Effect of Calcium Lactate Coating on Physicochemical and Sensory Characteristics of Red Delicious Apple *(Malus Pyrus)* During Storage

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ABSTRACT

Apple (*Malus Pyrus*. L) belongs to the family Rosaceae and is one of the most famous fleshy and pulpy fruit, mostly grown in the temperate zone. Apple fruit can be taken as fresh, dried, and processed into juices, jams, jellies, and canned products. There are several species of apple grown in Gilgit-Baltistan such as Red delicious, Golden delicious, Golden delicious hard, Kala-Kulu, Dhang, and Noor-shah. Apple plays an important role in health maintenance and prevents several diseases. Red delicious apple variety is treated with different levels (1%, 2%, and 3%) of calcium lactate and stored at room temperature for one month. The samples were analyzed at 7 days of the interval during the storage period. During storage, the moisture content of red delicious apple fruit decreased from 79.19 to 68.82%. Ash content of the best apple variety increased from 2.61 to 2.79 % during storage. It was noticed that during storage pH value increased from 3.84 to 4.02. The total soluble solids of the red delicious variety increased from 11.76 to 12.63. During storage total sugars and reduction, sugars are increased. Total sugars increased from 69.06 to 69.47% and reducing sugars inclined from 15.37 to 15.89% while non-reducing sugars of red delicious apple declined from 53.69 to 53.53%. Furthermore titratable acidity is also reduced during storage from 0.17 to 0.10 %. The total phenolics contents and antioxidant activity are decreased. Antioxidant activity decreased from 24.37 % to 23.99% and total phenolics contents declined from 201.53 mg/GA to 201.09 mg/GA. Sensory evaluation of red delicious apple fruit was conducted during the storage period for color, flavor, texture, and overall acceptability. The color score decreased from 8.30 to 6.63. The score for flavor given by judges also declined from 8.40 to 7.20. The texture score was

observed to be declined from 8.10 to 6.80. The overall acceptability score for the red delicious apple variety was lower from 8.26 to 6.06. It is concluded that the treatment that contains 3% calcium lactate showed best results in maintaining the physiochemical and sensory attributes followed by T2 and T1.

Keywords: Red delicious apple, Calcium lactate, Physicochemical properties, Antioxidant, Sensory attribute

1- ITRODUCTION

Apple *(Malus pumila L.)* is a sweet, edible fruit, which grows worldwide, and is the most widely cultivated in temperate zone belongs to species of Rosaceae family, is one of the most important perennial long-lived woody fruit crops of the world (Hussain et al., 2014). Apple is mostly taken fresh and it ripens from late summer to winter. Quality of fruit is made of its external and internal (morphological-physical, biochemical and sensory) factors. With its quality it has to correspond to wishes of many consumers so that it can satisfy most of their needs, preferences, tastes and habits (Violeta, Trandafir, & Ionica, 2010).

Apple is one of the most produced fruits in the world. China, USA and Poland are the top three countries in the production of apple. According to the USDA, China is the topmost producer of apple with producing 44 million tons produced annually. The second largest contributor is United States. It produces an average of 4.6 million tons. In the same year, the yield of apples was 310,000 tons (USDA, 2019). Apples are generally known as the "sweet gold" of Pakistan and are among the most popular fruits. According to the Pakistan Bureau of Statistics, during 2012/13 apples were produced over an area of 110,000 hectares with a total production of 556,000 metric tons, placing Pakistan among the top 25 producers globally. In Pakistan, it is grown as a commercial crop in Punjab, Khyber Pakhtunkhwa, Quetta and Gilgit-Baltistan (Akhtar, Khan, Ali, & Javid, 2013). In Gilgit-Baltistan, Nagar and Hunza are famous for producing good quality apples. Nagar and Hunza are blessed with many natural resources including fruits among which apple is most famous. However, the way of production, transportation, storage and marketing is traditional Apple is one of the commonly grown cash crops in Gilgit-Baltistan (Khan, Khan, Rehman, & Ali, 2013) and has a profound impact on poverty alleviation and income generation of pro-poor segment of mountain communities (Khudadad, Ali, & Jan, 2013) which cause many losses of local farmer.

(Akhtar & Javed, 2013).

