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COMPARATIVE STUDY OF SEESAW SOLAR AND CABINET DRIER TECHNIQUES ON OSMOTICALLY DRIED STRAWBERRIES

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Dehydration is a technique in which moisture is removed from the product. In the present work strawberry was chosen as a medium of study as it is very perishable and it is available for a very limited duration during the year so in order to make it available for the whole of the year, it was dehydrated and the different changes were quantified. During the study the fruit halves were first chemically treated with 2% calcium sorbate, 2% citric acid for eight minutes then the fruit was osmotically dehydrated using 20%, 40% and 60% sucrose solutions; therefore it was dehydrated again to reduce the moisture contents and water activity by electrical and solar dehydrator separately. Strawberry is a rich source of vitamin C, flavanoid, foliate and fiber. Strawberries contain an excellent antioxidant that is feistin and this is very potent against Alzheimer’s disease as well as kidney failure. This work saved a lot of commodity that was victim of spoilage by different microbial and environmental losses after dehydration we were able to save a lot of the fresh product. Ash content was increased while water activity was decreased with time. T_3 showed maximum total solids and ascorbic acid, acidity was decreased with passage of time while minimum change was observed in T_3.

Keywords: Cabinet drier, Osmotically drying, Shelf life, Strawberry

INTRODUCTION

Pakistan is producing fruits and vegetables on large scale but due to lack of many facilities i.e. cold chain and storage environment, a lot of the food commodity is spoiled. As a result of this, the average exports of fruits and vegetables are less as compared to other developing countries (Alvarez *et al*., 1995). Our country is having less than 10% exports and the wastage due to postharvest losses is 25 to 40% (GOP, 2008). The fruits and vegetables present in this country are of excellent quality but still they are not handled according to standards. Fruits and vegetables have digestible and indigestible components like carbohydrates, minerals, vitamins etc. Fruits and vegetables are living substances, number of processes are taken place in them which are affected by humidity, temperature, atmospheric composition, harvest and post-harvest handling practices (Viberg *et al*., 1998).

In addition to that mold and insects are also making problems. These changes also result in detrimental effects on nutrients value as well as composition. The factors that cut down the quality and shelf life of fruits and vegetables are enzymatic browning, texture deterioration and microbial growth. The strawberry (*Arbutus unedo* L.) is a fruit that belongs to ericaceous family and it is grown largely in Mediterranean region of turkey. It is a shrub like plant that maximally attains a height of 7-9 meter. It can bear harsh environment as well can grow in clay to dry soil. The fruit is having an orange-red globular rough surface (Fito, 2004). The fruit is yellow in the beginning and later on it turns red. The chemical composition of fruit is found to have crude oil, crude protein, crude fiber, crude energy, ash, pH, acidity, water soluble extract, ether-soluble extract, alcohol-soluble extract, Dimethyl sulfide and essential oil contents were found 2.1%, 3.36%, 6.4%, 327 kCal/100 g, 2.824%, 4.6, 0.4% (Malic acid%), 35.6%, 3.0%,19.6%, 5.3 g/kg and 0.02%, respectively.

The strawberry of Pakistan has well known value. It is nutritionally rich and delicious. Dried strawberry has good color, texture and flavor. Preserved foods demand is increasing day by day. Osmotic dehydration is a promising technique that not only gives a superior product due to use of minimal thermal treatment and as a result of this quality product is also obtained. A handsome amount of color, flavor, texture and nutrients are also saved and there is no need of high temperature due to which a lot of energy is also saved.

Osmotic dehydration produces products of enhanced shelf life, minor changes in aroma and does not cause unnecessary changes in texture quality (Fuchigami and Teramoto, 1997). It has been observed that osmotic dehydration caused 50% reduction in moisture of the commodity.

In osmotic dehydration we immerse the food to be dehydrated in the osmotic solution which may be a salt, alcohol, starch, or may be a concentrated sugar solution. Different solutes that may be used are sucrose, fructose, corn syrup, sodium chloride and glucose.

There are various types of solar driers that radar from simple to most complex that are also categorized according to passive energy and active energy utilization. Seesaw solar drying is very simple technique of passive solar driers. It has been observed that maximum water removal and sugar uptake take place during the first two hours and half hour respectively and the product produced as a result of this is further used for processing like solar dehydration and cabinet dehydration freeze drying and deep fat frying etc. and a better quality product is obtained as a result (Eshtiaghi *et al*., 2004).

