

EFFECT OF DIFFERENT FOOD ADDITIVES ON THE PHYSICOCHEMICAL AND MICROBIOLOGICAL QUALITY OF STORED STRAWBERRIES.

Z. Bashir¹, Maazullah K²., M. Khan²., Javedullah.K²., Saeed G².
Ras Al Khaimah Municipality, Ras Al Khaimah Emirate , UAE.

ABSTRACT

Strawberry fruit was purchased from the local market and brought to the Food science division of NIFA for processing. They were washed, cut into halves and were treated with different concentrations of sugar (0%, 20% and 40 %) and CaCl₂ (0%, 0.5% and 1%) solutions in 250ml plastic jars. The lids of the jars were tightly closed and stored at ambient condition for a period of 90 days. All the samples were analyzed for physicochemical properties (TSS, VIT C, %Acidity, Anthocyanin value, pH etc.), and microbiologically for Total Fungal Count (TFC). From the result, it was observed that the samples preserved with 40% sugar syrup were found better in Vitamin C and Anthocyanin retention after 90 days of storage. The anthocyanin content was leached out to some extent from the fruits into the syrup. The ratio of leaching was lesser in the samples treated with higher sugar concentration. No fungal contamination was noted in any sample irrespective of treatments while in controlled samples more than 10³ TFC/gm was noted and found unsuitable for human consumption. The sensory evaluation showed that all the samples were within the acceptable range except the controlled ones which were discarded after 7 days of storage.

INTRODUCTION:

Strawberry (*Fragaria ananassa*) belongs to Rosaceae family and is cultivated in many countries of the world like Japan, USA, Spain, Germany, Korea, Poland and Italy (Sharma, et al 2009). This fruit was originated from France and grown first as garden strawberry in 18th century. The fruit is famous for its unique aroma, delicious flavor, fine shape, structure and bright red

color. In Pakistan this fruit is produced in limited quantity due to the prevailing unfavorable climatic conditions in many parts of the country. Size, taste and perishable nature of the fruit are also responsible for its restricted production [Hordenburg et al 1986]. In the country, the price per KG of the fruits comes down during the month of March when the fruit

production touches its peak. The per acre income from strawberry crop is about 100000 to 120000 rupees per season. By overcoming the existing problems facing in the production of strawberry fruit, Pakistan has the potential to export it to other countries of the world.

The main growing nurseries of strawberry in Pakistan are located in Mingora and Madyan. In spite of its charming color and characteristic aroma, it is also a nutritious fruit. One serving (100g) contains about 33kcal and are rich source of Vitamin C(58.8mg) and manganese(0.39mg/100g). In addition, it also provides several other vitamins such as Thiamine(0.24mg), Riboflavin (0.022mg) Niacin (B3 0.39 mg) Pantothenic acid (B5 0.13mg), Vitamin B6 (folic acid 0.47 mg), Folate (B9 0.24 microgram), vitamin E(0.29mg), vitamin K (2.2microgram/100g) and other many dietary minerals in lesser amounts. Strawberry fruit has medicinal value also and other health benefits. Regular consumption of this fruit reduces constipation, allergies, diabetes, and depression. In addition, strawberry also contains antioxidants- anthocyanin which is useful to reduce the chances of causing several types of cancer (Navindra P.

Seeram 2008). Berry Fruits for Cancer Prevention: Current Status and Future Prospects. The presence of high polyphenol content in strawberry fruits is playing a very effective role in reducing the risk of heart diseases and hypertension.

As strawberry fruit is mostly consumed in fresh form but due to its juicy nature, the shelf life of fresh fruit is very short and can be easily attacked by several fungal species. Shelf life of the untreated fruit is less than 3 days when not treated properly. As strawberries are grown in soil and may get pathogenic microorganisms specially E. coli, Salmonella and several types of mold species, so it must be handled carefully before reaching to end users.

Keeping in view, the above facts, the present study has been initiated to test various food additives for prolonging shelf life of strawberry. This study will regulate the availability of strawberry fruit and also minimize price fluctuation during its peak season. This study will also help in analyzing the relationship between sugar and $CaCl_2$ in the preservation of perishable fruits.

