Journal of Applied Horticulture, 24(1): 47-52, 2022

DOI: https://doi.org/10.37855/jah.2022.v24i01.09

Journal of Applied Horticulture

ISSN: 0972-1045

Effect of pre-treatments on qualitative characteristics of osmotically dehydrated apple

Muskaan Gupta[1], Swati Kapoor[2]*, Amanpreet Kaur[1], Manpreet Kaur[1], Poonam Aggarwal[1] and Rajesh V Wagh[3]

*[1]Department of Food Science and Technology, Punjab Agricultural University, Ludhiana, [2]Punjab Horticultural Postharvest Technology Centre, Punjab Agricultural University, Ludhiana, [3]Department of Livestock Products Technology, GADVASU, Ludhiana. *E-mail*: *swatikapoor@pau.edu*

Abstract

The present study aimed to evaluate the effect of various pre-treatments *viz.*, potassium sorbate (T2), steam process (T3) and rose-flavored syrup (T4) compared to control (T1) on the final quality of osmo-dried apple cubes. Osmo-dried apple cubes developed from each treatment had moisture content in the range of 7.3-8.6% with 0.55-0.66 water activity. Pre-treatments proved to be effective on the product as bioactive components and antioxidant activity (%) were maximally retained in rose flavored apple cubes except ascorbic acid. Higher reducing sugars were observed in steam-treated apple cubes and lowest in rose-flavored apple cubes. In terms of colour attributes, potassium sorbate-treated apple cubes retained the most brightness, but texturally, these samples had the most hardness and the least cohesiveness. In contrast, steam-treated apple cubes had the lowest hardness and highest cohesiveness. The highest overall acceptability was noted for rose-flavored apple cubes in sensory properties. Red coloration of these apple cubes resulted in reduced L* and highest a* values with optimum textural properties. Overall, rose-flavored syrup as an osmotic agent produced flavoured dried apple cubes of improved quality.

Key words: Osmo-drying, apple cubes, *Malus domestica,* Golden Delicious, color, texture, pre-treatments

Introduction

Horticultural produce has significant share in the India's total agriculture production. According to FAO, upto 60% of the horticulture produce is wasted or lost during post-harvest handling, transportation, storage, sorting and processing operations (Sagar *et al.,* 2018). Apple (*Malus domestica* var. Golden Delicious) is a seasonal fruit with notable production in India. A sizeable loss has been reported in apples due to punctures, bruises and fungal disease during transportation. Efforts have been made to make it available throughout the year under cold storage conditions (1-4^{0}C and high humidity 85-90%) (Sumedrea *et al.*, 2018). However, cold store facilities are costly and not much available to small and marginal farmers, traders or processors. Most of the losses occur due to the presence of high moisture content and high water activity. Therefore, any approach that reduces the moisture content of produce will eventually lead to shelf life extension and reduction in postharvest losses. Drying is one such preservation technique used for producing high value and shelf stable fruits such as raisins and dried figs.

Apple possesses a unique flavor and is considered a rich source of vitamin A, C, minerals (Mg and K) and dietary fibre (Marwa *et al.*, 2015; Kowalska *et al.,* 2018). It contains appreciable amount of organic acids, lutein, folic acid and polyphenols including catechin, epicatechin, chlorogenic acids, quercetin glycosides, phloridzin and procyandins (Kowalska *et al.*, 2018). These phytochemicals present are known to have anti-hypercholestrolemic and antioxidative properties which in turn may reduce the risk of diabetes, coronary heart disease and asthma. Apple is largely consumed in form of processed fruit juice, concentrates and fresh cut cubes. Some other processed products like jam, jellies and candies are also produced. Apart from this, nowadays, dried apples are becoming quite popular as a healthy snack food owing to its inherent nutritional profile, longer shelf life and off-season availability.

Drying is widely used method to reduce the moisture content and slow down the chemical and microbial spoilage in apples. The major obstacle in the process of drying lies in preserving the original quality characteristics of produce *vis-à-vis* color, texture, nutrient value and organoleptic characters. Some of these quality parameters are immensely affected during artificial drying of apples, specifically enzymatic browning discoloration. Therefore, osmotic dehydration technique has emerged as the useful drying technique to inhibit browning reactions, improve flavor and retain color. The term osmotic dehydration is defined as dewatering and impregnation soaking process (Sonia *et al.*, 2015; Yadav and Singh, 2014).

