



Research Paper

The physicochemical and sensory evaluation of osmo-dehydrated intermediate moisture lychee slices

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ABSTRACT

Syed Masood Shah¹, Abdul Jalal^{2,3}, Rabia shabir¹,
Sumayya Rani^{1,4}, Syed Asim Shah Bacha^{2,5} and
Mohammad Ayub^{1*}

¹Department of Food Science and Technology,
Faculty of Nutrition Sciences, University of
Agriculture Peshawar, KP 25000, Pakistan.

²Department of Horticulture, Faculty of Crop
Production Sciences, University of Agriculture
Peshawar, KP 25000, Pakistan.

³College of Horticulture, Nanjing Agricultural
University, Nanjing, Jiangsu 210095, China.

⁴Department of Agriculture, University of Swabi,
Swabi, KP 23430, Pakistan.

⁵Institute of Pomology, Chinese Academy of
Agricultural Sciences, China.

*Corresponding author. E-mail:
ayub@aup.edu.pk

In the light of benefits of osmotic dehydration process in food industry, this study was designed to test the effect of osmodehydration on physicochemical and overall quality of lychee slices. The lychee slices were dipped in different concentrations of sucrose and glucose for 24 h and studied for the physicochemical and sensory attributes from the initial day in fifteen days of intervals stored for 90 days at room temperature (25±2°C). During storage durations, decrease in mean values of pH, ascorbic acid and non-reducing sugar was recorded. On other hand, increase in mean values of TSS, acidity and reducing sugar was observed. In organoleptic evaluation, the mean score of judges for color, flavor, texture and overall acceptability decreased during storage intervals. The minimum increase in TSS and acidity was observed in L2, maximum decrease in reducing sugar was observed in L4 and the maximum decrease in ascorbic acid was recorded for L0. Similarly, the minimum decrease in pH, ascorbic acid, non-reducing sugar, flavor, texture and overall acceptability was observed in L2. From these results, it can be concluded that the treatments L2 (sucrose 50%) and L4 (glucose 50%) gave the best results on the basis of physicochemical analysis sensory evaluation.

Key words: Osmodehydration, lychee slices, concentrated solutions, physicochemical analysis, storage.

INTRODUCTION

Osmotic process of fruits has great advantages in terms fruit quality, flavour, color and damaged by heat. It reduces distribution and packaging cost and gives stability to the product during storage period (Tortoe, 2010). Despite these known benefits, its industrial use is still limited because of the absorption of unwanted solids into the product. It should be noted that the application of osmotic drying is limited due to the high absorption of dissolved substances that reduces the drying rate and changes of the organoleptic and nutritional properties of the food. Different ways have been studied to control solid uptake during osmotic drying (Langari and Movagharnejad, 2015).

The method of partial dehydration of food with high amount of water content, by dipping them in a concentrate sugar and/or salt solution is generally termed as osmotic dehydration. This result in the removal of water from food to solution as well as the flow of solute from solution to food. Vitamins, minerals and sugar may also be removed by water flow from food. It is a preservation method which removes water from food and give high quality product for long-term use with a low effect on vitamin loss and mineral contents, retaining high nutritional content, aroma and flavor and it also give better result on sensory attribute of food (Gabriela et al., 2004).

Lychee (*Litchi chinensis* Sonn.) is recognized for its nice looking colour, tasty and juicy fruits with high food and nutritional importance. The lychee fruit is also rich source of vitamins C (Wall, 2006) and phenolic compounds that have antioxidant activities (Hu et al., 2010) but it may decrease after harvest (Taylor, 1993). Due to the relatively low total production of lychee in Pakistan, in domestic market there is about 90% lychee fruit used as fresh consumption. Only a small percentage is processed as juice and drinks as well as small amount is exported (Rajwana et al., 2010). In the past decades, there is an increasing trend of lychee production due to more demand of exotic fruit. Lychee has a short postharvest life due to pericarp desiccation and browning (Kaiser, 1994) and fruit cracking (Singh and Singh, 1995). The skin cracking of lychee fruits exposes the aril to external environments and provides entry to fungal pathogens resulting in rapid decay, thus, lychee has relatively short postharvest or storage life.