Temperature and concentration of osmotic agent has a prominent effect on the water loss. Higher temperature causes a deterioration effect on the flavor, color, texture and sensory quality characteristics of the products. Along with osmotic dehydration air dehydration is another technique that further reduces the moisture contents. The air dehydration has a significant effect on the color, flavor, texture and enzymatic activity of the fruit (Rastogi *et al*., 2000). The air dehydration further decreases the weight and volume of the commodity by which it can be handled easily and is transported and managed easily. Due to decreased water contents, the microbial activity is reduced to much extent and for air dehydration, if we use solar dehydration a lot of energy is also saved (Garrote *et al.*, 1992). Osmotic dehydration along with air dehydration technique for preservation has been world widely used but this technique is not widely used in Pakistan for strawberry.

The strawberry of Pakistan has well known for dietetic value, it is nutritionally rich and delicious. Dried strawberry has good color, texture and flavor. Preserved foods demand is increasing day by day (Karathanos, 1999). Osmotic dehydration is one of the promising technique that not only give a superior product due to use of reduced temperature but also it give us a very nutritive product having a handsome amount of color, flavor and texture as well as energy loss is also saved. Osmotic dehydration produced products, of increased shelf life, minor changes in aroma with decreased load on solar dehydration and cabinet dehydration without causing unnecessary changes in texture

(LericiI *et al*., 1995). It had been observed that osmotic dehydration caused 50% reduction in moisture of commodity. In osmotic dehydration we immerse the food to be dehydrated in the osmotic solution which may be a salt, alcohols, starch or any concentrated solution to dehydrate the food.(Shi and Fito, 2004). Different solutes can be used during the process are sucrose, fructose, corn syrup, sodium chloride and glucose (Panagiotou *et al*., 1999). The sugar uptake is the best in the low molecular saccharides such as (sucrose, glucose and fructose). It has been observed that good quality products are produced that are having characteristic similarity of natural and dehydrated products. In strawberry the osmotic dehydration has much effect on the solute concentration and kinetics water movement from

inside and outside the cells but it also has a much effect in the natural substances like vitamins, minerals, colorants, acids and saccharides (Garrote and Bertone, 2002).

Osmotic dehydration is popular in food industry due to a number of effects like it improvement on the organolaptic properties as well as on the sensory characteristics this technique also being operated at room temperature (Del Valle *et al*., 1998). During osmotic dehydration different types of osmotic agents can be used solemnly or in combination. It had been observed that maximum water removal and sugar gain take place in 2 hours and 30 minutes respectively and the product generated as a result of this is perfect for further processing like solar dehydration, cabinet dehydration, freeze drying and deep fat frying for a better quality product (Tregunno and Goff, 1996). Due to decreased moisture contents the activity of the microbes is decreased. For air dehydration, if we use solar dehydration a large amount of harvest can be saved along with energy (Khurdiya and Roy, 2008). This technique is also an ancient technique. Solar dehydration is easy to carry out, economical, low cost and cause minimal damage to food as compared to other technique. Osmotic dehydration along with air dehydration is in used widely throughout the world but in this technique is not used in Pakistan for strawberry. In Pakistan, strawberry of best quality is being produced but major part of that is spoiled.

This study was designed to preserve the foods by decreasing or lowering the moisture contents of the commodity, so that, the enzymatic activity, microbial activity and other parameters that are associated with the fruit. Secondly, we were able to save large amount of harvest which is wasted due to non-standard processing facilities.

MATERIALS AND METHODS

Research was conducted in national institute of food science and Technology. University of Agriculture Faisalabad.

***Procurement of Raw Material*:** Karoz variety of strawberry was purchased from the local market of Faisalabad. Strawberry was washed with tap water, cut into halves and then it was subjected to osmotic dehydration then afterwards for air and seesaw solar dehydration technique it has a rig and rectangular frame. The material to be dried is placed on a number of trays which have a wooden frame and a bottom mesh, which can be made of a variety of materials such as wire netting or old fish nets, bamboo lattice or any other material which allow a vertical air circulation and maximum evaporation. The bottom of improved seesaw drier is made of galvanized corrugated iron sheet reinforced crosswise by wooden planks and lengthwise by two wooden planks.

***Osmotic treatments*:** All the treatments of osmotic dehydration were carried out at room temperature shown in Table 1. Osmotic solution of 20°, 40° and 60° brix were prepared with commercial sucrose. The subsequent reagents were added in osmotic solution at the rate of 0.1% potassium metabisulphite, 2% calcium sorbate and 2% citric acid was used to improve the microbial standards, improve texture and finally color and taste of the final product. The slices were worn out and rinsed with cold water after completion of osmotic treatments. the slices were drawn out and they were made ready for the further processing as in the electrical air dehydrator which is maintained at 50°C and the same treatments were placed in solar dehydrator at an uncontrolled conditions in an average temperature of 60° to 70°C and a solar radiation of 1300 W/m2 was measured using (Ably Radio meter (Model 8-8 Serial No. 14046).