Apple has great nutritional value and contains many nutrients including vitamin C, Potassium and fiber. It also contains essential food elements such as sugar 11%, proteins 0.3%, nearly 14% of apple is made up of carbohydrates, 4% minerals and remaining part contains 80% of water (Whitney & Rolfes, 2007). Apple plays an important role in health maintenance and prevents several diseases. The health benefits of apple are associated with strong antioxidant activities, known to useful for weight loss and neuro-protective effects. Furthermore apple contains several polyphenols and antioxidants which have many biological characteristics. The dietary intake of fruits is connected with reducing the incidence of many diseases such as cancer and cardio vascular diseases. Calcium lactate used for coating plays very important role in fruit regarding to cell wall structure. The calcium lactate strengthens the cell wall structure and it has positive effect on cellular stabilization. Keeping in mind above all aspects this research was designed to check the effect of Calcium lactate treatments on the overall quality of Red delicious apple.

2- MATERIALS AND METHODS

The study was conducted at the Department of Food Technology Department Institute of Food and Nutritional Sciences, Pir Mehr Ali Shah, Arid Agriculture University Rawalpindi, Pakistan.

2.1 Collection of sample

For this research work red delicious apple was collected from Gilgit Baltistan and transported to the Food Technology Laboratory IFNS, PMAS-UAAR, Rawalpindi, Pakistan. Fruits were cleaned and washed to remove all foreign agents i.e dust particles, dirt, sand then treated with calcium lactate and stored at room temperature for one month.

2.3 Applied Treatments

T1 = Apple + 1 % Calcium Lactate

T2 = Apple + 2% Calcium Lactate

T3 = Apple + 3% Calcium Lactate

2.2 PHYSICOCHEMICAL ANALYSIS

Following physicochemical parameters were analyzed with 7 days of interval during storage.

2.2.1 Moisture Contents

The moisture of fruit sample was determined by AOAC method No.934-06 (AOAC, 1990). The following formula was used to calculate the moisture contents:

2.2.2 Total Soluble Solids

Total soluble solid of fruit of sample was determined by using refractometer, as described by AOAC method No.920-151 (AOAC, 1990).

2.2.3 Total Sugars

Total sugar content of apple varieties were determined by Lane and Eynon method described in AOAC method No.925-35 (AOAC, 1990). The following formula was used to calculate total sugar.

2.2.4 Reducing Sugars

Reducing Sugar contents of fruit sample was determined by Lane and Eynon method as described in AOAC method No. 925-36 (AOAC, 1990).

2.2.5 Non Reducing Sugars

Non Reducing Sugar content of was determined by subtracting total sugar from reducing sugar.

$$\text{Non Reducing Sugars} = \text{Total Sugars} - \text{Reducing Sugars}$$

2.2.5 Ash Contents

The ash content was determined by incinerating the dried sample in muffle furnace at 500-600^{o}C for 5 to 6 hours as described in AOAC method No.940-26 (AOAC, 1990). The formula use to calculate ash content;

2.2.6 pH

The pH value of fruit sample was measured by using pH meter as described in AOAC method No.918-12 (AOAC, 1990).

2.2.7 Titratable Acidity (% in term of Malic Acid)

Titratable acidity of fruit samples was determined by using AOAC method No.981-12 (AOAC, 1990).

2.2.7 Antioxidant activity

Antioxidant activity of fruit samples was calculated by using modified version of Brand-William (Williams, Wendy, Cuvelier, & Berset, 1995). The DPPH radical scavenging activity of extracts was expressed as % DPPH scavenging activity by using the following formula;

DPPH scavenging activity (%) = [(Abs. Control-Abs. Sample)/Abs. Control] × 100

2.2.8 Total Phenolics (mg GAE/100g)

The total phenolic content of fruit sample was determined by using the Foilin-Ciocalteau's as described by Sponas and Wrolstad (Spanos, Wrolstad, & Heatherbell, 1990).

2.3 Sensory evaluation

The sensory evaluation of apple fruits was carried out for taste, flavor, and color as described by Lawless and Heymann (Lawless & Heymann, 1998).

2.4.1 Statistical analysis

All the data were performed triplicate and results were analyzed statistically using CRD design. The means were compared by using LSD test as described by Steel, Torrie, & Dickey, (1997).

