Journal of Nutrition & Food Sciences
ISSN: 2155-9600

Zeb et al., J Nutr Food Sci 2015, S13
DOI: 10.4172/2155-9600.S13-001

Research Article Open Access

Post-Harvest Evaluation of Strawberry Fruit Preserves in Different Concentration of Sucrose Solution and Potash Alum Stored at Ambient Temperature

Alam Zeb[1], Noor Ul Amin[1], Sadiq Shah[1], Muhammad Ayub[1], Arsalan Khan[2]*, Muhammad Ali Khan[2], Falak Naz Shah[2], Zafar Ali[2] and Sher Hassan Khan[2]

[1]*The University of Peshawar, Khyber PukhtoonKhwa, Pakistan*
[2]*Agriculture Research Institute Tarnab Peshawar Khyber PukhtoonKhwa, Pakistan*

Abstract

This research work was conducted to study the effect of sucrose solution and pretreatment of potash alum at different concentration on overall quality of the strawberry fruit kept at ambient temperature. Various treatments were designed named as S_0, S_1, S_2, S_3, S_4, S_5, S_6 describing different concentrations of sucrose solutions and potash alum. All these treatments were examined physicochemically (Titratable acidity, pH, ascorbic acid, TSS, reducing and non-reducing sugar) and organoleptically (Texture, flavor, color and overall acceptability) at each 15 days interval for three months. Storage results shown that Decreased was found in pH from (3.50 to 3.33), ascorbic acid from (54..68 to 30.23 mg/100 g), non-reducing sugar from (11.89 to 11.04%), color score from (9 to 4.96), texture score from (9 to 5.63), flavor score from (9 to 5.23) and overall acceptability score from (9 to 5.40) while increased were found in TSS from (18.20 to 21.27Brix), titratable acidity from (0.38 to 0.53%) and reducing sugar from (5.58 to 7.88%) throughout storage period. The highest mean value for pH was occurred in treatment S1 (3.45), titratable acidity in S3 (0.50%), TSS in S6 (24.76°Brix), ascorbic acid in S2 (46.30 mg/100 g), reducing sugar in S6 (8.20%), non-reducing sugar in S3 (14.41%), color in S2 (7.60), texture in S2 (7.89), flavor in S3 and S4 (7.60) and overall acceptability in S1 (7.83). Findings revealed potash alum shows better results in 30° and 40°Brix sucrose solution concentration both for physicochemical and organoleptic properties of strawberry.

Keywords: Strawberry; Potash alum; Benzoate; Sucrose; Ambient temperature

Introduction

Strawberry (*Fragaria Spp.*) belongs to family "Rosaceae". Over six hundred varieties occurred which differ in taste, texture and size [1]. Strawberry is one of the important fruit among the berries. Various strawberry species grow wild all over the world, but the cultivated strawberry is based upon two species *Fragarin Chiloensis* and *Fragarin Verginiana*. Hybrids between these two species were the precursor of all the present strawberry cultivars [2]. Strawberry crop is recently introduced in Pakistan; its production in Pakistan is very low as compared to other countries of the world where strawberries were grown. In Pakistan it is grown inside definite places of Punjab, Islamabad and Khyber Pakhtunkhwa [3]. There are many varieties grown in the world but the main promising varieties grown in Pakistan are Mission, Corona, Tuft, Sweet Charlie, Super faction and Festival. During 2009-10 strawberry was grown on an area of about 193 acres and its production was 274 tons in Pakistan [4]. According to Food and Agriculture Organization (FAO), world production of strawberries has exceeds 4 million tons, in which United States contributes 28 percent [5]. Nutritionally, One cup of strawberry contains 1 g protein, 10.5 g carbohydrates, 0.6 gram fat, 1.6 gram fiber, 0.1 mg thiamin, 84.5 mg vitamin C, 26.4 mg folic acid, 0.1 mg riboflavin, 0.4 mg niacin, 0.2 mg zinc, 0.6 mg iron, 2 mg sodium, 21 mg calcium, 16 mg magnesium, 45 kcal calories [5]. Vitamin C level of Strawberry fruit is more than oranges. Strawberry fruit also give an exceptional supply of vitamin K, vitamin B5, vitamin B6, manganese, magnesium, copper, potassium and omega 3 fatty acids [6]. Malic and Citric acids are main organic acids which contribute to aroma. Strawberries also contain a higher percentage of antioxidants such as phenols and flavonoids as compared to other berry fruit [7]. Strawberry fruit have juicy, tiny, flavorful, nourishing, syrupy flavor, diuretic, demineralizing, tonic and astringent attributes [8]. The strawberry fruit can be used both in fresh form and preserved to Jellies, James and squashes that can be consumed in off season [9]. Osmotic dehydration (OD) is a technology that partially removes the water from fruits and vegetables, when it is dipped in a hypertonic solution of salt, sugar or others. This process is successfully applied to those fruit and vegetable, which is perishable and cannot be supplied to market in fresh form. However, OD is a pretreatment course of action so further is process is necessary for the stability of the product. Osmotic dehydration method (OD), also named dewatering and impregnation by immersion in concentrates or by immersion of fruits and vegetable in concentrated solutions or syrups of soluble solids, without phase change [10]. Alum is a salt that in chemistry is a combination of an alkali metal, such as sodium, potassium, or ammonium and a trivalent metal, such as aluminum, iron, or chromium. The most common form, potassium aluminum sulfate, or potash alum, is one form that has been used in food processing. The potassium-based alum has been used to produce crisp cucumber and watermelon-rind pickles as well as maraschino cherries, where the aluminum ions strengthen the fruits' cell-wall pectins [11,12] Sugar provides sweet taste and flavor to the product; they also provide freshens and contributes to