Table 1. Treatment Plan

Sugar selection treatments(%age)	
T_0	0% Solar+ dehy
T_1	20% Solar+ dehy
T_2	40% Solar+ dehy
T_3	60% Solar+ dehy
T_4	0% Elect+dehy
T_5	20% Elect+dehy
T_6	40% Elect+dehy
T_7	60% Elect+dehy

Solar+dehy = Solar dehydration.

Elect+dehy = Electrical dehydration

***Proximate Analysis*:** Proximate analyses were conducted every 15 days and it was conducted for 45 days.

***Ash Contents*:** The ash contents of sample were determined by the method as described in (AOAC, 2006). The ash content was determined by using the following formula.

***Moisture Loss*:** The moisture content of the strawberry halves was determined as described in (AOAC, 2006).

Physiochemical Analysis:

***Color measurement*:** The color of the dried product was determined by hand held colorimeter (color Test-II neuhausNeotec) as described by the Piga *et al*. (2005). The instrument was calibrated using standard lightness (L). The chromaticity of the sample color was measured in terms of L^* value. Among color component L^* value represents the value (lightness) of color and it is larger for lighter color and was less for darker color.

***Texture analysis*:** The textural characteristics of strawberry halves were analyzed for every fifteen days of storage intervals by mean of texture analyzer (Mod. TA-XT2, stable Microsystems, surrey, UK) as described by Mizrach, (2008).

***Total soluble solids*:** Weigh into the tarred beaker to the nearest 0.01 g, a suitable quantity (up to 40 g) of the sample and added 100 – 150 ml of distilled water. Heated the contents of the beaker to boiling and allowed boiling gently for 2-3 minutes, stirring with a glass rod. Cooled the contents and mixed thoroughly. After 20 minutes, I weighed to the nearest 0.01g and then filtered through a fluted filter paper or a Buchner funnels into a dry vessel. Reserve the filtrate for determination a small quantity of the test solution (2-3 drops are sufficient) on the fixed prism, then I recorded the value of refractive index (Mod, RA-620/600, Kyoto electronic manufacturing company. Co., Ltd. Japan) according to Sereno *et al.* (2001).

Acidity: Acidity of the sample was determined as per the procedure described by Sereno *et al.* (2001). 2 g sample was ground with 10 ml distilled water and few drops of the diluted sample were poured on the lens of the device and I got the acidity of the sample. The instrument which was used for this purpose is digital acidity device QA supplied of USA (GMK-835 KMP digital fruit acidity meter).

***Ascorbic acid (vitamin C)*:** Ascorbic acid of the sample was determined by 2, 6-dichloroindophenols dye titration method as described by Ranganna (1977).

***Water activity*:** The water activity was determined according to AOAC (2006).

***Sensory evaluation*:** Sensory evaluation, based on color, flavor, taste, texture, firmness and overall acceptability was conducted using 9-point hedonic scale (9 = like extremely; I = dislike extremely) by taste panel according to the method described by Meilgaard *et al. (*2007). The panelists were asked to express their opinion about the product on specified interval throughout the storage.

RESULTS

Strawberries were procured from the local market and they were selected with special care on the basis of color, texture, firmness, size and shape. Osmotic solutions were prepared with the commercial sucrose of 0, 20, 40 and 60% concentrations. These strawberries were pre-treated with 2% calcium sorbate, 2% citric acid and 0.1% potassium metabisulphite. Then they were given an osmotic treatment of 0, 20, 40 and 60% for six hours. After the osmotic treatment they were solar air dehydrated and electrical air dried at 65-75°C and 45-50°C for 36 hours and 24 hours respectively. All this work was done at the National Institute of Food Science and Technology Faisalabad. We dehydrated strawberry by two methods and stored at room temperature and were analyzed at an interval of 0, 15, 30 and 45 days for comparison.

Proximate Analysis of Strawberries:

***Ash contents*:** The data presented in Fig.1 represents that the ash contents were more in T_3 (2.93g) followed by T_7 (2.84g), T_2 (2.77g) then T_6 (2.72 g), T_1 (2.63g), T_5 (2.62g) and T_4 (1.31g) and T_0 (1.23). Minimum ash contents were recorded in T_0 (0.50g), while maximum ash contents were recorded in T_3(2.93g). During 45 days of storage 2.11 to 0.60 g ash contents was recorded in T_0, while 3.15 to 2.18g, 3.21 to 2.39g, 3.31 to 2.60g, 2.09 to 0.74g, 3.16 to 2.31g, 3.20 to 2.48g ash contents were recorded in T_1, T_2, T_3,T_4,T_5,T_6,T_7 respectively. Maximum ash contents was recorded on 0 day (2.93g) of storage than on 15th (2.48g), 30th (2.18g) and (1.93g) on 45th day.