3. RESULTS AND DISCUSSION

The main purpose of current research work was to study the effect calcium lactate treatments on physicochemical and sensory characteristics of red delicious apple grown in Gilgit Baltistan. Apple samples were analyzed at an interval of 7 days for physiochemical sensory characteristics that are mentioned as under. During this study the moisture content of red delicious apple samples were analyzed. Study showed that the applied treatments calcium lactate and storage interval had significant effect on moisture content. At first day moisture content were noted as 78.27, 79.36, and 80.01 for T_1, T_2 and T3 respectively which is finally declined up to 66.9, 69.50 and 70.06. The treatment T_3 (75.11) obtained highest mean value and T_1 (72.44) got lowest value during storage. In term of percentage the maximum decrease was recorded in initial sample (14.52) and minimum decline recorded in T_3 (12.40) as shown in Table 1. Result showed that during storage moisture value of apple samples were reduced from 79.31% to 68.82% respectively as given in table-1. The decreased in moisture contents during storage were due to changing of temperature and soft skin of apple fruit lead to rapid loss of water. Higher retention of moisture content found in calcium treated apple as compared to untreated apple which might be due to lowering the respiration rate, reduced evaporation loses and minimizing physiological disorders o apple fruit. This worked was interlinked with studied of Hussain et al., (2012).

The pH of red delicious apple sample was analyzed at every 7 days interval during storage results showed significant effect of storage and calcium lactate on pH of apple samples. At first day of research pH readings were recorded as 3.80, 3.82 and 3.90 for T_1, T2 and, T_3 respectively which increased finally to 3.97, 4.01 and 4.02 as shown in Table 2. The minimum mean value was found in T_1 (3.87) while maximum mean value recorded for sample T_3 post

(3.95). Statistically treatments and storage interval had significantly ($p< 0.05$) increased the pH of apple sample from 3.84 to 4.00 during storage. In term of percentage increase the lowest was noted in T_3 (2.98) while the highest value recorded in T_2 (4.28) as mentioned inTable-2. The pH value of apple samples was increase during storage. The reason behind the increase of pH might be due to the organic acids present in the fruits which are consumed and break down of acid to sugars during respiration was likely to observe an increase in the pH of the fruit. It was clear from results that apple coated with 3% had showed lower increment in pH values which might be due to effect of calcium lactate made strong layer which was helpful in decreasing respiration rate as well as preventing structure of cell wall and cell membrane. This study was interrelated with previous research works which showed that increased in pH value during storage ranged from 3.42 to 5.42 (Rab, Khan, & Iqbal, 2012) Rehman et al., 2017).

Table 1: Effect of Calcium lactate and storage period on Moisture content of Red delicious Apple

Treatments	Storage Interval (4 days)					%Decrease	Mean
	Initial	7	14	21	28		
T_1	78.27	75.8	72.75	68.48	66.9	14.52	**72.44c**
T_2	79.36	76.5	73.4	71.21	69.5	12.42	**73.994b**
T_3	80.01	78.12	75.23	72.15	70.06	12.40	**75.114a**
Means	**79.21a**	**76.80b**	**73.79c**	**70.61d**	**68.82e**		

The different small alphabet shows statistical difference ($p <0.05$) from each others

Table 2: Effect of Calcium lactate and storage period on pH of Red delicious Apple

Treatments	Storage Interval (4 days)					%Increase	Mean
	Initial	7	14	21	28		
T_1	3.8	3.83	3.86	3.90	3.97	4.28	**3.87c**

T_2	3.82	3.85	3.89	3.94	4.01	4.73	**3.90b**
T_3	3.9	3.92	3.95	3.99	4.02	2.98	**3.95a**
Means	**3.84e**	**3.86d**	**3.90c**	**3.94b**	**4.00a**		

The different small alphabet shows statistical difference ($p < 0.05$) from each others

The results showed significant effect of calcium lactate treatments and storage on total soluble solids of apple fruits during storage at room temperature. The results illustrated that the TSS content of the samples were increased. Initially the TSS content of treatments (T_1 to T_3) was 11.80, 12.00 and 11.50^0 Brix respectively that was finally increased to 13.00, 12.80 and 12.10^0 Brix. The T_1 (12.46) obtained maximum mean value while T_3 (11.80) showed minimum mean value, given in Table 2. In term of percentage increase highest TSS value was noticed in T_1 (9.23) while lowest increment noted in T_3 (4.95) as described in Table 2. Total soluble solids of apple samples were increased with the passage of during storage which was due to conversion starch and other polysaccharides into simple sugars as TSS has direct relation with sugars contents (Durrani et al., 2010). However, application of calcium lactate reduced TSS increment by making layer on the surface of apple which delay respiration rate and helped in the protection of cell wall and cell membrane. Result showed that apple coated with 3% calcium gave good results regarding TSS increment. This work was linked with the previous work of Rehman et al., (2017).