Osmotic dehydration in combination with pre-treatments could be used to enhance the final quality of the produce. Appropriate use of 0.15% potassium sorbate, 0.5% citric acid and 1% ascorbic acid as a pre-treatment during osmotic dehydration has also been reported by Nieto *et al.* (2013) to reduce enzymatic browning and minimize the microbial spoilage. Heat application also shows promising results as heat inactivates polyphenoloxidase that is responsible for color and flavor degradation (Silva and

Sulaiman, 2019). The application of heat also modifies the textural characteristics of apple. Heat softens and mellows the fruit tissues which otherwise possess firm and crisp texture (Kumar *et al.*, 2016). Therefore, the present investigation has been undertaken to study the effect of various pre-treatments on sensory, textural and nutritive quality of osmotically dried apple.

Material and methods

Raw material: Good quality apples (*Malus domestica var.* Golden Delicious) and sugar were bought from local market. Apples were sorted, washed and graded to attain uniform size sample.

Sample preparation and pre-treatments: Apples were peeled and cut into cubes (1.3 x 1.3 x 2.1 cm^3) while dipped in 0.1% KMS (potassium metabisulphite) solution. Concentration of sugar and citric acid was kept constant in osmotic solution used for osmo-drying @ 50% sucrose and 0.5% citric acid for all the treatments. Control (T1): Osmotic solution of 50% sucrose and 0.5% citric acid.Chemical treatment (T2): Osmotic solution containing 0.15% of potassium sorbate. Physical treatment (T3): The apple cubes were steamed for about 3 minutes prior to dipping in osmotic solution. Flavored (T4): The osmotic solution was prepared using the rose concentrate by Malas food products™ and TSS was maintained at 50 ^{o}B.

Osmotic dehydration: The TSS of the osmotic solutions was maintained at 50^{0}B and the fruit to solution ratio was maintained as 1:2 (w/w). Following osmotic treatment, apple cubes were rinsed with water for few seconds to reduce stickiness.

Hot air cabinet drying: Osmotic treated apple cubes from each treatment (T1-T4) were spread on trays in a single layer. The drying was carried out at 60 ^{o}C in a convective hot air cabinet drier for 12-14 h. After drying, the osmo-dried apples were packed in food grade zip-locks pouches and stored at room temperature for further analysis.

Physico-chemical analysis: The total soluble solids of osmo-dried apples were measured using a hand-held refractometer (Erma, Japan) and expressed as ^{0}B. Measured amount of ground sample was blended with about 10 mL of distilled water and ^{0}Brix was calculated using dilution factor. Water activity was determined with water activity meter (Aqualab, USA) at 24 to 26 ^{o}C and expressed as a_w. Moisture content was estimated using oven drying method as per AOAC (2005). The dry matter content was calculated using the difference of total content and moisture content. The titratable acidity was measured by titrating the sample against 0.1 N NaOH solution using phenolphthalein indicators to light pink color as end point. The titratable acidity was expressed as % malic acid (Ranganna, 1997). The reducing sugars were determined via Lane and Eyon method (Ranganna, 1997). A weighed amount of ground sample was diluted and neutralized using 1N NaOH solution. The neutralized solution was precipitated using 4% lead acetate and 22% potassium oxalate solution. The filtrate obtained was used to titrate Fehling solution A and B using methylene blue as an indicator under constant boiling condition. The brick red precipitates were observed as end point. The result was expressed as % reducing sugars.

Bioactive components: Ascorbic acid content was determined via titrimetric method where the sample is titrated against 2,6- dichloroindophenol dye to pink color as end point and is expressed as mg of ascorbic acid/100g (Ranganna, 1997). Total phenolic content of methanolic extract of samples was determined according to Folin-Ciocalteu spectrophotometric method. Methanolic extract was prepared by refluxing weighed quantity of ground sample with 80% methanol for one hour in a round bottom flask followed by filtration of the extract and volume make up to 100 mL with 80% methanol. The results were expressed as g Gallic acid Equivalent (GAE)/100g by taking gallic acid (100μg/mL) as reference material to construct standard curve (Swain and Hillis, 1969). Antioxidant activity was determined by di phenyl picryl hydrazyl (DPPH) method according to Brand-Williams *et al.* (1995) with some modifications. Methanolic extract of samples was taken for antioxidant activity analysis and calculated according to the following formula. The assay contained 2 mL of sample aliquot, 2 mL of tris HCl buffer (pH 7.4) and 4 mL of 0.1mM DPPH. The contents were mixed immediately and the degree of reduction of absorbance was recorded continuously for 30 min at 517 nm (Spectronic 20, Bausch & Lomb, USA).