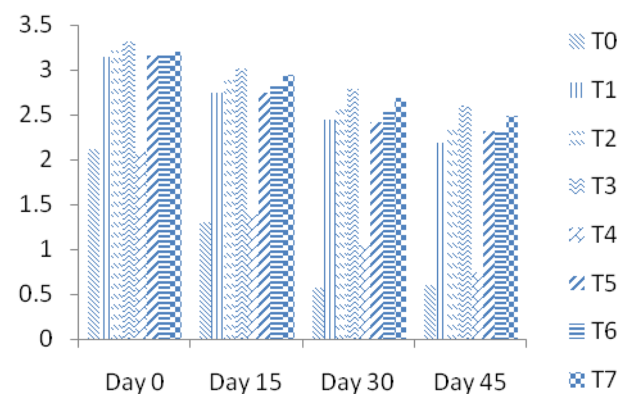

Figure 1. Ash content

***Moisture loss*:** The data presented in Fig.2 showed that the moisture loss was more in T0 and minimum moisture loss was recorded in T7, while maximum moisture loss was recorded in T0. During 45 days of storage 2.5 to 0.58 g moisture loss was recorded in T0, while 1.30 to 0.50g, 1.10 to 0.46g, 0.70 to 2.0g, 1.4 to 1.22g, 1.50 to 0.29g, 1.20 to 0.40g moisture loss was recorded in T1, T2, T3,T4,T5,T6 andT7, respectively.

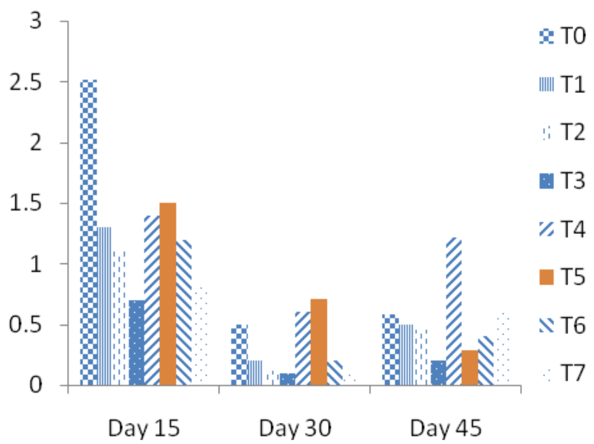

Figure 2. Moisture loss

Maximum moisture loss was recorded on 15th day of storage and minimum on 30th that was 0.31g.

Color: The statistical data in Fig.3 showed that the color had highly significantly affected by treatment days and their interaction. It is vividly represented in graph that the color L^* value was more in T_1 (17.59) followed by T_5(16.21), T_3 (14.70) then T_7 (14.51), T_6 (14.03), T_2 (13.32g), T_4 (8.89) and T_0 (8.08). Minimum color L^* value was recorded in T_0 (8.08), while maximum color L^* value was recorded in T_1 (17.59). During 45 days of storage 12.17 to 5.05 L^* value was recorded in T_0, while 21.18 to 14.85, 16.26 to 11.05, 17.06 to 12.95, 13.15 to 5.72, 20.17 to 13.25,17.26 to 11.54 and 16.94 to 13.13 L^* values were recorded in T_1, T_2, T_3,T_4,T_5,T_6 and T_7, respectively. Maximum L^* value was recorded on 0 day (16.77) of storage then on 15^{th} (13.96), 30^{th} (11.98) and (10.94) on 45^{th} day.