***Corresponding author:** Arsalan Khan, Agriculture Research Institute Tarnab Peshawar, Khyber Pukhtoon Khwa Pakistan, Tel: +92-314-9602556; E-mail: arsalankhan.fst@gmail.com

Received April 12, 2015; **Accepted** July 01, 2015; **Published** July 06, 2015

Citation: Zeb A, Amin NU, Shah S, Ayub M, khan A, et al. (2015) Post-Harvest Evaluation of Strawberry Fruit Preserves in Different Concentration of Sucrose Solution and Potash Alum Stored at Ambient Temperature. J Nutr Food Sci S13: 001. doi:10.4172/2155-9600.S13-001

the product quality [13]. Different chemical preservatives are used in food products to extend their shelf life but the most important are sodium benzoate, potassium sorbate, potassium metabisulphite, sorbic acid, sulphur dioxide etc. Potassium sorbate, retard yeasts and molds growth in numerous food stuffs like yogurt, cheese, wine, dried meats and dehydrated commodities. Sodium benzoate is a becteriostatic and fungistatic preservative underneath acidic environment and is mostly used in acidic foods like salad dressings (vinegar), carbonated munchies (carbonic acid) and condiments [14]. Nonetheless, the future of strawberry production and processing might be very much bright in our country in general and Khyber Pakhtunkhwa in particular because this fruit fetches maximum economic returns for the farmer. Due to the perishability of strawberry fruit, this research work was designed to prepare a value added product from strawberry fruit to maintain is texture properties and physiochemical properties.

Materials and Methods

Sound, healthy and ripened strawberries were purchased from the orchard at Charsadda and were brought to the laboratory of Food Technology section, Agriculture Research Institute, Tarnab Peshawar where research work was conducted. Strawberry fruit without visible defects and color were selected. After washing with cold water the stalks of the fruits were removed with stainless steel knives. First two different concentration of potash alum solution was made (1.2% and 2%), strawberry fruit were dipped for 30 minutes [11]. At the same time three different concentrations of sucrose solutions (30°Brix, 40°Brix, 50°Brix) were prepared with supplementation of chemical preservative (Sodium benzoate) described by Khan [15] Furthermore, various treatments were prepared and named as; Table 1. Then the collected samples of strawberry fruit were immersed in 500 ml sterilized plastic jars filled with respective treatment solutions. For physiochemical and organoleptic analysis and shelf life study, the jars were completely sealed and stored at ambient temperature. The experiment was repeated with three replications.

Chemical used

Sodium Benzoate (Analytical grade-Merck Germany), Potash alum (Analytical grade-Merck), Sodium hydroxide (Analytical Grade-Sigma), Copper sulphate (Analytical Grade-Merk Germany), Oxalic Acid (Analytical Grade- Sigma), 2,6-dichloro indophenols (UK Chemical LTD), Potassium hydroxide (Analytical Grade-Sigma), Methylene Blue (Sigma), Phenolphthalein (Analytical Grade-Merk). Ascorbic Acid (Merk Germany), Sodium Potassium tartrate (ChemPol England).

Chemical analysis

Acidity, pH, Total soluble solids, reducing and non-reducing sugar, Ascorbic acid were evaluated through standard methods of AOAC [16].

Organoleptic analysis

The samples of strawberry fruit preserve were sensory evaluated for color, texture, flavor and overall acceptability by 10 trained judge's panel. Organoleptic study was carried out at each 15 days interval for 3 month storage. The evaluation was conceded out by using 9 points hedonic scale of Larmond [17]. The results are of scoring rate 1-9 awarded by judges of panel.

Statistical analysis

All the data concerning treatments and storage interval were statistically analyzed using factorial experiment in completely randomized design and the means were separated by applying least significant difference (LSD) Test at 5% possibility level as defined by Steel and Torrie [18].

Results and Discussion

Chemical analysis

pH: pH of the fruit is mainly associated to the flavor and perishability. The mean pH values decrease during storage from

S.No	Code	Treatment
1	S_0	Control
2	S_1	Strawberry fruit + sucrose solution (30° brix) + Sodium benzoate 0.1% + Potash alum 1.2%)
3	S_2	Strawberry fruit + sucrose solution (30° brix) + sodium Benzoate 0.1% + Potash alum 2%)
4	S_3	Strawberry fruit + sucrose solution (40° brix) + Sodium benzoate 0.1% + Potash alum 1.2%)
5	S_4	Strawberry fruit + sucrose solution (40° brix) + Sodium benzoate + Potash alum 2%)
6	S_5	Strawberry fruit + sucrose solution (50° brix) + Sodium benzoate 0.1% + Potash alum 1.2%)
7	S_6	Strawberry fruit + sucrose solution (50° brix) + Sodium benzoate 0.1% + Potash alum 2%

Table 1: Treatment preparations.

