ for 9 minutes increase shelf life. We recommend the dipping of apple fruits for 9 minutes to store it for longer period of time. We also suggest to carrying out the experiment in other months of the year.

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