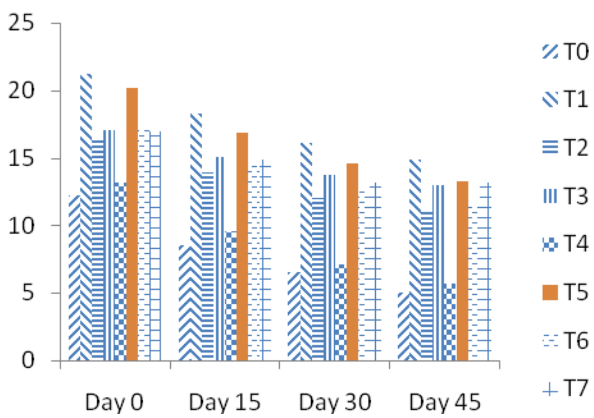

Figure 3. Color

Texture: The data presented in Fig.4 showed that the texture was more in t_3 followed by T_7, T_2 then T_6, T_1, T_7 and T_4. Minimum texture was recorded in T_4, while maximum moisture loss was recorded in T_3 .during 45 days of storage 200.7 to 154.4 texture was recorded in T_0, while 345.2 to 160.5, 451 to 166.5, 893.1 to 341.1, 210.7 to 90.3, 306.17 to 110.4, 431.4 to 157.5 and 632.1 to 210.73 texture were recorded in T_1, T_2, T_3, T_4, T_5, T_6, T_7, respectively. Maximum texture value was recorded on 0 day of storage then on 15^{th}, 30^{th} and on 45^{th} day. The texture decreased during 45 days of storage. The texture is much greater in T_3 is (624.33) which is a solar dehydrated sample while the texture is for the same treatment in electrical dehydrated sample is (456.51).

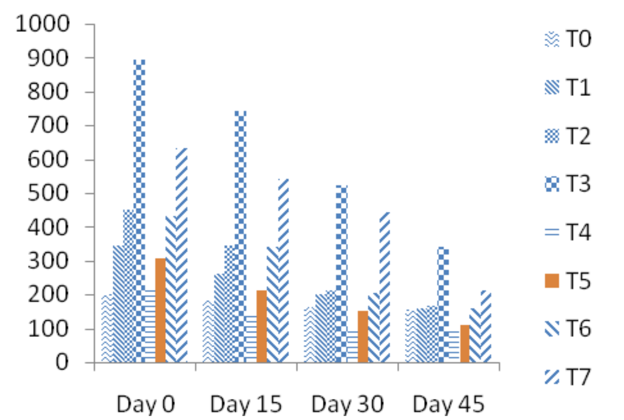

Figure 4. Texture

Total soluble solids: The data presented in Fig. 5 disclosed that the texture was more in T_3 (14.27) followed by T_4, T_6 then T_2, T_1, T_0, T_5 and T_4. Minimum total soluble solids were recorded in T_4 (7.47), while maximum total soluble solids were recorded in T_3 (14.27). During 45 days of storage 3.31 to 11.24 total soluble solids were recorded in T_0, while 5.51 to 12.14, 7.82 to 13.23, 11.03 to 16.05, 2.92 to 10.3, 3.44 to 10.46, 8.14 to 14.04 and 10.14 to 15.35 texture were recorded in T_1, T_2, T_3,T_4,T_5,T_6,T_7 respectively. Maximum total soluble solids were recorded on 45^{th} day (12.86) of storage then on 30^{th} (12.47), 15^{th} (10.12) and (6.54) on 0^{th} day. The total soluble solids increased during 45 days of storage. The total soluble solids were much greater in T_3 is (14.27) which is a solar dehydrated sample while the total soluble solids for the same treatment in electrical dehydrated sample in T_7 is (13.50). The change in

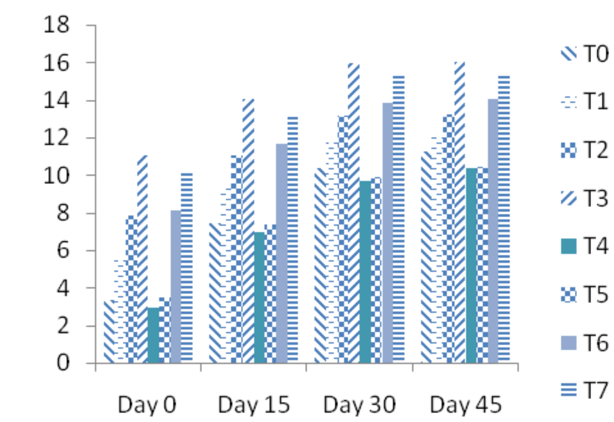

Figure 5. Total soluble solids

T_0 is quite visible as compared to T_4 which is an electrical dehydrated sample. If the sample of TSS is compared for T_3 and T_7 the change in $T_{3,}$ TSS is quite different then T_0 and T_4. It means that minimum change is being observed in case of T_3 as well as T_7.

During 45 days of storage the total soluble solid increased. During the process of ripening free sugars like fructose, sucrose and glucose increase mean while the sucrose contents in the time of storage increase three to four-folds and this leads to increase in solids.