MATERIALS AND METHODS:

COLLECTION OF SAMPLES: Fresh strawberry fruit (*Fragaria ananassa*) was purchased from local market and was brought to Food science division NIFA. They were washed with clean water and cut into halves with stainless steel knives. The following treatments of preservation were applied:

1. 40% SUGAR+1% CaCl₂+0.2% sodium benzoate
2. 40% sugar+ 0.5% CaCl₂+0.2% sodium benzoate
3. 40% sugar + 0% CaCl₂ + 0.2% sodium benzoate
4. 20% sugar + 1% CaCl₂+ 0.2% sodium benzoate
5. 20% sugar+ 0.5% CaCl₂+0.2% sodium benzoate
6. 20% sugar+0% CaCl₂+0.2% sodium benzoate
7. 0% sugar+ 1% CaCl₂+0.2% sodium benzoate
8. 0% sugar+ 0.5% CaCl₂+o.2% sodium benzoate
9. 0% sugar+0% CaCl₂+ 0.2% sodium benzoate

The cut fruit was dipped in the above concentrations in triplicate and were sealed in sterilized plastic jars. The samples were stored for 90 days at ambient conditions. Biochemical and microbial assessment of the samples were made at 0 day and after the interval of one month.

Following parameters were studied:

PHYSICOCHEMICAL ANALYSIS:

Vitamin C content was determined by standard AOAC method (1975).

Total soluble solid content was assessed with the help of Brix refractrometer while pH, anthocyanin and Titratable acidity were determined by applying standard method of AOAC (1984).

MICROBIAL ANALYSIS (Fungal Determination):

The samples were assessed for Total Fungal Count (TFC) by initially and after interval of one month by using standard plate count method. (Microbiological methods, 2004).

ORGANOLEPTIC ANALYSIS:

The samples were evaluated organoleptically for color, texture and smell by using 9-point hedonic scale. (Larmond 1977).

STATISTICAL ANALYSIS:

The statistical analysis was carried out by using split plot design. All the statistical analysis was carried out by Analytical Software Statistic 8.1. It was carried out to determine the significance in the effects ($p < 0.05$) of TSS, pH, Anthocyanin, Acidity etc.

RESULTS AND DISCUSSIONS:

The strawberry fruit brought to NIFA, Food science division, to test its storage quality and effect of different food additives on the physicochemical, microbial and sensory characteristics. Different treatments were applied to the halved strawberry fruit, sealed in plastic jars and stored at ambient conditions for a period of 90 days.

The samples were analyzed for vitamin c, and the data are given in table#1, which shows that vitamin c content was decreased significantly with the passage of storage time. The initial Vitamin C content in the

sample T1 was recorded 42.47 mg/100 gms of the sample which decreased to 19.9mg/100 gm after 90 days of storage. Similarly, the vitamin c content at 0 day in sample T2, T3, T4, T5, T6, T7, T8 and T9 were 21.3,21.3,22.07,23.47,29.33,22.13,26.87,28.23 and 33.13mg/ 100 gm respectively. Maximum decrease was recorded in T1 While minimum decline was observed in T9. Our results are in agreement with the findings of Oyetade et al (2012) and Emes. etal. (2008). As they reported that stability of ascorbic acid decreases with increase in temperature and pH during storage.

Table # 1. Effect of different treatments and storage time on Vitamin C content of strawberry fruit.

SR NO.	Concentration		Storage - Days				Mean
	Sugar	CaCl ₂	0	30	60	90	
T1	0	0	42.47	35.43	28.03	19.90	31.45 i
T2	0	0.5	40.83	37.47	31.23	21.30	32.71 h
T3	0	1.0	42.97	37.53	32.60	22.07	33.79 g
T4	20	0	44.87	39.50	32.17	23.47	35 f
T5	20	0.5	47.13	42.57	34.87	29.33	38.47 d
T6	20	1.0	49.63	43.53	35.50	32.13	40.2 b
T7	40	0	47.50	39.47	34.03	26.87	36.96 e
T8	40	0.5	49.20	42.50	36.37	28.23	39.07 c
T9	40	1.0	51.67	44.53	38.43	33.13	41.9 a
	Mean		46.25 a	40.28 b	33.69 c	26.27 d	

Values are the average of triplicate readings.