Keeping in view the importance of osmotic dehydration and the perishable nature of Lychee, the present study was conducted to evaluate the physicochemical properties and overall quality of osmotic dehydrated intermediate moisture lychee slices.

METHODOLOGY

Preparation of lychee slices

Lychees fruits having same size were collected from the local orchard in Mardan, KP-Pakistan at optimum maturity and taken to the Food Technology Lab., University of Agriculture Peshawar, Pakistan for experiment. The Lychees were sorted carefully and all the damaged and low quality fruits were removed. All the fruits were washed with tap water for removing the dust, residues and other particles to control the microbial activities. The fruits were peeled using stainless steel knife. All fruits were cut into desired (conical slices) shape with stainless steel knife and seeds were removed. The slices were dipped in 0.1% citric acid + potassium metabisulphite 0.1% for 30 min prior to osmotic dehydration to prevent browning during handling and obtained high acceptable product.

Preparation of syrup solution and treatment of lychee slices

Different concentrations of sucrose and glucose solutions separately and also combined were prepared and were labelled as L0 (Control), L1 (sucrose 40% + Citric acid 0.1% + KMS 0.05%), L2 (sucrose 50% + Citric acid 0.1% + KMS 0.05%), L3 (glucose 40% + Citric acid 0.1% + KMS 0.05%),

L4 (glucose 50% + Citric acid 0.1% + KMS 0.05%), L5 (sucrose 20% + glucose 20% + Citric acid 0.1% + KMS 0.05%), and L6 (sucrose 25% + glucose 25% + Citric acid 0.1% + KMS 0.05%). The fruit slices were dipped in different concentrated solutions of sucrose and glucose following the dip technique as described by Hussain et al. (2012) for 24 h in the syrup solution. The prepared osmotically dehydrated lychee slices were packed in transparent glass jars for further study.

Analysis for physico-chemical properties

Data were collected at first day and then after 15 days intervals (Fresh, 15 and up to 90 days). Lychee treated slices were analyzed for physicochemical properties of percent Acidity (%), pH, TSS ($^{\circ}$ Brix), Non-reducing sugars (%), Reducing sugar (%), and Ascorbic Acid/ Vitamin C (mg/100g) using the standard procedures described by AOAC (2012).

Sensory evaluation

The osmotic dehydrated Lychee was sensory judged for flavor, color, overall acceptability and texture by the panels of 15 trained judges from the Department of Food Science and Technology, University of Agriculture Peshawar, Pakistan. The evaluation was carried out by using 9 points hedonic scale given earlier by Larmond (1977) and the judges score was received for color, flavor, texture and overall acceptability of treated lychee slices.

Statistical analysis of results

All the data were analyzed statistically by using Complete Randomized Design (CRD) having two factors (that is, Treatments of various concentrations of glucose and sucrose alone or in combined form and different intervals of storage period) and the means were compared by LSD test with 5% probability. The statistical analysis was done using MS-Excel 2013, Statistix 8.1, and OriginPro 8.5 softwares.

RESULTS

Physicochemical Analysis of treated lychee slices

Lychee slices treated with various solutions of sucrose and glucose and stored for 90 days were analyzed for physicochemical properties (pH, TSS, Percent acidity, Ascorbic acids, Non-reducing sugars and Reducing sugars).

Table 1: Mean results of different levels of treatments and storage intervals on Physico-chemical properties of intermediate moisture lychee slices.

Treatment	pH	TSS	Acidity	Ascorbic Acid	Non reducing sugar	Reducing Sugar
L ₀	3.87f	18.65f	0.63f	8.59e	7.53g	10.71d
L ₁	3.94c	19.54e	0.64e	11.03d	23.82f	14.04b
L ₂	4.08a	20.56b	0.68b	12.07a	24.92a	14.12a
L ₃	3.98d	19.89d	0.65d	11.32c	24.09e	14.09ab
L ₄	4.05b	20.60a	0.68a	11.84b	24.90b	14.11ab
L ₅	3.95e	20.42c	0.66cd	11.27c	24.29d	14.10ab
L ₆	3.95e	20.45c	0.66c	11.26d	24.39c	13.85c
Sig.	*	*	*	*	*	*