Treatments	Storage Intervals (Days)							% Decrease	Means
	0	15	30	45	60	75	90		
S_0	3.48	3.44	3.41	3.4	3.37	3.34	3.33	4.32	3.39d
S_1	3.52	3.5	3.48	3.45	3.42	3.4	3.38	3.99	3.45a
S_2	3.47	3.44	3.41	3.38	3.34	3.31	3.29	5.2	3.37e
S_3	3.5	3.47	3.45	3.42	3.39	3.36	3.32	5.16	3.41bc
S_4	3.54	3.51	3.48	3.44	3.41	3.38	3.36	5.1	3.44a
S_5	3.49	3.49	3.46	3.42	3.39	3.37	3.35	4.02	3.42b
S_6	3.51	3.48	3.45	3.41	3.37	3.33	3.31	5.71	3.41c
Means	3.50a	3.48b	3.45c	3.42d	3.38e	3.36f	3.33g		

Values having different alphabetical letters are significantly different (P<0.05)
Least Significant Difference (LSD) at 5% level for treatments and storage interval=0.0112

Table 2: pH analysis of different treatments of strawberry fruit.

3.50 to 3.33 (Table 2). The highest percent decreased was found in S_6 (5.71%) followed by S2 (5.20%) while the lowest percent decrease was observed in S_1 (3.99%) followed by S_5 (4.02%). A decrease in pH value during osmotic dehydration and rehydration was found as major characteristics of pineapple slices [19]. For sugar solution, pH showed a slight decrease from 5.4 to 5.1 while in sugar/salt solution it decreased from 5.1 to 4.9. The pH fluctuated with osmotic dehydration time but the changes were not significant, and these values have advantage of inhibiting microbial growth [10]. Similarly, strawberry syrup was also featured with decreasing trend of pH level with storage interval due to development of acidic compounds [20]. Similar results were also found by Khan [14] during storage of strawberry fruit in different concentration of sucrose solution and chemical preservatives. The Fluctuations in pH range was specifically observed in strawberry fruits while the syrup exhibited an unchanged pH levels.

Total soluble solid (TSS): The mean Total Soluble Solids of the treatments increase from 18.20 to 21.07° brix during storage. Highest percent increase was found in S_0 (21.25) followed by S_2 (2.19) while lowest percent increase was observed in S_5 (11.81) followed by S_1 (17.48) as shown in Table 3. Increase in TSS was due to the movement of sucrose molecules from osmotic solution to strawberry fruit through the semipermeable wall of the fruit. Similar findings were recorded by Kumar [21]. Who observed an increase in total soluble solid during osmo dehydration of pineapple slices? Additionally, another study explained that the raise in TSS during storage interval of the pineapple slices was due to diffusion of molecule from dilute medium to concentrated solution (hypertonic solution) through a semi-permeable membrane until the concentration equilibrium was reached. The total soluble solid of the medium of strawberry fruits increased due to the movement of sugar content from higher concentration (sucrose solution) to lower concentration (strawberry fruit) [19].

Titratable acidity (%): Mean values for Titratable acidity increase from 0.38 to 0.53 during storage period (Table 4). The highest percent increase was observed in S_0 (31.63%), followed by S_3 (30.51%) while lowest percent increase was noted in S_1 (25.0%), followed by S_5 (27.27%) shown in Table 4. The results are in agreement with the conclusions of Ali [22] who observed an increase in titratable acidity during preservation of persimmon slice. Similar results were investigated by Kumar [23] in osmotically vacuumed dried mango slice. The increase in acidity might be due to development of acidic substances by the degradation of pectic bodies or breakdown and also attributed to hydrolysis of polysaccharides and non-reducing sugars through utilization of acids for converting them to hexose sugar [24]. High concentration of sucrose solution decreased the loss of acid from fruit to syrup. Sugar form a barrier on the surface of the fruit at high concentration, which makes it difficult to lose solids from the fruit. Such results are in treaty with those obtained by Heng [25] and Khan [15]. The titratable acidity of the blue berries also increased during osmodehration by Giovanelli [26]. Figure 1 shows various treatments on the strawberry fruit preserve, So, S_1, S_2, S_3, S_4, S_5 represents different treatments used during preservation procedure of strawberry fruit.

Ascorbic acid (mg/100 g): Ascorbic acid content decreased with the storage time. The mean values of ascorbic acid content were significantly decreased from 54.68 to 30.23 mg/100 g during storage. Maximum percent decrease was found in S_0 (63.17%) followed by S_6 (49.10%), while minimum percent decrease was found in S_2 (32.93%) followed by S_3 (37.28%) shown in Table 5. These outcomes are in agreement with the conclusions of Kumar and Sangarand-lata [23]

Treatment	Storage Intervals (Days)							% increase	Means
	0	15	30	45	60	75	90		
S0	6.78	5.6	4.86	3.97	2.89	1.91	1	85.25*	3.86d
S1	18.6	19.2	20	20.8	21.4	21.9	22.54	17.48	20.63bc
S2	18.98	19.9	20.8	21.4	22.18	22.98	23.78	20.19	21.43b
S3	21	22.6	23.1	23.68	24.32	25.12	26.21	19.88	23.72a
S4	21.6	22.5	24	24.5	25.1	25.7	26.58	18.74	24.28a
S5	18.97	18	19.2	19.8	20.5	20.9	21.51	11.81	19.84c
S6	21.5	23.1	23.9	25	25.8	26.7	27.3	21.25	24.76a
Means	18.20d	18.70cd	19.41bcd	19.88abc	20.31ab	20.74ab	21.27a		

*showed decrease in TSS
Values having different alphabetical letters are significantly different (P<0.05)
LSD at 5% level for treatments and storage interval=1.5632

Table 3: Analysis of TSS (°brix) of different treatment of strawberry fruit.