The samples were assessed for Titratable acidity and the data are given in table#2. It was observed from the result obtained that storage has a significant effect on the

content of total Titratable acidity. The initial content of the sample T1 was 0.74% which increased to 0.92% after 90 days' storage period. The mean values indicated that

maximum increase was recorded in sample T8 while minimum was noted in sample T1. Storage effect on Titratable acidity was also investigated and observed significant storage effect on % acidity. The increase of acidity might be due to hydrolysis of the

conversion of sugar by hydrolysis and subsequent fermentation to alcohol and formation of organic acids. Rachna Mishra and Abhijit Kar (2014), also reported similar results while working on the storage quality of strawberry fruit.

TABLE#2. Effect of different treatments and storage time on % Acidity of strawberry fruit

SR NO.	Concentration		Storage - Days				Mean
	Sugar	CaCl ₂	0	30	60	90	
T1	0	0	0.74	0.82	0.93	0.92	0.855 e
T2	0	0.5	0.72	0.83	0.94	0.94	0.856 e
T3	0	1.0	0.72	0.92	0.93	0.96	0.882 e
T4	20	0	0.79	0.91	0.92	0.97	0.899 cd
T5	20	0.5	0.82	0.95	0.94	0.98	0.92 bc
T6	20	1.0	0.82	0.97	0.92	0.96	0.918cd
T7	40	0	0.77	1.16	0.96	0.94	0.957 ab
T8	40	0.5	0.93	1.10	0.98	0.96	0.992a
T9	40	1.0	0.78	1.16	0.98	0.95	0.966a
	Mean		0.79 c	0.98 a	0.94 b	0.95ab	

Values are the average of triplicate readings

The results regarding the PH content are listed in table3. Our findings indicated that storage time had significant effect on PH values. Initial PH sample T1 was 4.53 which decreased 3.92 after the stipulated storage period of 90 days. The pH of samples at Zero day was T2, (4.87) T3, (4.10), T4 (4.37), T5 (4.33), T6(4.37), T7

(4.92), T8 (4.57), T9 (4.7) which decreased to 4.02, 3.73, 3.93, 3.83, 3.93, 3.47, 3.05, and 3.27 respectively. Our results are in accordance with the findings of Malik et al., (1994) and Oyarzabal et al., (2003) who reported the similar of storage on pH content of fruits.

TABLE#3: Effect of different treatments and storage time on pH of strawberry fruit

SR NO.	Concentration		Storage - Weeks				Mean
	Sugar	CaCl ₂	Four	Eight	Twelve	Sixteen	
T1	0	0	4.53	4.37	4.10	3.92	4.23 b
T2	0	0.5	4.87	4.70	4.45	4.02	4.51 a
T3	0	1.0	4.27	4.10	3.93	3.73	4.01 d
T4	20	0	4.67	4.37	4.20	3.93	4.29 b
T5	20	0.5	4.53	4.33	4.18	3.83	4.22 bc
T6	20	1.0	4.50	4.37	4.15	3.93	4.24 b
T7	40	0	5.17	4.92	4.67	3.47	4.55 a
T8	40	0.5	4.57	4.40	4.23	3.05	4.06 d
T9	40	1.0	4.70	4.50	4.15	3.27	4.15 c
	Mean		4.64 a	4.45 b	4.23 c	3.68 d	

Values are the average of triplicate readings

Data regarding total soluble solids (TSS) are shown in table 4. The TSS content of strawberry cut fruit increased significantly with the length of Storage period and higher

sugar concentration. The mean values of TSS were 12.93, 13.23, 13.58 and 14.1 at zero, 30, 60 and 90 days of storage period. Maximum TSS content was recorded in sample.

TABLE#4. Effect of different treatments and storage time on TSS of strawberry fruit

SR NO.	Concentration		Storage - Days				Mean
	Sugar	CaCl ₂	0	30	60	90	
T1	0	0	6.07	6.40	6.70	7.37	6.63 f
T2	0	0.5	6.40	6.77	6.87	7.43	6.86f
T3	0	1.0	6.27	6.60	6.90	7.17	6.73f
T4	20	0	11.93	12.27	12.63	13.13	12.49de
T5	20	0.5	12.30	12.65	12.87	12.93	12.68 d
T6	20	1.0	12.07	12.07	12.50	12.77	12.35 e
T7	40	0	22.07	22.07	22.60	22.80	22.38 a
T8	40	0.5	20.07	20.40	20.90	21.57	20.73 b
T9	40	1.0	19.23	19.87	20.27	22.43	20.45 c
	Mean		12.93 d	13.23 c	13.58 b	14.18 a	

Values are the average of triplicate readings

Followed by T9 after 3-month storage period while lowest content was observed in T3 followed by sample T1. R. Sabina et-al (2011) also

concluded the similar results while investigating the storage effects on the quality of strawberry juice.