Storage duration	pH	TSS	Acidity	Ascorbic Acid	Non reducing sugar	Reducing Sugar
0 Day	4.11a	16.34a	0.53g	16.66a	23.74a	12.17g
15 Day	4.07b	17.37b	0.57f	14.58b	23.27b	12.67f
30 Day	4.01c	18.72c	0.6e	12.84c	22.77c	13.20e
45 Day	3.98d	19.89d	0.65d	10.45d	22.07d	13.50d
60 Day	3.93e	21.19e	0.71c	9.03e	21.36e	13.98c
75 Day	3.89f	22.55f	0.74b	7.44f	20.65f	14.38b
90 Day	3.84g	24.07g	0.78a	6.38g	20.06g	15.13a
Sig.	*	*	*	*	*	*

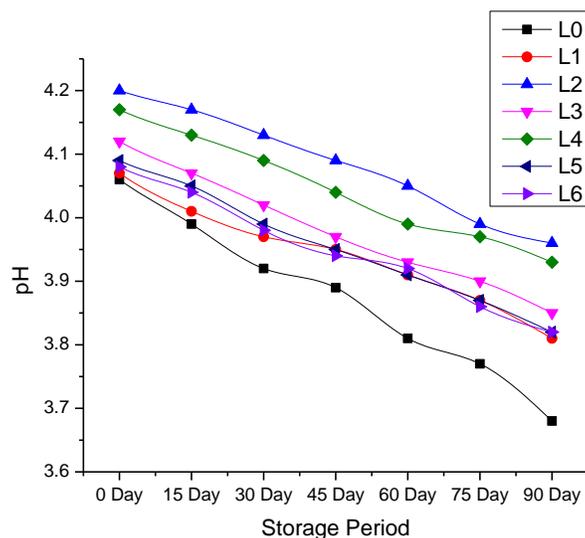


Figure 1: Effect of different levels of treatments and storage intervals on the pH of intermediate moisture lychee slices.

The mean data of all the physicochemical properties taken at different storage intervals from treated lychee slices as compared with the control is shown in Table 1.

pH

The lychee slices which were applied with different

treatments of sucrose and glucose were stored analyzed for pH after every 15 days up to 90 days of storage, as shown in Figure 1. The stored slices of lychee were analyzed for pH. Initially, the recorded values were 4.06, 4.07, 4.20, 4.12, 4.17, 4.09 and 4.08 for the samples of L₀ to L₆. These were decreased to 3.68, 3.81, 3.96, 3.85, 3.93, 3.82 and 3.82. As related with the means, the figures reduced significantly

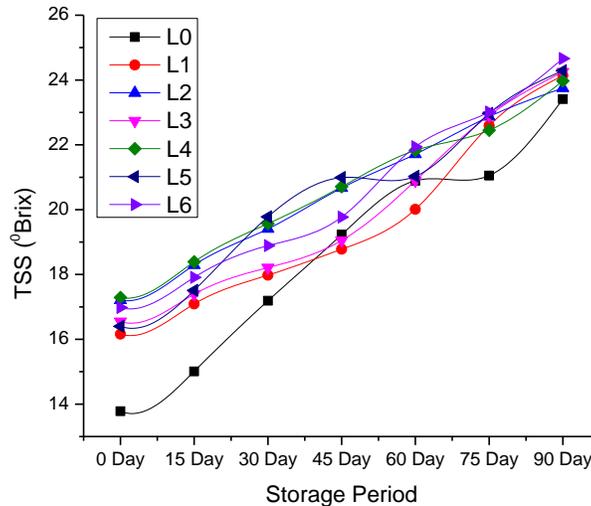


Figure 2: Effect of different levels of treatments and storage intervals on the TSS of intermediate moisture lychee slices.

($P < 0.05$) from 4.11, 4.07, 4.01, 3.98, 3.93, 3.89 and 3.84. Maximum recorded mean was 4.08, followed by 4.05 and the minimum was 3.87 followed by 3.95 for L2, L4, L0 and L1 respectively. The maximum reduction of 9.36% was found in L0, whereas, the minimum reduction of 5.71% was observed in treatment L2.