$$\text{Radical scavenging activity (\%)} = \frac{\text{COD-SOD}}{\text{COD}} \times 100$$

COD=Control OD (0 min), SOD= Sample OD (30 min)

Color Analysis: Color analysis of all the samples was observed with the help of CR-400 Konica chroma meter (Konica Minolita, Japan). CIE tristimulus values measured were L*, a* and b* where a* value ranged from −100 (greenness) to +100 (redness), the *b** value from −100 (blueness) to +100 (yellowness), whereas the *L** value, indicating the measure of lightness, ranged from 0 (black) to 100 (white). Hue angle was calculated using the formula $\tan^{-1}b^*/a^*$.

Texture analysis: Overall instrumental texture profile analysis was carried out using a TMS-pro texture analyzer (Food technology corporation, USA). Compression test was performed on the apple cubes using a cylindrical plate under 100N force. The apple cubes of height nearly 11mm were taken and compressed to 50% of their original height. The data from the TPA curve was characterized in terms of hardness, chewiness, springiness, adhesiveness and cohesiveness.

Sensory evaluation: Sensory evaluation was carried out using 9-point hedonic scale rating done by 15-20 semi-trained personnel with no reported medical disorders in the age group of 22-55 years for the parameters like appearance, texture, odor, flavor and overall acceptability (Marwa *et al.*, 2015).

Statistical analysis: For each parameter, three independent determinations were taken and expressed as mean ± standard deviation. The sensory evaluation results were calculated as mean of sixteen independent values. Post-hoc tukey's test was performed to calculate mean and standard deviation values at 95% confidence interval. The statistical analysis is performed using SPSS software (IBM version 26.0).

Results and discussions

Proximate composition of fresh apple: Data pertaining to proximate composition of fresh apples has been shown in Table 1. Moisture content in fresh apples was observed as 85.21% and the corresponding water activity was recorded as 0.94. Moisture content as reported by Marwa *et al.* (2015) in apples was also around 85.48%. The TSS of apples was around 13.86 °B, total solids amounted to 14.78% and reducing sugars was observed as 10.69%. Bioactive components such as ascorbic acid and total phenols contributed 6.80 mg/100g and 73.54 mg GAE/100g, respectively in fresh apples. Ascorbic acid content was found quite close to those reported by Sharma *et al.* (2018) who observed 8.90mg/100g in Golden Delicious apples. Antioxidant activity known to be contributed by bioactive components in terms of radical scavenging activity was found to be 72.46%.

Table 1. Proximate composition of Fresh Apple

Parameters	Fresh apple
TSS (^{0}Brix)	13.86 ± 0.14
Water activity (a_w)	0.94 ± 0.01
Moisture content (%)	85.21 ± 0.33
Total Solids (%)	14.78 ± 0.33
Titratable acidity (% malic acid)	0.38 ± 0.02
Ascorbic acid (mg/100g)	6.80 ± 0.13
Reducing sugars (%)	10.69 ± 0.45
Total Phenolic content (mg GAE/ 100g)	73.54 ± 0.48
Antioxidant activity (% Radical scavenging Activity)	72.46 ± 0.68

Mean ± SD

Physico-chemical properties: The effects of various pre-treatments on the physico-chemical properties of osmo-dried apples were studied and described in Table 2. Total soluble solids (TSS) of osmotically dried apple ranged from 79.20 to 81.70 °B for various treatments. Highest and significant TSS was recorded in flavored apple cubes (81.70 °B) whereas non-significant differences were observed in TSS for rest of the treatments (79.2-79.7 °B). Rongtong *et al.* (2018) used near infrared spectroscopy to determine the total soluble solids in osmotically dehydrated papaya wherein the authors reported that the total soluble solids content varied significantly from 58.00-73.6 °B.