Data regarding the syrup anthocyanin content are presented in table no 5. As anthocyanin is a natural pigment widely found in nature and play very important role in fruit colors. Our result indicated that anthocyanin content was increasing during the first two months

of storage while decreasing trend was observed during the third month of the storage period. It was also observed that significant content of anthocyanin was leached out from the cut fruit into the syrup. More leaching was observed in sample T1

TABLE#5. Effect of different treatments and storage time on Anthocyanin content of strawberry fruit, bleached in Syrup during storage

SR NO.	Concentration		Storage - Weeks				Mean
	Sugar	CaCl ₂	Four	Eight	Twelve	Sixteen	
T1	0	0	16.03	18.27	15.80	13.14	15.81 a
T2	0	0.5	15.37	16.90	15.82	10.90	14.75 b
T3	0	1.0	14.02	17.38	14.94	10.58	14.23 c
T4	20	0	10.13	15.68	12.73	10.91	12.36 d
T5	20	0.5	14.03	11.95	10.83	9.82	11.66 e
T6	20	1.0	12.59	12.49	11.06	10.03	11.54 e
T7	40	0	5.57	8.06	9.28	8.29	7.80 h
T8	40	0.5	6.27	8.21	10.43	8.42	8.33 g
T9	40	1.0	6.92	9.32	11.12	8.30	8.91 f
	Mean		11.21 c	13.14 a	12.45 b	10.04 d	

Values are the average of triplicate readings

Syrup which was 16.03mg and minimum leaching of the anthocyanin was recorded in the sample T7 (5.57mg).

Along with assessment in syrup, anthocyanin content was also determined in cut fruit. The data obtained are given in table#6,

which shows increasing trend of anthocyanin content with the increasing concentration of sugar syrup. The maximum content was found in sample T9 (12.08 mg) while the minimum was noted in sample T2 (8.63mg). The anthocyanin content was decreased with the passage of storage.

TABLE# 6. Effect of different treatments and storage time on Anthocyanin of strawberry fruit

SR NO.	Concentration		Storage - Weeks				Mean
	Sugar	CaCl ₂	Four	Eight	Twelve	Sixteen	
T1	0	0	8.97	7.73	6.20	6.19	7.27 d
T2	0	0.5	8.63	7.43	6.18	6.27	7.13 d
T3	0	1.0	8.65	7.29	6.06	6.42	7.11 d
T4	20	0	10.87	10.32	8.27	6.26	8.93 c
T5	20	0.5	8.97	9.05	10.17	6.68	8.72 c
T6	20	1.0	9.74	8.51	9.94	6.14	8.58 c
T7	40	0	12.0	11.88	11.72	6.05	10.37 b
T8	40	0.5	11.73	12.79	10.57	8.24	10.83 a
T9	40	1.0	12.08	11.68	9.88	9.36	10.75 a
	Mean		10.05 a	9.75 a	8.78 b	6.85 c	

Values are the average of triplicate readings

Wrolstad et al (1990) and Rosso V.V. and A.Z. Mercadante (2007) told while investigating the stability of anthocyanin of tropical fruits that the addition of sugars and salts had negative effect on the anthocyanin stability. They also explained that the protective role of sugar on anthocyanin content could be occurring during freezing time rather than storage.

The data was also analyzed microbiologically for Total Fungal Count. All the treated samples were found free of fungal infestation during the entire storage period irrespective of treatments. Microbiologically, the samples remained fit for human consumption for the entire storage time.

CONCLUSIONS:

In this study it was concluded that storage period and sugar

concentration with CaCl₂ had significant effect on the vitamin C and anthocyanin content. A gradual decrease in vitamin C was noted in all the samples. Among all the treatments, the samples preserved in 40% sugar concentration showed best results regarding the retention of fruit qualities during storage at ambient conditions.

Preservation of Strawberry cut fruit in higher concentrated sugar syrup minimizes the leaching of anthocyanin from fruits in to the syrup.

This study will be helpful in preserving different types of fruits and acts as a useful tool to minimize the price fluctuations existing between its peak and off seasons.

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