***Acidity*:** The data depicted in Fig. 6 showed that the acidity was more in T3 (1.15), T7 (1.05) followed by T_2 (0.99), T_6 (0.82) then T_1 (0.80), T_5 (0.65), T_4 (0.49), and T_0 (0.47). Minimum acidity was recorded in T_0(0.47), while maximum acidity was recorded in T_3 (1.15). During 45 days of storage 0.66 to 0.33 acidity was recorded in T_0, while 0.94 to 0.71, 1.11 to 0.99, 1.24 to 1.15, 0.65 to 0.35, 0.87 to 0.51, 0.95 to 0.74 and 1.15 to 1.00 acidity was recorded in T_1, T_2, T_3,T_4,T_5,T_6,T_7 respectively. Maximum acidity was recorded on 0th day (0.94) of storage then on 15th (0.80), 30th (0.77) and (0.71) on 45th day. The acidity decreased during 45 days of storage. The decrease in acidity is much less in T_3 (1.12) which was a solar dehydrated sample while the acidity for the same treatment in electrical dehydrated sample in T_7 was (1.00). The change in $T_0$was quite visible as compared to T_7 which was an electrical dehydrated sample. If we see the change in sample acidity, the change is much less in T_3 which is solar dehydrated sample while the control sample acidity is decreased to much an extent. It means that the osmotic treatment prove beneficial as it reduced the decrease in acidity of the samples.

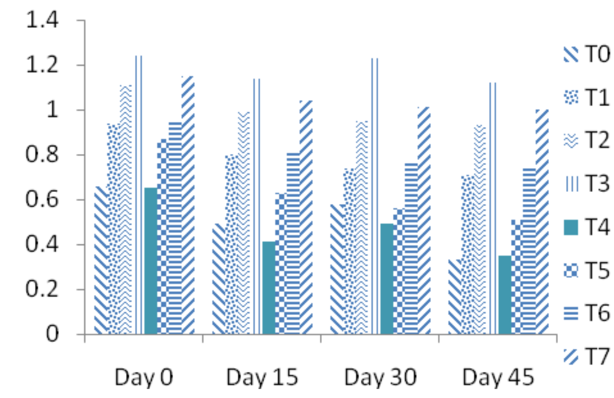

Figure 6. Acidity

Ascorbic acid: The data presented in Fig. 7 showed that the ascorbic acid was more in T_3 (31.15), T_7 (30.496), T_0 (29.951) followed by T_4 (26.649), T_1 (26.087) then T_2 (25.665), T_5 (24.296) and T_6 (23.032). Minimum ascorbic acid was recorded in T_6(23.032), while maximum acidity was recorded in T3 (31.15).

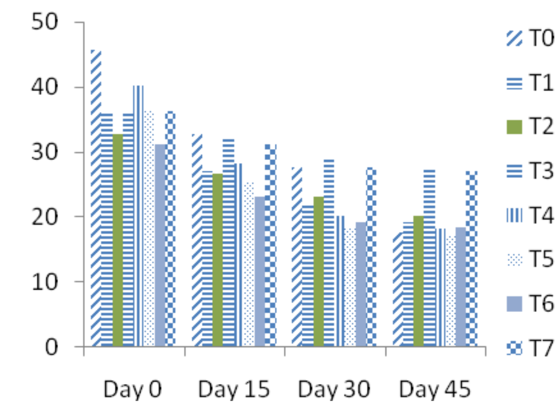

Figure 7. Ascorbic acid

During 45 days of storage 45.75 to 17.66 ascorbic acid was recorded in T_0, while 36.12 to 19.06, 32.66 to 20.27, 36.17 to 27.14, 40.19 to 18.12, 36.46 to 16.09, 31.23 to 18.49 and 36.24 to 27.00 ascorbic acid was recorded in T_1, T_2, T_3,T_4,T_5,T_6,T_7 respectively. Maximum ascorbic acid were recorded on 0th day of storage then on 15th (28.327), 30th (22.901) and (20.581) on 45th day. The ascorbic acid decreased during 45 days of storage. The decrease in ascorbic acid is much less in T_0 (17.66) which was a solar dehydrated sample while the ascorbic acid for the same treatment in electrical dehydrated sample in T_4 was (16.90). The change in T_0 was quite visible as compared to T4. Change in sample T7, the change is much less in T3 which is solar dehydrated sample while the control sample ascorbic acid is decreased to much an extent. It means that the osmotic treatment prove beneficial as it reduced the decrease in ascorbic acid of the samples.

***Water activity*:** The data presented in Fig. 8 showed that the water activity was more in T_7 (0.57), T_3 (0.55) followed by T_2 (0.53), T_1 (0.50) then T_6 (0.49), T_5 (0.49), T_0 (0.48), and T_4 (0.43). Minimum water activity was recorded in T_4(0.43), while maximum water activity was recorded in T_7 (0.57). During 45 days of storage 0.53 to 0.44 water activity was recorded in T_0, while 0.54 to 0.47, 0.55 to 0.51, 0.57 to 0.54, 0.48 to 0.40, 0.53 to 0.54, 0.52 to 0.46 and 0.59 to 0.55water activity was recorded in T_1, T_2, T_3,T_4,T_5,T_6,T_7 respectively. Maximum water activity was recorded on 0^{th} day (0.54) of storage then on 15^{th} (0.51), 30^{th} (0.49) and (0.48) on 45^{th} day. The water activity decreased during 45 days of storage. The decrease in water activity is much less in T_3 (0.54) which was a solar dehydrated sample while the water activity for the same treatment in electrical dehydrated sample in T_7 was (0.55). The change in T_0 was quite visible as compared to T_7 which was an electrical dehydrated sample. If we see the change in sample, the change was much less in T_3 which is solar dehydrated sample while in the control sample, water activity is decreased to much an extent.