TSS (°Brix)

The lychee slices which were applied with different treatments of sucrose and glucose were stored analyzed for TSS after every 15 days up to 90 days of storage, as shown in Figure 2. The stored slices of Lychee were analyzed for TSS. Initially the recorded values were 13.78, 16.16, 17.21, 16.55, 17.29, 16.4 and 16.98 for the samples of L0 to L6. These were increased to 23.41, 24.14, 23.75, 24.25, 23.97, 24.29 and 24.66. As related with the means, the figures induced significantly from 16.34, 17.37, 18.72, 19.89, 21.19, 22.55 and 24.07. Maximum recorded mean was 20.60, followed by 20.56 and the minimum was 18.65 followed by 19.54 for L4, L2, L0 and L1 respectively. The maximum increase of 41.14 was found in L0, whereas the minimum increase of 27.54 was observed in treatment L2.

Percent acidity (%)

The lychee slices which were applied with different treatments of sucrose and glucose were stored analyzed for percent acidity after every 15 days up to 90 days of storage, as shown in Figure 3. The stored slices of Lychee were analyzed for acidity. Initially, the recorded values were 0.49, 0.52, 0.55, 0.53, 0.57, 0.51 and 0.53 for the samples of

L0 to L6. These were increased to 0.78, 0.77, 0.78, 0.76, 0.81, 0.77 and 0.81. As related with the means, the figures induced significantly from 0.53 to 0.78. Maximum recorded mean was 0.68 in L2 which was same in L4 followed by 0.66 found in L5 equaling to L6. The minimum observed mean was 0.63 followed by 0.64 in L0 and L1, respectively. The maximum increase of 37.18% was found in L0, whereas the minimum increase of 29.49% was observed in treatment L2.

Ascorbic acid (mg/100 g)

The lychee slices which were applied with different treatments of sucrose and glucose were stored analyzed for ascorbic acid after every 15 days up to 90 days of storage, as shown in Figure 4. The stored slices of Lychee were analyzed for ascorbic acid. Initially, the recorded values were (15.97, 16.28, 17.11, 16.51, 17.05, 16.81 and 16.88) for the samples of L0 to L6. These were decreased to 3.78, 6.59, 7.81, 6.39, 7.52, 6.06 and 6.53. As related with the means, the figures reduced /induced significantly ($P < 0.05$) from 16.66 to 6.38. Maximum recorded mean was 12.07 followed by 11.84 and the minimum was 8.59 followed by 11.03 for L2, L4, L0 and L1, respectively. The maximum reduction of 76.33% was found in L0, whereas, the minimum reduction of 54.35 was observed in treatment L2.

Non-reducing sugar (%)

The lychee slices which were applied with different treatments of sucrose and glucose were stored analyzed for

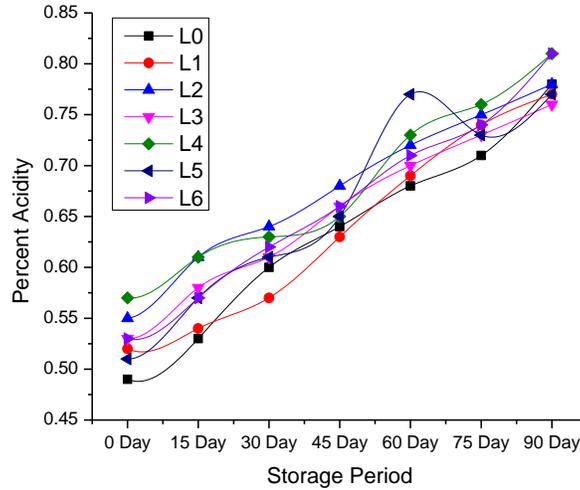


Figure 3: Effect of different levels of treatments and storage intervals on the percent acidity of intermediate moisture lychee slices.