Red delicious apple fruit samples were tested at 7 days interval for titratable acidity during 30 days storage. The result showed that the titratable acidity was decreased significantly ($P < 0.05$) during storage as data presented in Table 4. Initially titratable acidity readings were noted as 0.16, 0.17 and 0.18 for T_1, T_2 and T_3 respectively which is finally decreased to 0.08, 0.11 and 0.13. The mean value decreased from 0.17 to 0.12 during storage. The treatment T_3 got highest mean value (0.15) followed by T_2 (0.13), on other hand treatment T_1 (0.12) indicated lowest mean value followed by T_2 (0.13.).The titratable acidity of apple sample decreased during storage and highest decreased recorded in T_1 (0.16- 0.08) 50.00 % and lowest decreased was noted in T_3 post (0.18-0.13) 27.77% as shown in Table 4. During storage period Titratable acidity of apple was decreased from 0.17% to 0.10 % which might be due depletion of organic acid as result of metabolic activities in living tissues. As titratable acidity has inverse relation to pH which was increase in fruit during storage. Calcium lactate retarded the oxidation reaction, maintained the hardness of fruit cell wall and reduced metabolic process (Rehman et al., 2017; Hussain et al., 2010). The ash contents of red delicious apple sample was analyzed at every 7 days interval during storage results showed significant effect of storage and treatment with calcium lactate on ash of apple fruit samples. On the first day ash readings were recorded as 2.52, 2.61 and 2.70 for T_1, T2, and T3 respectively which increased finally to 2.76, 2.73 and 2.90. Minimum mean value was found for sample T_1 (2.64) while maximum mean value

recorded for sample T_3 (2.79). Statistically treatments and storage interval had significantly ($p< 0.05$) increased the ash content of apple sample from 2.61 to 2.79 during storage. In term of percentage increment the lowest was noted in T_2 (6.89) while the highest value recorded in T_1 (8.69) presented in Table 5. During storage period ash contents of apple were decreased (Durrani et al., 2010; Oluwaliana, Oluwamukomi, & Olajide, 2006).

Table 3: Effect of Calcium lactate and storage period on TSS of Red delicious Apple

Treatments	Storage Interval (4 days)					%Increase	Mean
	Initial	7	14	21	28		
T_1	11.8	12.1	12.5	12.9	13	9.23	**12.46a**
T_2	12	12.25	12.4	12.6	12.8	6.25	**12.41b**
T_3	11.5	11.65	11.8	11.95	12.1	4.95	**11.80c**
Means	**11.76e**	**12d**	**12.23c**	**12.48b**	**12.63a**		

The different small alphabet shows statistical difference ($p <0.05$) from each others

Table 4: Effect of Calcium lactate and storage period on TA of Red delicious Apple

Treatments	Storage Interval (4 days)					%Decrease	Mean
	Initial	7	14	21	28		
T_1	0.16	0.14	0.12	0.1	0.08	50.00	**0.12c**
T_2	0.17	0.15	0.13	0.12	0.11	35.20	**0.13b**
T_3	0.18	0.17	0.15	0.14	0.13	27.77	**0.15a**
Means	**0.17a**	**0.15b**	**0.13c**	**0.12d**	**0.10e**		

The different small alphabet shows statistical difference ($p <0.05$) from each others

Table 5: Effect of Calcium lactate and storage period on Ash content of Red delicious Apple

Treatments	Storage Interval (4 days)					%Increase	Mean
	Initial	7	14	21	28		

T_1	2.52	2.58	2.64	2.7	2.76	**8.69**	**2.64c**
T_2	2.61	2.65	2.68	2.7	2.73	**4.39**	**2.67b**
T_3	2.7	2.73	2.79	2.85	2.9	**6.89**	**2.79a**
Means	**2.61e**	**2.65d**	**2.70c**	**2.75b**	**2.79a**		

The different small alphabet shows statistical difference ($p < 0.05$) from each others

During one month storage period apple fruit samples were examined for reducing sugar at 7 days interval. Results showed that total sugars value was increased with the passage of time. At the beginning stage total sugars value for treatment (T_1, T_2, T_3) were 68.76, 68.95 and 68.48 which is increased finally to 69.31, 69.40 and 69.70. The highest increase occurred in T_1 (68.76-69.31) 0.79% followed by T_2 (68.95-69.40) 0.64% while lowest increased occur in T_3 (69.48-69.72) 0.34%. The treatment T_3 (69.60) obtained maximum mean value while T_1 (69.03) got minimum mean value summarized in Table 6. During storage period total sugars of fruit was increase from 69.06% to 69.47% which was due to conversion of pectin into fructose and glucose. As apple is climacteric fruit whose ripening and senescence process are continued during storage which lead to maximum conversion of polysaccharides such as starch and pectin to smaller unit of sugars. The lower increment of total sugars was recorded in treatment 3 where calcium slow down the ripening and senescence process led to slower the hydrolysis of polysaccharides into monosaccharide so T3 considered as best among all treatments. This research was interrelated with the previous work of Ayub et al., (2010).