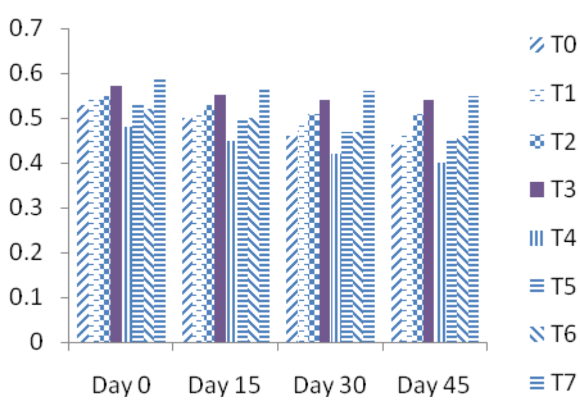

Figure. Water acidity

***Sensory evaluation*:** One of the most important and influencing factor for the product acceptability is the product acceptability. The product having good flavor, color, taste and acceptability is preferred for consumption. The strawberries are subjected to sensory evaluation and were judged on the basis of taste, color, texture, acceptability and flavor. These parameters are given points according to nine point hedonic scale by a team of experienced judges at an interval of 0, 15, 30 and 45 days storage period according to Meilgaard *et al*. (2007). The brief description of these parameters is given below.

***Overall acceptability*:** The overall acceptability of products is an important quality index. The mean values of overall acceptability varied from 7.95 to 5.97 in all the treatments. It had been observed that the overall acceptability values for all the treatments decreased during the forty days of storage from 7.78 to 5.02. Highest value for the dried fruit was recorded in T_3 while T_0 getting the lowest grade in this respect. It had been observed that the values of overall acceptability had decreased in all the treatments while the maximum scoring was observed in T_3 and T_7. Whereas the minimum scores were recorded in T_0 and T_4.

DISCUSSION

Results for ash content were similar to Alam *et al*. (2010) who studied that the decrease in present ash contents may be due to translocation of mineral salts along with transpiration and osmotic with drawl of water from the fruit.

Akesowan (2010) observed the increase in the total soluble solid in preserved mango. Sabrina bernardi *et al.* (2009) observed the increase of total soluble solids during mango osmotic dehydration. It had been observed that acidity decreased during storage of the dehydrated product reported Alzamora *et al.* (2005).

These results for ascorbic acid were in accordance of the previous investigations that prove that the decrease in ascorbic acid take place during storage and this was reported by Azeredo *et al.* (2006). Ascorbic decrease during the process of ripening it had been observed by Calligaris *et al*. (2002).

The decrease in the lightness of the fruit is quite evident in case of the control treatments both in case of electrical and in solar dehydrated samples. It means that the sugar treatment as well as the citric acid 2% treatment is both helpful in reducing the decrease in the lightness L^* values of the dehydrated fruit. The decrease in the lightness L^* values of the fruit is due to enzymatic activity and cellular degradation. Anino *et al*. (2006) observed that the water activity increase during the storage of the fruit due to absorption of moisture from the environment.

***Conclusion*:** So it was concluded that strawberry slices treated with higher concentration of sucrose solutions and solar dehydration showed better storage life and other characteristics such as sensory evaluation by adopting this method strawberry storage can be increased without much effecting the other desired characteristics and marketability as well as postharvest losses of strawberry can be decreased by this method compared to electrically dehydrated and without concentrated sucrose solutions used dehydrated samples.

REFERENCES

Akesowan, A. 2010. Storage Stability of Reduced-Sugar Preserved Mangoes Prepared with Acesulfame-K and Aspartame. Res. J. Agri. Biol. Sci. 6: 150-156.

Alam, M.S., M.M. Hossain, M.I. Ara, A.S.M. Amanullah and M.F. Mondal. 2010. Effect of packaging material and growth regulators on quality and shelf life of papaya. Bangladesh Res. Pub. J. 3: 1052-1061.

Alzamora, S.M., J. Chirife and P.E. Viollaz. 2005. A simplified model for predicting the temperatures of foods during air dehydration. J. Food Technol. 14: 369-80.