Treatments	Storage Intervals (Days)							% increase	Means
	0	15	30	45	60	75	90		
S_0	0.34	0.36	0.39	0.4	0.44	0.47	0.49	31.63	0.41e
S_1	0.39	0.4	0.43	0.45	0.46	0.48	0.52	25	0.45c
S_2	0.38	0.41	0.42	0.47	0.49	0.5	0.54	29.63	0.46bc
S_3	0.41	0.44	0.47	0.5	0.54	0.56	0.59	30.51	0.50a
S_4	0.36	0.37	0.4	0.42	0.46	0.48	0.51	29.41	0.43d
S_5	0.4	0.41	0.43	0.45	0.48	0.51	0.55	27.27	0.46b
S_6	0.37	0.39	0.43	0.4	0.42	0.46	0.53	30.19	0.43d
Means	0.38g	0.40f	0.42e	0.44d	0.47c	0.49b	0.53a		

Values having different alphabetical letters are significantly different (P<0.05)
LSD at 5% level for treatments and storage interval= 0.0140

Table 4: Analysis of Titratable acidity of different treatment of strawberry fruit.

Citation: Zeb A, Amin NU, Shah S, Ayub M, khan A, et al. (2015) Post-Harvest Evaluation of Strawberry Fruit Preserves in Different Concentration of Sucrose Solution and Potash Alum Stored at Ambient Temperature. J Nutr Food Sci S13: 001. doi:10.4172/2155-9600.S13-001

Figure 1: Various treatments on the strawberry fruit preserve, So, S_1, S_2, S_3, S_4, S_5 represents different treatments used during preservation procedure of strawberry fruit.

Treatments	Storage Intervals (Days)							% Decrease	Means
	0	15	30	45	60	75	90		
S_0	52.1	48.01	41.43	36	30.19	25.78	19.19	63.17	36.10d
S_1	51.31	48.76	43.13	39.89	36.75	33.1	30	41.53	40.42c
S_2	57.4	53	48.4	44.1	42.7	40	38.5	32.93	46.30a
S_3	55.8	52	48.2	46	41.8	39.1	35	37.28	45.41ab
S_4	59	54.12	49.08	45.1	40.6	37	34	42.37	45.56ab
S_5	58	55.4	50	42	36.3	32.7	29.9	48.45	43.47b
S_6	49.12	46.4	42.89	37.45	32.67	28.98	25	49.1	37.50d
Means	54.68a	51.10b	46.16c	41.51d	37.29e	33.81f	30.23g		

Values having different alphabetical letters are significantly different (P<0.05)
LSD at 5% level for treatments and storage interval=2.4006

Table 5: Analysis of Ascorbic acid content (mg/100 g) of different treatment of strawberry fruit.

who observed decreased in ascorbic acid (AA) content of osmo-vac dehydrated mango slices. In all cases, the osmotic treatment caused significant losses in the AA content of samples, ranging from 24 to 43%. An additional decrease was observed during storage. Two independent mechanisms could be considered to explain these AA losses: losses by diffusion from the fruit tissue into the Osmotic Solution (OS) during dehydration and losses due to chemical degradation during processing and storage. The reaction mechanism of ascorbic acid decomposition in foods has been extensively studied. When oxygen is present, AA degradation occurs simultaneously by oxidative and anaerobic mechanisms, the latter pathway being slower than the oxidative one [27]. The oxidative degradation of AA is related to ascorbinase activity and by indirect degradation throught polyphenol oxidase, cytochrome oxidase and peroxidase activity [28]. During the first two weeks of storage, the predominant effect is that of the oxidation of the AA to L-dehydroascorbic acid (DHA). From that storage time, the anaerobic degradation becomes predominant [29].

Reducing sugar: During storage interval amount of reducing sugars gradually increased from 8.35 to 11.16. Maximum percent increase was found in S_2 (43.85%) followed by S_3 (32.18%) while minimum percent increase was found in S_1 (24.15%) followed by S_5 (26.31%) while control samples S_0 showed decrease during storage as shown in Table 6. Results showed that reducing sugar increased with time but the control decreased with time. The reason for increasing the reducing sugar might be due to the presence of invertase enzymes but invertase enzymes works properly at 4.6 pH and 50°C temperature And since the temperature was ambient in this condition, thus making it inadequate for activity of invertase enzyme.. The possibility of acid hydrolysis of sucrose will also increase. These results are shown by Wisal [30] during storage of strawberry juice with different chemical preservatives and sucrose content. Kumar [21] also show similar results during pineapple slices osmo dehydration.

Non reducing sugar: The mean values of non-reducing sugar of strawberry fruit samples (S_o to S_6) were decreased from 11.89 to 11.04 during storage duration. Highest percent reduction in non-reducing was occurred in S_0 (89.29%) followed by S_4 (6.88%), while percent lowest reduction was recorded in S_1 (3.40%) followed by S_2 (4.84%) as shown in Table 7. The reason for decreasing in non-reducing content might be due to inversion by acid. [31] Zia and Ayub observed similar results in decreased in non-reducing sugar of sucrose and glucose preserved melon cubes. Wisal [30] Reviewed similar results in strawberry juice preservation in different chemical and sucrose contents.