During 30 days storage period apple fruit samples were examined for reducing sugar at 7 days interval at room temperature. Results showed that reducing sugar value was increased with the passage of time. At the beginning stage reducing sugar value for treatment (T_1, T_2, T_3) were 14.96, 15.30 and 15.85 which is increased finally to 15.60, 16.00 and 16.07. The highest increase occurred in T_2 (15.30-16.00) 4.37% while lowest increased occur in T_3 (15.85-16.07) 1.36%. The treatment T_3 (15.98) obtained maximum mean value while T_1 (15.22) got minimum mean value presented in Table 7. Ripening and senescence process of apple fruit were continued after it detached from tree which leads to increment of TSS during storage ultimately increase total sugars as well as reducing sugars. The conversion of starch to sugars continued during storage and hence the total and reducing sugars content were increased with storage duration Different studies suggested that reducing sugars of apple was increased from 10% to 16 % (Rab et al., 2012).

Table 6: Effect of Calcium lactate and storage period on Total sugar contents of Red delicious Apple

Treatments	Storage Interval (4 days)					%Increase	Mean
	Initial	7	14	21	28		
T_1	68.76	68.9	69.02	69.16	69.31	0.79	**69.03c**
T_2	68.95	69.05	69.18	69.3	69.4	0.64	**69.17b**
T_3	69.48	69.55	69.61	69.68	69.72	0.34	**69.60a**
Means	**69.06e**	**69.16d**	**69.27c**	**69.38b**	**69.47a**		

The different small alphabet shows statistical difference ($p < 0.05$) from each others

Table 7: Effect of Calcium lactate and storage period on reducing sugar contents of Red delicious Apple

Treatments	Storage Interval (4 days)					%Increase	Mean
	Initial	7	14	21	28		
T_1	14.96	15.05	15.2	15.3	15.6	4.10	**15.22c**
T_2	15.3	15.5	15.7	15.9	16	4.37	**15.68b**
T_3	15.85	15.95	16	16.03	16.07	1.36	**15.98a**
Means	**15.37f**	**15.5e**	**15.63d**	**15.74c**	**15.89a**		

The different small alphabet shows statistical difference ($p < 0.05$) from each others

The study showed that significant effect of storage and calcium chloride on non reducing sugar content of red delicious apple samples. Initially in treatment (T_1 to T_3) non-reducing sugars were recorded as 53.80, 53.65 and 53.63 respectively which are declined finally to 53.71, 53.40 and 53.65. The highest mean value for treatment found in T_1 (53.80) and lowest recorded in T_2 (53.49). Reduction in term of percentage maximum noticed in T_2 (0.46) and minimum noted in T_3 (0.03). Non reducing sugars of apple fruit was declined during storage period because non-reducing sugars such as sucrose may also be consumed in the respiration, it was likely observe decreased non- reducing sugars with increasing storage duration. Calcium coated apple has ability to maintain respiration for longer time as compared to untreated apple. During storage non reducing sugars are declined from 1% to 3% (Durrani et al., 2010).

Table 8: Effect of Calcium lactate and storage period on Non-reducing sugar contents of Red delicious Apple

Treatments	Storage Interval (4 days)					%Decrease	Mean
	Initial	7	14	21	28		
T_1	53.8	53.85	53.82	53.86	53.71	0.16	**53.80a**
T_2	53.65	53.55	53.48	53.4	53.4	0.46	**53.49c**
T_3	53.63	53.6	53.61	53.65	53.65	-0.03	**53.62b**
Means	**53.69a**	**53.66b**	**53.63c**	**53.63d**	**53.58e**		

The different small alphabet shows statistical difference ($p < 0.05$) from each others

The antioxidant content of red delicious apple samples was analyzed at every 7 days interval during storage. Study showed significant effect of storage and applied treatments on antioxidant content of red delicious apple samples. Initial antioxidant content were recorded as 24.30, 24.3 and 24.43 for T_1, T_2 and T_3 respectively which is finally reduced up to 23.85, 23.98 and 24.15. The treatment T_3 (24.29) obtained highest mean value and T_1 (24.10) got lowest value during storage. In term of percentage the maximum decrease was recorded in T_1 sample (1.85) and minimum decline noted in T_3 (1.14) as shown in Table 9. Storage study of Red delicious apple fruit samples was carried out at regular interval of 7 days interval for total phenolics contents during 30 days storage.