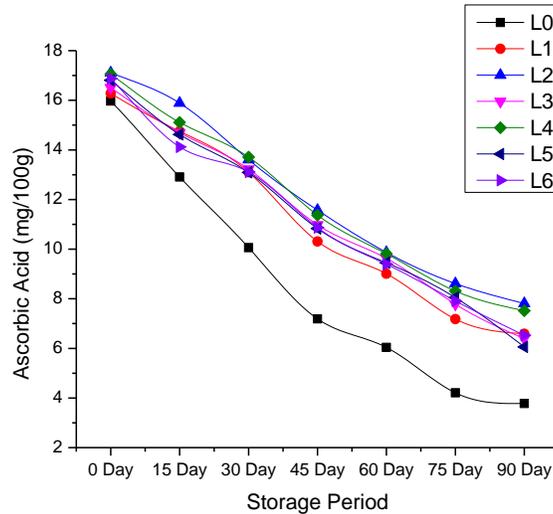


Figure 4: Effect of different levels of treatments and storage intervals on the ascorbic acid of intermediate moisture lychee slices.

non-reducing sugar after every 15 days up to 90 days of storage, as shown in Figure 5. The stored slices of lychee were analyzed for non-reducing sugar. Initially, the recorded values were 9.3, 25.69, 26.19, 25.95, 26.32, 26.25 and 26.49 for the samples of L0 to L6. These were decreased to 2.28, 21.95, 23.81, 21.80, 23.47, 22.11 and 22.03. As related with the means, the figures reduced significantly from 23.74 to 20.06. Maximum recorded mean was 24.92 followed by 24.90 and the minimum was 7.53 followed by 23.82 for L2, L4, L0 and L1, respectively. The

maximum reduction of 43.23 was found in L0, whereas, the minimum reduction of 9.09 was observed in treatment L2.

Reducing sugar (%)

The lychee slices which were applied with different treatments of sucrose and glucose were stored analyzed for reducing sugar after every 15 days up to 90 days of storage, as shown in Figure 6. The stored slices of lychee were

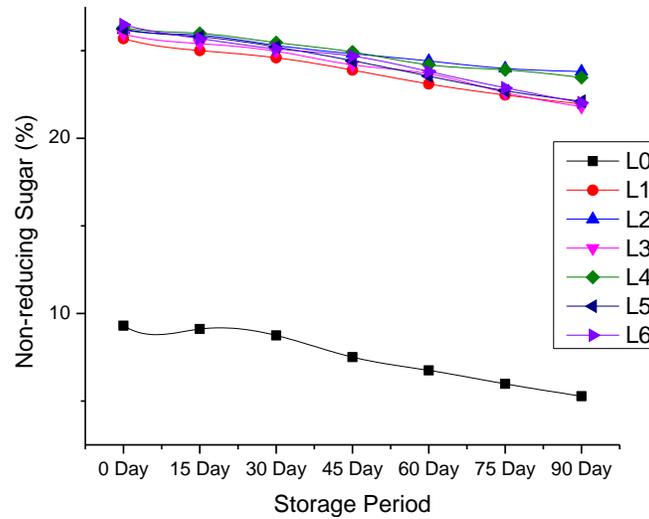


Figure 5: Effect of different levels of treatments and storage intervals on the non-reducing sugar of intermediate moisture lychee slices.

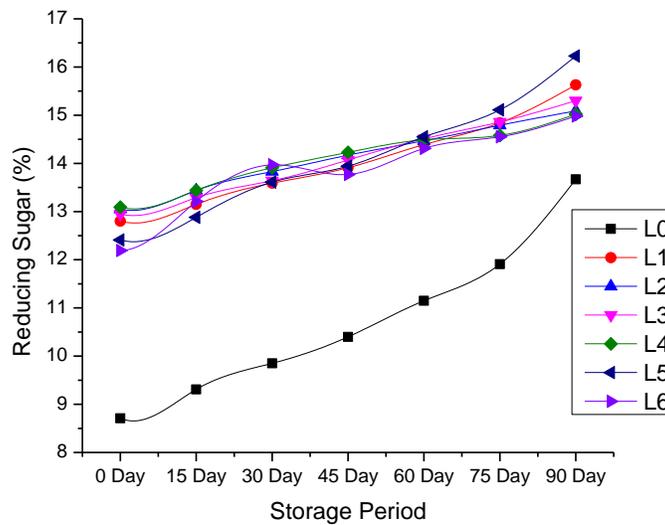


Figure 6: Effect of different levels of treatments and storage intervals on the reducing sugar of intermediate moisture lychee slices.

analyzed for reducing sugar. Initially, the recorded values were 8.71, 12.80, 13.05, 12.95, 13.09, 12.41 and 12.19 for the samples of L0 to L6. These were increased to 13.67, 15.63, 15.09, 15.30, 15.02, 16.23 and 14.98. As related with the means, the figures induced significantly from 12.17 to 15.13. Maximum recorded mean was 14.12 followed by 14.11 and the minimum was 10.71 followed by 13.85 for L2, L4, L0 and L6, respectively. The maximum increase of 36.28% was found in L0, whereas, the minimum increase of

12.85 was observed in treatment L2.