Sensory evaluation

Color: The average mean values for strawberry fruits preserved were considerably (P< 0.05) declined from 9.00 to 4.96 during storage period. Highest percent decreased in color occurred in S_o (88.89%)

Treatments	Storage Intervals (Days)							% increase	Means
	0	15	30	45	60	75	90		
S_0	3.52	3.04	2.51	2.09	1.69	1.19	0.64	81.82*	2.10d
S_1	5.6	5.82	6.37	6.68	6.91	7.34	7.93	29.38	6.66c
S_2	5.59	6.04	6.56	6.92	7.42	7.84	8.23	32.08	6.94bc
S_3	6.2	6.82	7.24	7.78	8.19	8.76	9.55	35.08	7.79ab
S_4	6.4	6.98	7.56	8.12	8.89	9.38	10.09	36.57	8.20a
S_5	5.39	5.87	6.25	6.54	6.86	7.33	7.52	28.32	6.54c
S_6	6.39	6.87	7.24	7.88	8.43	8.99	9.68	33.99	7.93a
Means	5.58e	5.92de	6.25cde	6.57bcd	6.91abc	7.26ab	7.66a		

*Showed decrease in reducing sugar
Values having different alphabetical letters are significantly different (P<0.05)
LSD at 5% level for treatments and storage interval= 0.8711

Table 6: Analysis of reducing sugar (%) of different treatments of strawberry fruit.

Treatments	Storage Intervals (Days)							% Decrease	Means
	0	15	30	45	60	75	90		
S_0	2.24	2.04	1.82	1.59	1.32	1.08	0.24	89.29	1.48f
S_1	12.34	12.28	12.22	12.16	12.1	12.03	11.92	3.4	12.15e
S_2	13.01	12.95	12.84	12.73	12.62	12.51	12.38	4.84	12.72c
S_3	14.78	14.67	14.54	14.39	14.28	14.18	14.03	5.07	14.41a
S_4	14.09	13.95	13.83	13.69	13.47	13.29	13.12	6.88	13.63b
S_5	12.58	12.52	12.47	12.41	12.35	12.28	12.22	2.86	12.40d
S_6	14.22	14.12	14.03	13.89	13.65	13.43	13.34	6.19	13.81b
Means	11.89a	11.79ab	11.68bc	11.55cd	11.40de	11.26e	11.04f		

Values having different alphabetical letters are significantly different (P<0.05)
LSD at 5% level for treatments and storage interval=0.2056

Table 7: Analysis of non reducing sugar (%) of different treatment of strawberry fruit.

Treatments	Storage Intervals (Days)							% Decrease	Means
	0	15	30	45	60	75	90		
Color Score rate									
S_0	9	6.3	5.2	3.9	2.5	1	1	88.89	4.13c
S_1	9	8.6	7.8	7.2	6.9	6.7	6.1	32.22	7.47a
S_2	9	8.4	7.7	7.5	7.2	6.9	6.5	27.78	7.60a
S_3	9	8.3	7.5	6.7	6.5	5.9	5.7	36.67	7.09ab
S_4	9	8.4	7.1	6.5	6.1	5.8	5.4	40	6.90ab
S_5	9	7.6	6.4	6.2	5.7	5.1	4.7	47.78	6.39b
S_6	9	8	7.6	7.1	6.4	5.9	5.3	41.11	7.04ab

Values having different alphabetical letters are significantly different (P<0.05)
LSD at 5% level for treatments and storage interval=0.7709

Table 8: Sensory evaluation score for color of strawberry fruit.

followed by S_5 (47.78%) while percent lowest decreased in color occurred in S_2 (27.78%) followed by S_1 (32.22%) as presented in Table 8 [32]. Moreno observed color changes during ohmic heating, vacuum impregnation and osmodehydration of strawberry fruits. Mancilla [33] showed similar changes in color during osmo dehydration under hydrostatic pressure of strawberry fruits. The change in strawberry color is associated with chromatic coordinates which is affected by osmodeydration under hydrostatic pressure. Perera [34] also observed a decrease in color due to browning reaction (millard) that occurred throughout storage in pineapple juice. A decrease in color intensity was recorded in pineapple slices and mango chips due to osmodehydartion [21,35]. Red color of strawberry is due to presence of anthocyanin pigments. Reduction in anthocyanin pigments causes loss in color for strawberry fruits during the preservation due to osmosis or solubility of anthocyanin in free water present in osmotic solution. Many investigations revealed that fructose is one of the major carbohydrates in promoting color degradation during processing while sucrose stabilizes anthocyanin level [36].