The result showed that the total phenolics contents was decreased significantly ($P < 0.05$) during storage as data presented in Table (10). At the beginning total phenolics contents readings were noted as 201.00, 201.60 and 202.00 for T_1, T_2 and T_3 respectively which is finally decreased to 200.63, 200.86 and 201.3. The mean value decreased from 201.53 to 201.09 during storage. The treatment T_3 got highest mean value (201.89) followed by T_2 (201.08) while lowest mean value was found in T_1 (200.81). The total phenolics contents of apple sample decreased during storage and highest decreased recorded in T_1 (201-200.63) 0.18 % and lowest decreased was noted in T_3 (202-201.80) 0.09 as presented in Table 10.

Table 9: Effect of Calcium lactate and storage period on Antioxidant contents of Red delicious Apple

Treatments	Storage Interval (4 days)	%Decrease	Mean

	Initial	7	14	21	28		
T_1	24.3	24.25	24.12	24	23.85	1.85	**24.10c**
T_2	24.38	24.29	24.2	24.09	23.98	1.64	**24.18b**
T_3	24.43	24.36	24.3	24.22	24.15	1.14	**24.29a**
Means	**24.37b**	**24.3c**	**24.20d**	**24.10e**	**23.99a**		

The different small alphabet shows statistical difference ($p < 0.05$) from each others

Table 10: Effect of Calcium lactate and storage period on Total phenolic contents of Red delicious Apple

Treatments	Storage Interval (4 days)					%Decrease	Mean
	Initial	7	14	21	28		
T_1	201	200.9	200.81	200.72	200.63	0.18	**200.81b**
T_2	201.6	201	201	200.95	200.86	0.36	**201.08c**
T_3	202	201.94	201.89	201.84	201.8	0.09	**201.89a**
Means	**201.53a**	**201.28b**	**201.23c**	**201.17d**	**201.09e**		

The different small alphabet shows statistical difference ($p < 0.05$) from each others

3.1 SENSORY EVALUATION

The red delicious apple fruit samples were evaluated for sensory analysis such as color, flavor, texture and overall acceptability during storage.

The statistical result showed that the fruit color scores were found to be highly significant ($P<0.05$) among all coated samples. At first date the scores recorded were 8.40, 8.30 and 8.20 for T_1, T_2 and T_3 respectively. The scores were gradually to 5.60, 6.90 and 7.40 during storage time. The highest mean value was noticed in T3 (7.80) while lowest mean value was recorded in T1 that is 7.04 as given in figure-1(A). The color score for apple fruit during storage period was decreased due to enzyme browning and oxidation of color pigment present in fruit .Color of apple fruit changes due to degradation of cell wall and cell membrane during storage. Calcium

treated apple retain color as compared to untreated apple by maintain cell well protection and enzyme browning. This work was interlinked with Lysiak et al., 2008 and Prakash et al., (2000). Similarly, the flavor scores noted as 8.50, 8.40 and 8.30 in T1, T2 and T3 respectively. During storage the flavor scores of all treatments were declined to 6.50, 7.30 and 7.80 in T1, T2 and T3, illustrated in figure-1(B). Result showed that the highest mean value was found as 8.04 in treatment 1 while lowest mean was recorded in treatment 1 which was 7.50. The results showed that the flavor of apple samples was decreased due the decrease in ascorbic acid content. Ayub *et al*., (2005) reported that the reduction of flavor from in guava fruits during storage. The results proved that calcium lactate and storage significantly affect texture of red delicious apple fruits during storage period. At initial day of study the scores for texture for apple samples were determined as 8.20, 8.10 and 8.00 T1, T2 and T3 respectively which were finally decreased to 6.20, 6.80 and 7.40 during storage as presented in figure-2(A). Results showed that the maximum mean value for texture score noted as 7.72 in treatment 3 while minimum mean value was found in treatment 2 as 7.20. The statistical result showed that the fruits the texture score among all treated variety were significant ($P<0.05$). Surmacka-Szczesniak (2002) suggested that texture is an indicator of structural and mechanical properties of food products and determines consumer's acceptability. Texture loss is the most commonly change occurring in fruits and vegetables during prolonged storage and it is related to metabolic changes and water content. During storage texture loss is common problem which might be due to the pectic acid undergoing acid hydrolysis. This study was correlated with work of (Ghavidel, Davoodi, Asl, Tanoori, & Sheykholeslami, 2013). Calcium effect on rate of texture changes during storage by reducing the rate of hydrolysis and enzyme browning. High concentration of calcium due to thick and strong layer showed good result in this study. Apple samples coated calcium lactate was analyzed for overall acceptability after every week during one month of storage. At the start of study the reading for overall acceptability were recorded as 8.30, 8.40 and 8.10 respectively for treatment (T1 to T3) which were gradually reduced to 5.70, 6.00 and 6.50 as shown in figure-2(B). During storage the overall acceptability score was decreased because assessment was based on fruit texture, flavor and visual appearance storage period.