The moisture content of dried apple cubes was recorded well below 10%. The moisture content of osmotically dehydrated samples varied between 7.36-8.66%. The water loss and solid gain in apple cubes owes to the osmotic process of sugar intake and corresponding moisture loss. The least moisture content was found in physically treated apple cubes (T3) suggesting that steaming process facilitated higher moisture loss in apple cubes as fruit tissue softens on application of heat due to membrane degradation, turgor loss and cell wall separation (Kumar *et al.*, 2016). The disruption of the cell wall and membrane helps in the migration of water from the inner tissues to the surface and hastens the process of drying (Lewicki, 1998).

Water activity is an important measure to study storage susceptibility, texture, and spoilage. Water activity of osmotically dried samples is expressed in Table 2. Physically treated sample showed lowest water activity values (0.55) whereas highest water activity was noted in T1 samples followed by T4 and T2. As per the data, a direct relationship could be established between the moisture content and water activity values of osmotically dehydrated apples as sample with higher values of moisture content exhibiting higher values of water activity and vice-versa. Aktas *et al.* (2013) suggested 0.62 as the critical value for water activity during storage with respect to osmophillc yeasts growth as value of water activity below 0.6 shows effective protection against microbial growth (Kowalska *et al.*, 2018). Water activity of dehydrated apple cubes in present study was slightly high in control apple (T1) as compared to treated apple cubes (T2-T4).

The titratable acidity for osmotically dehydrated samples is expressed in Table 2. Among the treated apple cubes, higher acidity was observed in chemically treated sample and lowest in flavored apple cubes. The higher titratable acidity could be associated to higher acidity of the osmotic solutions due to presence of potassium sorbate known as an acidic preservative, as penetration of these high acidic compounds from the solutions into the apple cubes during osmosis might be responsible for the increased acidity. In a similar study, Kowalska *et al.* (2018) observed that apple chips immersed in high acidity cherry juice was found to increase total acidity of apple chips.

The data on reducing sugar content of osmotically dehydrated apple cubes using different pre-treatments reveals that physically treated sample was found to contain higher reducing sugars followed by control, chemically treated and least in flavored apple cubes (Table 2). The reducing sugar range varied from 21.29% in T4 apple cubes to 26.49% in T3 apple slices. Cichowska-Bogusz *et al.* (2020) elucidated that reducing sugars comprising of glucose and fructose content was recorded as 6.20% and 20.38%, respectively in osmotically dehydrated apples slices in 50% sucrose solution. The higher reducing sugars indicate the hydrolysis of sugars during the drying process.

Table 2. Effect of pre-treatment on physio-chemical properties of osmo-dried apples

Treatments	TSS (^{0}B)	Moisture content (%)	Water activity (a_w)	Titratable acidity (% malic acid)	Reducing sugars (%)
T1	79.70 ± 1.41^b	8.42 ± 0.03^a	0.66 ± 0.01^a	0.51 ± 0.03^b	24.27 ± 1.51^a
T2	79.20 ± 0.80^b	8.16 ± 0.48^a	0.62 ± 0.02^b	0.67 ± 0.06^a	22.52 ± 0.44^b
T3	79.47 ± 1.8^b	7.36 ± 0.10^b	0.55 ± 0.01^c	0.55 ± 0.03^b	26.49 ± 0.13^a
T4	81.70 ± 0.49^a	8.66 ± 0.24^a	0.64 ± 0.01^a	0.41 ± 0.03^c	21.29 ± 1.08^b

Mean ± SD0. Values with different superscripts in a column vary significantly ($p<0.05$)

Bioactive compounds: The pre-treatments applied on the apple cubes have shown prominent effect on the bioactive compounds of osmotically dried apple cubes as shown in Table 3. Ascorbic acid content reduced after osmotic dehydration in all the treated apple cubes with lowest value being recorded in physically treated apple cubes (2.77 mg/100g) which could be due to heat degradation of tissues causing excessive leaching of water-soluble vitamins. For other treatments, the ascorbic acid value ranged from 2.92 mg/100g to 3.01 mg/100g. Sharma *et al.* (2018) also reported ascorbic acid values as 8.90mg/100g in raw apples which reduced upto 5.60-5.62 mg/100g, post osmo-drying. Ascorbic acid being water soluble in nature tends to leach out in the osmotic solution during process of immersion in solution.