Texture: The average mean values for strawberry fruits preserved were considerably (P< 0.05) declined from 9.0 to 5.14 during storage period. Highest percent decreased in texture occurred in S_0 (88.89%) followed by S_6 (34.44%) while percent lowest decreased in texture occurred in S_2 (26.56%) followed by S_1 and S_4 (26.67%) shown in Table 9. These results are similar to those reported by Iman [37] who preserved apple slices in sucrose/glucose solution. Maldonado [38] showed decline of the texture during rehydration of mangoes. Texture is usually related to the firmness of the fruit. Aday and Caner [39] observed changes in firmness of the strawberry fruit using an oxygen absorber in a bio based package. Change in texture might be due to cell rupture or conversion of starch to sugar [40]. Deng and Zhao observed decrease in firmness of osmodehydrated apple with storage period. Textural properties are intimately associated with the cellular structure

Treatments	Storage Intervals (Days)							% Decrease	Means
	0	15	30	45	60	75	90		
Texture Score rate									
S_0	9	6.6	4.8	3.7	2.8	2	1	88.89	4.27b
S_1	9	8.3	8	7.7	7.45	7.05	6.6	26.67	7.73a
S_2	9	8.53	8.3	7.98	7.62	7.13	6.7	25.56	7.89a
S_3	9	8.21	7.97	7.5	7.19	6.87	6.4	28.89	7.59a
S_4	9	8.45	8.15	7.78	7.47	7.06	6.6	26.67	7.79a
S_5	9	8.15	7.9	7.4	7.12	6.7	6.18	31.33	7.49a
S_6	9	8.25	7.87	7.34	7.04	6.5	5.9	34.44	7.41a

Values having different alphabetical letters are significantly different (P<0.05)
LSD at 5% level for treatments and storage interval=0.7951

Table 9: Sensory evaluation score for texture of strawberry fruit.

Treatments	Storage Intervals (Days)							% Decrease	Means
	0	15	30	45	60	75	90		
Flavor Score rate									
S_0	9	6	5.3	4.5	3.4	2.3	1	88.89	4.50c
S_1	9	8	7.7	7.3	6.7	6.2	5.7	36.67	7.23ab
S_2	9	8.3	7.7	7.4	7	6.7	6.5	27.78	7.51a
S_3	9	8.3	8.1	7.6	7.1	6.9	6.2	31.11	7.60a
S_4	9	8.1	7.9	7.5	7.1	6.9	6.7	25.56	7.60a
S_5	9	8.2	7.6	7.2	6.9	6.3	5.6	37.78	7.26ab
S_6	9	7.7	7.1	6.4	5.9	5.3	4.9	45.56	6.61b

Values having different alphabetical letters are significantly different (P<0.05)
LSD at 5% level for treatments and storage interval=0.6962

Table 10: Sensory evaluation score for flavor of strawberry fruit.

and pectic composition. Fuchigami, Miyazaki and Hyakumoto [41] observed that the inferior texture of frozen tomatoes was accompanied by a decrease in the content of pectic compounds. Also the level of protopectins and pectins were significantly reduced by the freezing process itself and during subsequent frozen storage of tomato tissue.

Flavor: The mean value of the strawberry fruit preserved for flavor considerably (P< 0.05) declined from 9.0 to 5.23 during the whole storage period. Highest percent decreased in flavor score was observed in S_0 (88.89%) followed by S_6 (45.56%) while lowest percent decreased was found in S_4 (25.56%) followed by S_2 (27.78%) as described in Table 10. Flavor is the blend of taste and smell perceptions noted when food is taken. The overall flavor impression is the result of taste perceived by the taste buds in the mouth and the aromatic compounds detected by the epithelium in the olfactory organ in the nose. Loss of aromatic substances occurred in osmo dehydration of mango and concluded that high osmodeydration level effect the volatile compound negatively while lower osmodehydration level give rise to enhancement of the volatile profile [42]. Similarly, Pani [43] also observed degradative event during osmodehydration and air dehydration of tomato slices. Another study also displayed a decline in flavor of mango fruit after 15 days of storage interval. The biochemical and physiological changes in mango fruits were slower and the conversion of complex organic compounds into esters, aldehydes, acids, alcohols, ketones and ethers that contributes significantly to the aroma/ flavor developed at the later stage of storage period [44] Osmotic treatments stimulates changes in volatile profile of strawberry fruits [45] and kiwi fruit [46] altering the overall aroma of the fruits that leads to flavor degradation.

Overall acceptability

The mean score for overall acceptability of the strawberry fruit preserve decreased from 9.00 to 5.40. Highest percent decreased in overall acceptability was founded in S_0 (88.89%) followed by S_6 (46.67%), while the lowest percent decreased was occurred in S_2 (25.56%) followed by S_4 (26.67%) as shown in Table 11. These results are in commerce with Sabrina [47] who observed decline in the overall acceptability of osmo dehydrated mango slices with inverted sugar syrups and sucrose. The overall acceptability showed that the sucrose solution retain the volatile component of the strawberry fruit as compared to way of preservation Khan [15]. Results investigated that treatment S_2 followed by S_4 showed better overall acceptability score as compared to treatments. Figure 2 Shows all different treatments and replications of the strawberry fruit preserve.

Conclusion

The objective of the research work was to evaluate the effect of treatment on overall quality of strawberry fruit. The resulted data showed that changes in chemical nature of the strawberry affect the organoleptic properties of the strawberry fruit. The sample showed significant response to the treatment but the temperature dependent of color changes and vitamin C losses were observed after 15 days of storage interval. The changes in color was due to the water soluble nature of anthocyanin, continuously changes the color of osmotic medium. The potash alum shows significant effect on the texture property of the strawberry fruit, as compared to the treatment without potash alum. It is concluded from the present research study that all the treatment response well to the potash alum both during physiochemical and organoleptic evaluation. The potash alum showed better results in 30° and 40° brix sucrose solution concentration. Among all other treatment S_2 (Strawberry fruit + sucrose solution (30° brix) + sodium Benzoate 0.1% + Potash alum 2%) was found highly adequate during 90 days of storage interval both physiochemically and organleptically.