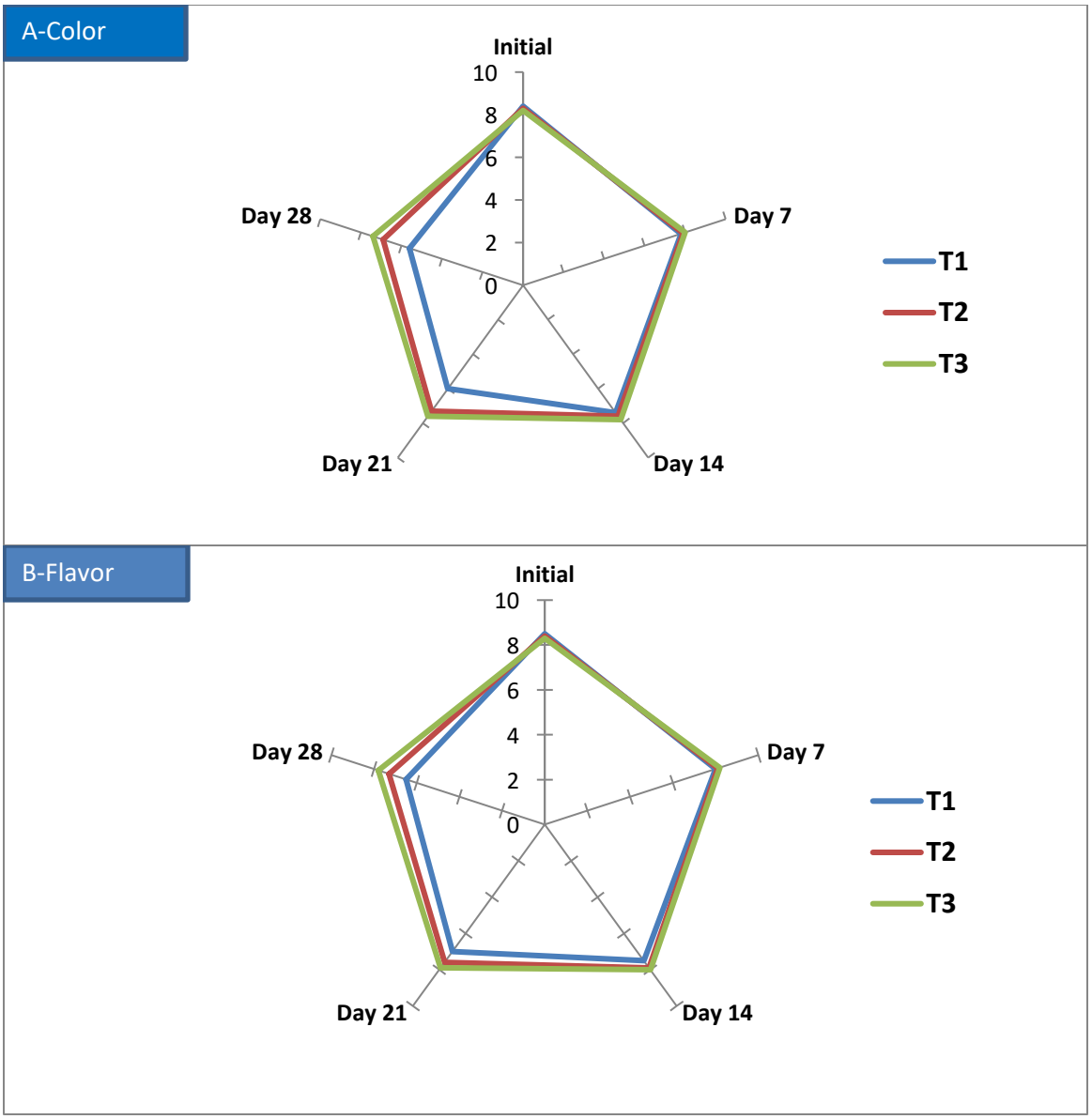

Figure 1: Effect of calcium lactate and storage period on color (A) and flavor (B) of red delicious apple Note: T1 (calcium lactate 1%), T2 (calcium lactate 2%), T3 (calcium lactate 3%)