Sensory evaluation

The lychee slices treated with sucrose and glucose solution with different concentrations and stored for 90 days were studied for sensory evaluation (Color, flavor, texture and overall acceptability). The mean data taken at different

Table 2: Mean results of different levels of treatments and storage intervals on sensory evaluation of intermediate moisture lychee slices.

Treatment	Color	Flavor	Texture	Overall Acceptability
L ₀	4.33g	4.84g	4.00g	4.39g
L ₁	6.57d	6.30f	7.39c	6.75e
L ₂	7.61a	7.43a	7.57a	7.54a
L ₃	7.06b	7.29c	7.34d	7.23c
L ₄	7.47c	7.39b	7.53b	7.46b
L ₅	7.04e	7.04d	7.19e	7.09d
L ₆	6.37f	6.41e	6.36f	6.38f
Sig.	*	*	*	*

Storage duration	Color	Flavor	Texture	Overall Acceptability
0 Day	9.00a	9.00a	9.00a	9.00a
15 Day	7.89b	8.04b	7.73b	7.89b
30 Day	7.09c	7.14c	7.17c	7.13c
45 Day	6.47d	6.61d	6.77d	6.62d
60 Day	5.86e	5.84e	6.26e	5.99e
75 Day	5.31f	5.23f	5.60f	5.38f
90 Day	4.84g	4.83g	4.84g	4.84g
Sig.	*	*	*	*

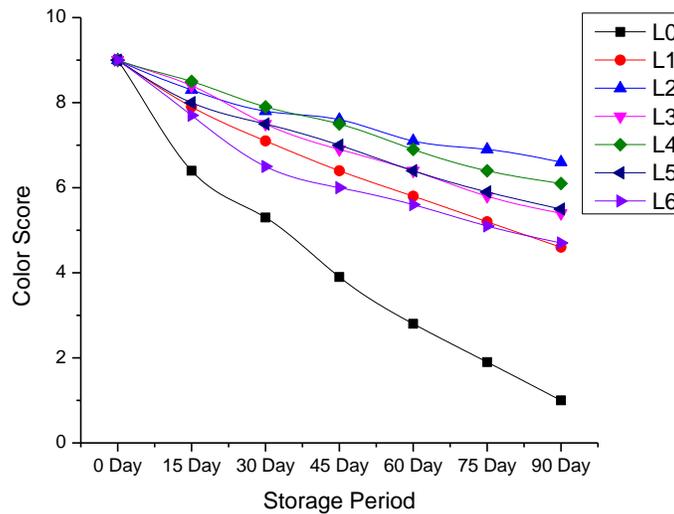


Figure 7: Effect of different levels of treatments and storage intervals on the colour score of intermediate moisture lychee slices.

storage intervals from treated lychee slices as compared with the control for sensory evaluation are shown in Table 2.

Color score

The lychee slices which were applied with different

treatments of sucrose and glucose were stored analyzed for color after every 15 days up to 90 days of storage, as shown in Figure 7. The stored slices of Lychee were analyzed for color. Initially, the recorded values were 0 in L0 and 9 in L1, L2, L3, L4, L5 and L6. These were decreased to 1, 4.6, 6.6, 5.4, 6.1, 5.5 and 4.7. As related with the means, the figures reduced significantly from 9 to 4.84. Maximum recorded