Treatments	Storage Intervals (Days)							% Decrease	Means
	0	15	30	45	60	75	90		
Overall Score Rate									
S0	9	7.6	5.3	3.8	1.7	1	1	88.89	4.20c
S1	9	8.4	8.2	8	7.6	7.1	6.5	27.78	7.83a
S2	9	8.3	8	7.7	7.5	7.2	6.7	25.56	7.77a
S3	9	8.2	7.8	7.6	7.1	6.7	6.2	31.11	7.51a
S4	9	8.4	8.1	7.8	7.4	7	6.6	26.67	7.76a
S5	9	8.1	7.6	7.2	6.8	6.3	6	33.33	7.29ab
S6	9	7.7	6.5	5.9	5.3	4.9	4.8	46.67	6.30c

Values having different alphabetical letters are significantly different (P<0.05)
LSD at 5% level for treatments and storage interval=0.991

Table 11: Sensory evaluation of overall acceptability score of strawberry fruit.

Figure 2: Shows all different treatments and replications of the strawberry fruit preserve.

The treated sample could be used for syrup, squash, salads and ready to eat is also possible.

References

1. Childer NF (1983) Strawberry growing. Modern Fruit Science, Gainesvile. Hort Publ: 451-480.
2. John (1994) Fruit size and general characteristics of strawberry varieties. Infos Paris 117: 19-23.
3. Amin (1996) Progress and prospects of strawberry production in NWFP. Annual Report, Agricultural Research Station (North) Mingora, Swat 212: 4-7.
4. Aslam M, Rasool S (2012) Potential of strawberry's export from Pakistan. Published on 8th Jun.
5. Food and Agriculture Organization (FAO) (2009) Data on Potassium sorbate in food and beverages. United States Food and Drug Administration.
6. USDA (1998) Nutrient database for standard reference. U. S. Deptt. Agric.
7. Hakkinen SH, Torronen AR (2000) Content of flavonols and selected phenolic acids in strawberries and Vaccinium species, influence of cultivar, cultivation site and technique. Food Res Int 33(6): 517-524.
8. Johnson AH, Peterson MS (1974) Encyclopedia of Food Technology. The AVI. Co. Inc. Westport. Connenticut, USA.
9. Galleta, Bringhurst (1995) Small fruit culture and nutritional value. The AV publishing west report. (5th Ed) USA 357.
10. Sapata ML, Ferreira1 A, Andrada L, Leitão AE, Candeias M (2009) Osmotic dehydration of mandarins: Influence of reutilized osmotic agent on behavior and product quality. Acta Sci Pol Tech Aliment 8: 23-35.
11. Nwankwo CF, Ijioma BC, Ihediohanma NC (2007) Effect Of Alum On The Proximate Composition Of Raw African Breadfruit (Treculla africana). J. Agriculture and Social Research 7: 77-81
12. Wenhao L, Yunfei B, Qing Z, Xiaosong H, Qun S (2011) Effects of potassium alum addition on physicochemical, pasting, thermal and gel texture properties of potato starch. International Journal of Food Science and Technology 46: 1621-1627.
13. Ayub M, Zeb A, Ullah J, Khattak MMAK (2005)Effect of nonnutritive sweeteners, chemical preservatives and antioxidants on microbial and sensory characteristics of dehydrated guava. J Sc Tech Uni Peshawar 29.
14. Krebs HA, Wiggins D, Stubbs M, Sols A, Bedoya F (2006) Studies on the mechanism of the antifungal action of benzoate. J Biochem 214: 657-63.
15. Khan A, Shamrez B, Litaf U, Zeb A, Rehman Z, Naz R, Khan SH, Shah AS (2014) Effect of Sucrose Solution and Chemical Preservatives on Overall Quality of Strawberry Fruit. J Food Process Technol 6: 413.
16. AOAC (2012) Official Methods of Analysis of AOAC International (19th edition) volume II. Association of Official Analytical Chemists. Gaithersburg, Maryland 20877-2417, USA.
17. Larmond E (1977) Laboratory methods of sensory evaluation of foods. Publication 1673. Canada Dept Agri Ottawa.
18. Steel RGD, Torrie JH (1997) Principles and procedures of statistics. A Biometrical approach (3rd Ed) McGraw Hill book Co. NY. USA.
19. Fasogbon BM, Gbadamosi SO, Taiwo KA (2013) Studies on the Osmotic Dehydration and Rehydration Characteristics of Pineapple Slices. J Food Proc Tech 4: 220-228.
20. Khan MM (2010) Preservation of strawberry syrup with benzoate and sorbate. M.Sc. Theis . Dept. of Food Sci. & Tech. Agri. Uni. Peshawar.
21. Kumar SP and Devi P (2011) Optimization of some process variable in mass transfer kinetics of osmotic dehydration of pineapple slices. Int Food Res J 18: 221-238
22. Ali S, Ayub M, Zeb A, Muneer S (1999) Effect of potassium metabisulfite on Physico chemical properties of dried persimmon. Sarhad J Agric 15: 631 - 634.

23. Kumar SP and Sagarand-lata VR (2008) Quality of osmovac dehydrated ripe mango slices influenced by packaging material and storage temperature. J Sci Industrial Res 67: 1108-1114.