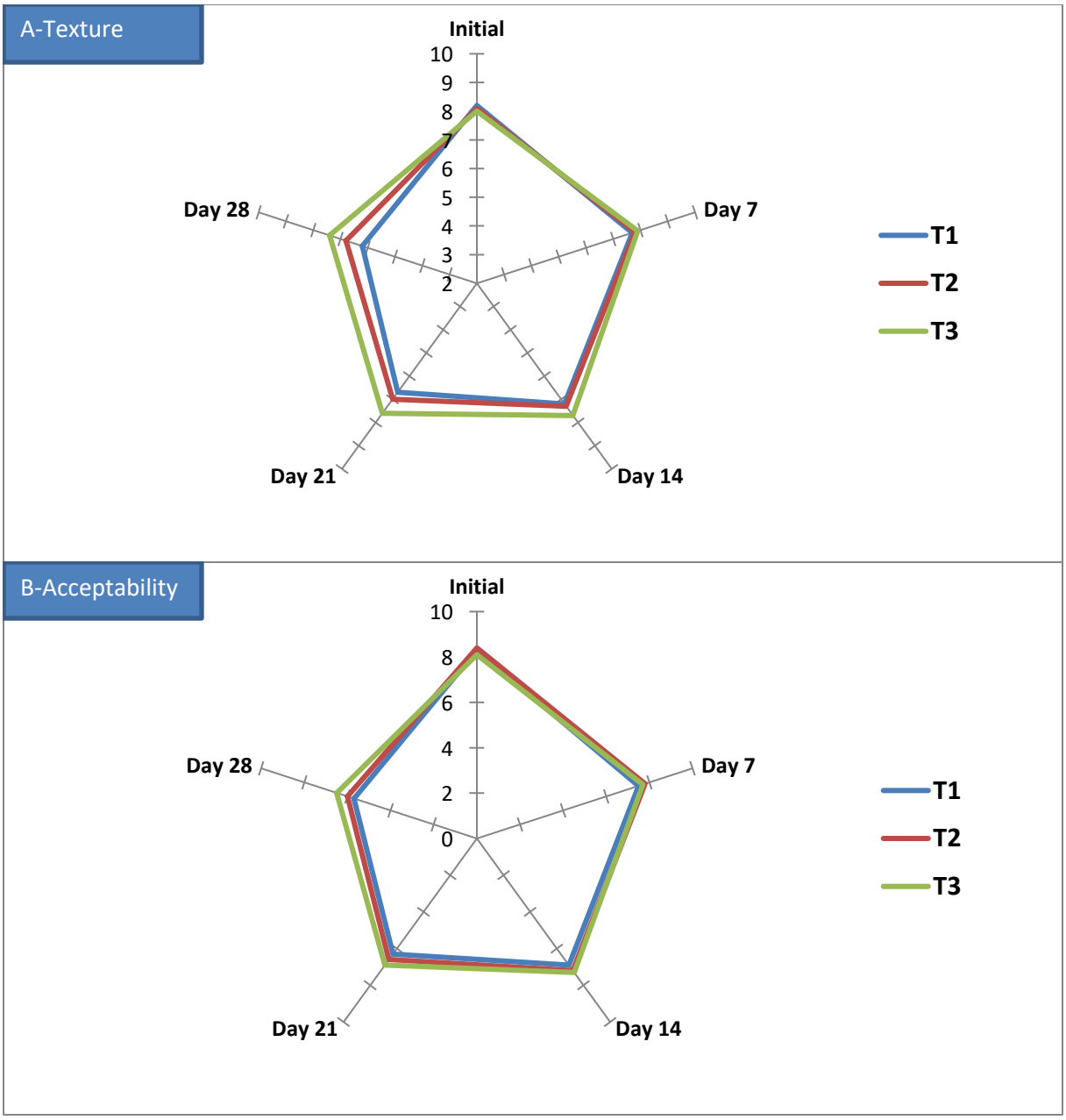

Figure 2: Effect of calcium lactate and storage period on texture and overall acceptability of red delicious apple Note: T1 (calcium lactate 1%), T2 (calcium lactate 2%), T3 (calcium lactate 3%).

Conclusion

According to the findings it is concluded that there is significant effect of calcium lactate and storage period on overall quality of red delicious apple. It demonstrated that calcium lactate treatment can be maintained overall quality and enhance shelf life of fruits. It is concluded that the T3 (calcium lactate 3%) showed best results in maintaining the physiochemical and sensory attributes followed by T2 (calcium lactate 2%) and T1 (calcium lactate 1%).

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