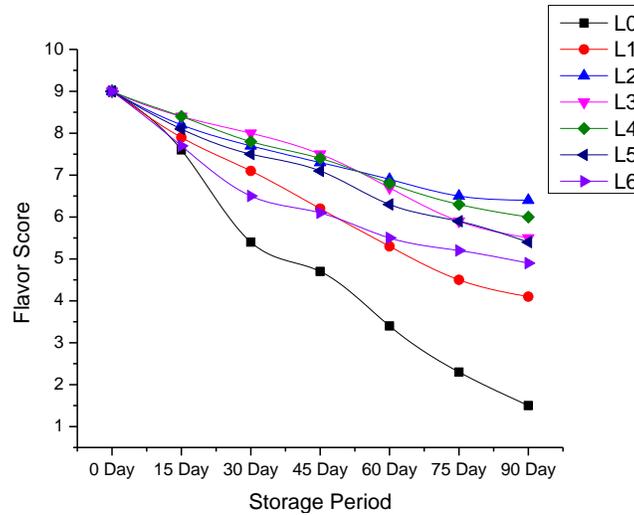


Figure 8: Effect of different levels of treatments and storage intervals on the flavour score of intermediate moisture lychee slices.

mean was 7.61 followed by 7.47 and the minimum was 4.33 followed by 6.37 for L2, L4, L0 and L6, respectively. The maximum reduction of 88.89% was found in L0, whereas, the minimum reduction of 26.67% was observed in treatment L2.

Flavor score

The lychee slices which were applied with different treatments of sucrose and glucose were stored analyzed for flavor after every 15 days up to 90 days of storage, as shown in Figure 8. The stored slices of lychee were analyzed for flavor. Initially, the recorded values were 0 in L0 and 9 in L1, L2, L3, L4, L5 and L6. These were decreased to 1.5, 4.1, 6.4, 5.5, 6, 5.4 and 4.9. As related with the means, the figures reduced significantly from 9.00 to 4.83. Maximum recorded mean was 7.43 followed by 7.39 and the minimum was 4.84 followed by 6.30 for L2, L4, L0 and L1, respectively. The maximum reduction of 83.33% was found in L0, whereas, the minimum reduction of 28.89% was observed in treatment L2.

Texture score

The lychee slices which were applied with different treatments of sucrose and glucose were stored analyzed for texture after every 15 days up to 90 days of storage, as shown in Figure 9. The stored slices of lychee were analyzed for texture. Initially, the recorded values were 0 in L0 and 9 in L1, L2, L3, L4, L5 and L6. These were decreased

to 1, 4.6, 6.6, 5.4, 6.1, 5.5 and 4.7. As related with the means, the figures reduced significantly from 9.00 to 4.84. Maximum recorded mean was 7.57 followed by 7.53 and the minimum was 4.00 followed by 6.36 for L2, L4, L0 and L6, respectively. The maximum reduction of 26.67% was found in L2, whereas, the minimum reduction of 88.89% was observed in treatment L0.

Overall acceptability score

The lychee slices which were applied with different treatments of sucrose and glucose were stored analyzed for pH after every 15 days up to 90 days of storage, as shown in Figure 10. The stored slices of lychee were analyzed for pH. Initially, the recorded values were 0 in L0 and 9 in L1, L2, L3, L4, L5 and L6. These were decreased to 1.17, 4.43, 6.53, 5.43, 6.07, 5.47 and 4.77. As related with the means, the figures reduced significantly from 9.00 to 4.84. Maximum recorded mean was 7.54 followed by 7.46 and the minimum was 4.39 followed by 6.38 for L2, L4, L0 and L6, respectively. The maximum reduction of 87.04% was found in L0, whereas, the minimum reduction of 27.41% was observed in treatment L2.

DISCUSSION

The treatments along with the storage interval significantly affected all the physicochemical properties. Same results for the pH were reported prior by Riaz et al. (1989) working on Kinnow fruit, and also by Imtiaz et al., (2004)

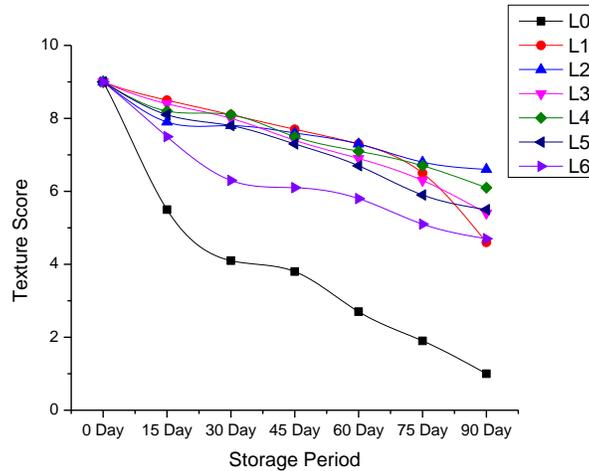


Figure 9: Effect of different levels of treatments and storage intervals on the texture score of intermediate moisture lychee slices.