24. Muhammad A, Ayub M, Khaliq A, Ullah S (2008) Microstructural changes during osmotic dehydration of parenchymatic pumpkin tissue . J Food Engg 85: 326-339.

25. Heng K, Guilbert S, Cuq JL (1990) Osmotic dehydration of papaya: influence of process variables on the product quality Science des Aliments. 10: 831-848.

26. Giovanelli G, Brambilla A, Rizzolo A, Sinelli N (2012) Effects of blanching pretreatment and sugar composition of the osmotic solution on physicochemical, morphological and antioxidant characteristics of osmodehydrated blueberries (Vacciniumcorymbosum L.) Food Res Int 49: 263-271.

27. Rojas AM, Gerschenson LN (2001) Ascorbic acid destruction in aqueous model systems: an additional discussion. Journal of the Science of Food and Agriculture 81: 1433-1439.

28. Lee SK, Kader AA (2000) Preharvest and postharvest factors influencing vitamin C content of horticultural crops. Postharvest Biology and Technology 20: 207-220.

29. Wong M, Stanton DW, Burns DJW (1992) Effect of initial oxidation on ascorbic acid browning in stored kiwifruit juice and model concentrates. LWTFood Science and Tech 25: 574-578.

30. Wisal S, Ullah J, Zeb A, Khan MZ (2013) Effect of refrigeration temperature, sugar concentrations and different chemicals preservatives on the storage stability of strawberry juice. Int J Engg Tech 13: 160-168.

31. Zia A, Ayub M (2012). Quality evaluation of melon cubes preserved in sweetener solution. M.Sc. Thesis. Food Sci. Tech. Deptt. Uni. Agri. Peshawar.

32. Moreno J, Simpson R, Baeza A, Morales J, Muñoz C, Sastry S, Almonacid S (2012) Effect of ohmic heating and vacuum impregnation on the osmodehydration kinetics and microstructure of strawberries (cv. *Camarosa*). L.W.T. Food Sci Tech 45: 148-154.

33. Mancilla YN, Won MP, Uribe E, Galvez AV, Scala KD (2013) Osmotic dehydration under high hydrostatic pressure: Effects on antioxidant activity, total phenolics compounds, vitamin C and color of strawberry (*Fragariavesca*). L.W.T. Food Sci Tech 52: 151-156.

34. Perera N, Gamage TV, Wakeling L, Gamlath GGS, Versteeg C (2010) Color and texture of apple high pressure processed in pineapple juice. Innovative Food Sci Emerging Tech 11: 39-46.

35. Zou K, Teng J, Huang L, Dai X, Wei B (2013) Effect of osmotic pretreatment on quality of mango chips by explosion puffing drying. L.W.T. Food Sci Tech 51: 253-25.

36. Wrolstad RE, Skrede G, Lea P, Enersen G (1990) Influence of sugar on anthocyanin pigment stability in frozen strawberries. Journal of Food Science 1072: 1064-1065.

37. Iman S, Ayub M, Abbas M, Qazi IM (2006) Analysis of intermediate moisture apple slices during storage. Sarhad J. Agric 22: 545-549.

38. Maldonado S, Arnau E, Bertuzzi MA (2010) Effect of temperature and pretreatment on water diffusion during rehydration of dehydrated mangoes. J Food Eng 96: 333-341.

39. Aday MS, Caner C (2013) The shelf life extension of fresh strawberries using an oxygen absorber in the biobased package. L. W. T. Food Tech 52: 102-109.

40. Deng Y, Zhao Y (2008) Effects of pulsedvacuum and ultrasound on the osmodehydration kinetics and microstructure of apples (Fuji). J. Food Eng 85: 84-93.

41. Fuchigami M, Miyazaki K, Hyakumoto N (1995) Frozen carrots' texture and pectic components as affected by low temperature blanching and quick freezing. Journal of Food Science 60: 132-136.

42. Torres JD, Talens P, Carot JM, Chiralt A, Escriche I (2007) Volatile profile of mango (*Mangiferaindica* L.), as affected by osmotic dehydration. Food Chem 101: 219-228.

43. Pani P, Leva AA, Riva M, Maestrelli A, Torreggiani D (2008) Influence of an osmotic pretreatment on structure property relationships of air dehydrated tomato slices. J Food Eng 86: 105-112.

44. Habib AR, Masud T, Sammi S, Soomro AH (2007) Effect of storage on physiochemical composition and sensory properties of mango (mangiferaincdica L.) variety Dosehri. Pak J Nut 6: 43-148.

45. Escriche I, Chiralt A, Moreno J, Serra JA (2000) Influence of blanching-osmotic dehydration treatments on volatile fraction of strawberry. J Food Sci 65: 1107-1111.

46. Talens P, Escriche I, Navarrete NM, Chiralt A (2003) Influence of osmotic dehydration and freezing on the volatile profile of kiwi fruit. Food Res Int 36: 635-642.

47. Sabrina B, Renata BB, Bruna M, Petrus RR, Carmen, Trindade SF (2009) Quality and sensorial characteristics of osmotically dehydrated mango with syrups of inverted sugar and sucrose. Sci. Agric. (Piracicaba, Braz) 66: 40-43.

This article was originally published in a special issue, **Let food be thy medicine and medicine be thy food** handled by Editor(s). Dr. Meena Shah, Texas Christian University, USA