Fresh fruits have high antioxidant activity which is majorly credited to the presence of phenolic components. However, during the process of drying, polyphenols oxidizes and losses the antioxidant activity (Al-juhaimi *et al.*, 2018). The total phenolic content in osmotically dehydrated samples is expressed in Table 3. The phenolic contents varied with respect to different pre-treatments. Maximum phenolic compound was found in flavored apple cubes and minimum in control apple cubes while phenolic content varied non-significantly between sorbate treated sample and steam treated sample. Cichwoska *et al.* (2018) suggests that degradation of polyphenol compounds during convective drying owes to combination of high drying temperature used up for extended period of time and structural and cellular damage of tissues. These results obtained are also in a good agreement with those of Stojanovic and Silva (2007) and Mancilla *et al.* (2013), who reported that osmotic concentration caused a loss in total phenolic compounds. Higher retention of phenolic contents in flavored apple cubes could be explained as inclusion of phenols from rose extract in sugar syrup. The antioxidant activity in terms of radical scavenging properties for osmotically dried apple cubes is elucidated in Table 3. Maximum antioxidant activity was retained in T4 osmo-dried apple cubes and lowest in control apple cubes. The antioxidant capacity of a particular food majorly depends upon a type of individual antioxidants present, their concentration or combined effect of antioxidants (Rai *et al.*, 2011). With respect to bioactive components and antioxidant activity, it could be established from Table 3 that apple cubes with higher phenolic content also resulted in corresponding higher radical scavenging activity. Many authors have reported that antioxidant effect is mainly due to radical scavenging activity of phenolic compounds (Rahman and Moon, 2007) which is also evident in the current study.

Table 3. Effect of pre-treatment on ascorbic acid, total phenols and antioxidant activity (%) of osmo-dried apples

Treatments	Ascorbic acid (mg AA/ 100g)	Total phenols (mg GAE/100 g)	Radical scavenging Activity (%)
T1	2.92 ± 0.50^a	40.15 ± 0.84^c	21.28 ± 0.34^d
T2	3.01 ± 0.25^a	45.78 ± 0.38^b	24.97 ± 1.38^b
T3	2.77 ± 0.43^b	44.43 ± 0.46^b	22.86 ± 0.39^c
T4	2.95 ± 0.02^a	48.02 ± 0.14^a	27.50 ± 0.38^a

Mean ± SD. Values with different superscripts in a column vary significantly ($p<0.05$)

Color properties: Color is an important stimulus to the consumer towards the acceptability of the product. Color attributes of osmo-dried apple cubes has been elucidated in Table 4 in terms of L*, a*, b*values. With respect to lightness, highest L* value was observed for sorbate treated apple cubes. Flavored apple cubes (T4) resulted in darker color due to red pigment coloration of the cubes whereas some loss of lightness value was observed in physically treated samples (77.06). The a* value indicating greenness/redness depicted that all the pre-treatments applied has worked in order to keep apple cubes in the green zone except the flavored sample which falls into the red zone. This could be ascribed to the red coloration of the apple cubes during osmosis in the rose flavored syrup. The b* values indicating blueness/ yellowness depicted that all the osmotic dried apple cubes showed positive zone elucidating yellowness in the apple cubes and was found to be highest in physically treated samples. The hue angle was in the range of 81.3- 87.9 for control sample, chemically treated and physically treated sample. The hue angle varied significantly in flavored sample due to the absorption of evidently dark colored osmotic solution. The steam treated apple cubes turned translucent as compared to the product obtained succeeding other pre-treatments. This is caused due to action of steam on the tissues. Steaming expels air out of intercellular spaces in tissues (deaeration). Thus, reducing the opacity and increasing transparency. Expulsion of gases from tissues also softens the fruit tissue (Wei-Xiao *et al.*, 2017).

The L* and a* values correspond well to the extent of browning reactions occurred during the process resulting in darkening of the final product (Chauhan *et al.*, 2011). Higher L* values and lower a* values suggest the preserved creamish color comparable to fresh apple. The sugar impregnation is responsible for maintenance of lightness in the apple cubes (Marwa *et al.*, 2015; Chauhan *et al.*, 2011). The sugar uptake and its coating on the surface of the fruit tissues lower the exchange of oxygen and prevent enzymatic browning due to the action of polyphenoloxidase. The action of heat also aids in inactivation of enzymes like polyphenoloxidase in physically treated sample. Aktas *et al.* (2013) reported the L*, a*, b* values for fresh apples as 86.73, -6.88 and 27.84, respectively.