Anino, S.V., D.M. Salvatori and S. Alzamora. 2006. Changes in calcium level and mechanical properties of apple tissue due to impregnation with calcium salts. Food Res. Int. 39: 157–164.

AOAC. 2006. Official Method of Analysis. The association of Official Analytical Chemists. Arlington, Virgina, USA.

Azeredo, M.C., S. Brito, E.G. Moreira, L. Farias and M. Bruno. 2006. Effect of drying and storage time on the physico-chemical properties of mango leathers. Int. J. Food Sci. Tech. 4: 635-638.

Calligaris, S., P. Falcone and M. Anese. 2002. Colour changes of tomato purees during storage at freezing temperatures. J. Food Sci. 67: 2432-2435.

Del Valle, J.M, V. Aranguiz and H. Leon. 1998. Effects of blanching and calcium infiltration on PPO activity, texture, microstructure and kinetics of osmotic dehydration of apple tissue. J. Food Res. Int. 31: 557–569.

Eshtiaghi, M.N., R. Stute and D. Knorr. 2004. High pressure and freezing pre-treatment effects on drying, rehydration, texture and colour of green beans, carrots and potatoes. J. Food Sci. 59: 1168-1170.

Fito, P. 2004. Modelling of vacuum osmotic dehydration of food. J. Food Eng. 22: 313-328.

Fuchigami, M. and A. Teramoto. 1995. Structural and textural changes in Kinu-Tofu due to high pressure freezing. J. Food Sci. 62: 828-830.

Garrote, R.L. and R.A. Bertone. 2002. Osmotic concentration at low temperature of frozen strawberry halves: Effect of glycerol, glucose and sucrose solutions on exudate loss during thawing. Leben. Wiss. Technol. 22: 264-267.

Garrote, R.L., S.R. Silva and R.A. Bertone. 1992. Osmotic concentration at 5°C and 25°C of pear and apple cubes and strawberry halves. Leben. Wiss. Technol. 25: 133–138.

GOP. 2008. Economic Survey 2007-2008. Government of Pakistan, Economic Advisor Wing, Finance division, Islamabad-Pakistan.

Karathanos, V.T. 1999. Determination of water content of dried fruits by drying kinetics. J. Food Eng. 39: 337-344.

Khurdiya, D.S. and S.K. Roy. 2008. Solar drying of fruits and vegetables. Indian Food Packer 4: 28-39.

Lericil, C.R., G. Pinnavaia, M. DallaRosa and L. Bartolucci. 1995. Osmotic dehydration of fruit: Influence of osmotic agents on drying behaviour and product quality. J. Food Sci. 50: 1217-1219.

Meilgaard, M.C., G.V. Civille and B.T. Car. 2007. Sensory evaluation techniques, 4th Ed. C.R.C. press L.L.C., New York, USA.

Mizrach, A. 2008. Ultrasonic technology for quality evaluation of fresh fruits and vegetables in pre and post harvest processes. Postharvest Biol. Technol. 48: 315-330.

Panagiotou, N.M., V.T. Karathanos and Z.B. Maroulis. 1999. Effect of osmotic agent on osmotic dehydration of fruits. Drying Technol. 17: 175-189.

Piga, A., P. Catzeddu, S. Farris, T. Roggio and E. Scano. 2005. Textural evaluation of amaretti cookies during storage. J. Food Res. Tech. 221: 387-439.

Ranganna, S. 1977. Manual of analysis of fruit and vegetable products. Central Food Technological Research Institute, Mysore. New Delhi:McGraw-Hill Publishing Company Limited.

Ranganna, S. 1999. Handbook of analysis and quality control for fruit and vegetable products. Tata McGraw Hill Pub. Co. Ltd., New Delhi.

Rastogi, N.K., A. Angersbach and D. Knorr. 2000. Synergistic effect of high hydrostatic pre-treatment and osmotic stress on mass transfer during osmotic dehydration. J. Food Eng. 45: 25-31.

Sereno, A.M., D. Moreira and E. Martinez. 2001. Mass transfer coefficients during osmotic dehydration of apple single and combined aqueous solution of sugar and salts. J. Food Eng. 47: 43–49

Shi, X.Q. and P.M. Fito. 2004. Mass transfer in vacuum osmotic dehydration of fruits: a mathematical model approach. Leben. Wiss. Technol. 27: 67-72.

Tregunno, N.B. and H.D. Goff. 1996. Osmodehydrofreezing of apples: structural and textural effects. J. Food Res. Int. 29: 471-479.

Viberg, U., S. Freuler, V. Gekas and I. Sjoholm. 1998. Osmotic pre-treatment of strawberries and shrinkage effects. J. Food Eng. 35: 135-145.