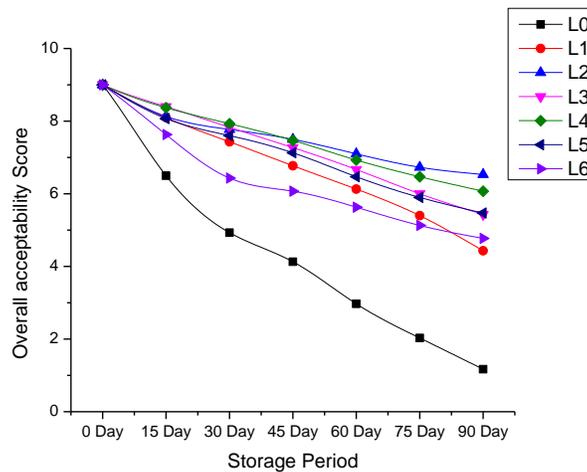


Figure 10: Effect of different levels of treatments and storage intervals on the overall acceptability score of intermediate moisture lychee slices.

working on Banana slices, demonstrating that the changes appeared in the pH during storage and proposed that there comes a gradual decline in the pH during storage. Regarding TSS of lychee slices, the same results were reported by Chyau et al. (1992) prior. They also studied the sugar acid ratio along with the total soluble solids (TSS). Moreover, some other literature also proposed the same results such as Durrani et al. (2010) who worked on Apple pulp. The results of the percent Acidity of lychee slices are highly in accordance with those of Muhammad et al., (2006). They reported that this gradual change in the acidity during storage is highly affected by sucrose and

glucose treatments. Similarly, the results obtained on the parameter of Ascorbic acid contents or Vitamin-C are much similar to that of Kumar et al. (2012) and is also in accordance with Warczok et al. (2007) who published the same changes in ascorbic acid in cantaloupe as well as Apple slices. They have given an increase pattern of ascorbic acid as stated in the present research study. For the Non-Reducing and Reducing Sugar of lychee slices, the non-reducing sugar contents in Lychee in storage intervals reduced. This could be due to the increase in that of acidity of Lychee dehydrated osmotically. This is in line with the report of Ayub et al. (2005). They submitted the same

research work in guava slices and highly are in line with the present study. The manner of increase observed in reducing sugar of lychee in the present study is in line with that of Ayub et al. (2005) and Kumar et al. (2012). In all the parameters shown in the separate graphs, the Physicochemical properties were maintained by the treatments L2 (sucrose 50%) and L4 (glucose 50%) as compared with all other treatments and control.

The results of sensory evaluation were obtained based on scoring by the judges for color, flavor, texture and over all acceptability. The data are greatly in lined with those of Iman et al. (2006) and Ayub et al. (2005). The mean score for all the sensory parameters showed a decreasing trend in separate graphs, leading to loss of organoleptic properties; however, the treatments L2 (sucrose 50%) and L4 (glucose 50%) as compared with all other treatments and control enhanced the scores of sensory evaluation keeping quality of the lychee slices.

Conclusions

The results obtained in the present study showed that the treatments L2 (sucrose 50% Citric acid 0.1% & KMS 0.05%) and L4 (glucose 50% Citric acid 0.1% & KMS 0.05%) were found to be the best during the physicochemical analysis as well as in organoleptic evaluation.

Significance Statement

At present, there is an increase in demand for exotic fruits. Lychee is one of exotic fruit gaining popularity in Pakistan. Lychee is highly perishable fruit and cannot be stored for too long in fresh form. Due to its high perishability, almost 90% of the produce is consumed as fresh and only small quantity is used for processing. It is the need of the hour to preserve lychee using suitable method to ensure its availability throughout the year and also ensure that it is juicy and its original flavor is maintained. Osmo dehydration is a technique that extends shelf life of food along with preserving its original flavor and texture. In this research, we found a suitable concentration of sucrose and glucose solution for preservation of lychee. This will help the producers to preserve lychee for availability in all season in Pakistan.

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