Table 4. Effect of pre-treatment color parameters of osmo-dried apples

Treatments	L* value	a* value	b* Value	Hue angle(^{0})
T1	80.32 ± 0.35^b	-3.41 ± 0.16^d	26.66 ± 0.29^b	82.70 ± 0.25^b
T2	86.24 ± 0.70^a	-2.66 ± 0.25^c	17.45 ± 0.20^c	81.33 ± 0.69^c
T3	77.06 ± 0.54^c	-1.31 ± 0.32^b	35.90 ± 0.42^a	87.91 ± 0.47^a
T4	51.36 ± 0.56^d	55.49 ± 0.27^a	17.54 ± 0.32^c	17.54 ± 0.26^d

Mean ± SD. Values with different superscripts in a column vary significantly ($p<0.05$)

Textural properties: Different pre-treatments have shown variable effects on the textural parameters of apple cubes as described in Table 5. The hardness values were found minimum in physically treated samples (T3). Hardness values for control and flavored samples were found to be similar and maximum in potassium sorbate treated samples. Increase in hardness of apple cubes after osmotic dehydration process might be accorded to the formation of sugar coating on the surface of apple cubes and high solid uptake (Chauhan *et al.*, 2011). However, the lower hardness value in physically treated sample might be due to the steaming of apple cubes before immersion in osmotic solutions. Internal structure of fruit tissues damages due to tension established as an effect of heat and mass transfer in the process (Kowalska *et al.*, 2018).

Table 5. Effect of pre-treatment on textural parameters of osmo-dried apples

Treatments	Hardness	Adhesiveness	Chewiness	Springiness	Cohesiveness
T1	4.33 ± 0.40^b	-0.14±0.63a	41.08 ± 0.21^c	12.60 ± 0.55^b	0.74 ± 0.01^d
T2	9.27 ± 2.06^a	-0.15 ± 0.33^b	75.11 ± 2.34^a	9.25 ± 0.24^c	0.70 ± 0.85^c
T3	2.18 ± 0.04^c	-0.16 ± 0.03^b	46.19 ± 0.59^b	17.23 ± 0.28^a	1.23 ± 0.03^a
T4	3.74 ± 1.83^b	-0.18 ± 0.92^c	31.73 ± 2.66^d	6.49 ± 2.17^d	0.93 ± 0.08^b

Mean ± SD. Values with different superscripts in a column vary significantly ($p<0.05$)

The adhesive force was found maximum in physically treated sample (-0.16 N) followed by flavored, chemically treated sample and control sample whereas chewiness and springiness, both the properties were found minimum in physically treated and maximum in potassium sorbate treated samples. Adhesiveness is regarded as the work required to overcome attractive force between food surfaces that corresponds to degree of stickiness to teeth during mastication as per sensory terms (Gwartney *et al.,* 2004). However, cohesiveness values were found similar in control and chemically treated samples and slightly higher in flavored and physically treated samples. Thus, it could be inferred that the physically treated sample had a soft and sticky texture with a dense body owing to the lower values of hardness, springiness and higher values of adhesiveness, chewiness and cohesiveness. This alteration in the textural properties in comparison to other treatments could be due to change in texture of apple cubes by steaming before immersion in osmotic solutions. Also, it could be presumed that hardness and chewiness showed direct relationship. This can also be established as following-

Chewiness = Hardness*Cohesiveness*Springiness (Chandra and Shamasundar, 2015)

Similarly, adhesiveness and cohesiveness manifest direct relationship as higher values of adhesiveness in physically treated sample also indicated higher values of cohesiveness. The lower values of springiness and corresponding higher values for adhesiveness shows inability of the product to spring back during second compression force due to the dominating adhesive force between the apple tissues (Chandra and Shamasundar, 2015).

Sensory evaluation: Sensory attributes of variedly treated osmo-dried apple cubes has been depicted in Fig. 1. Amongst control, sorbate treated and physically treated samples, physically treated sample exhibited maximum acceptability in terms of appearance, odor and flavor. The only fallback was observed in the scoring for texture. This could be explained due to alterations in cell wall tissues of apple cubes upon steaming, resulting in loss in chewiness and high adhesiveness. The influence of addition of rose syrup in the flavored sample affected the overall acceptability considerably. The overall acceptability with respect to sensory attributes was found maximum in flavored sample except the flavor which is due to the personal preference of the panelists towards rose flavor. The rose flavored gained the highest overall

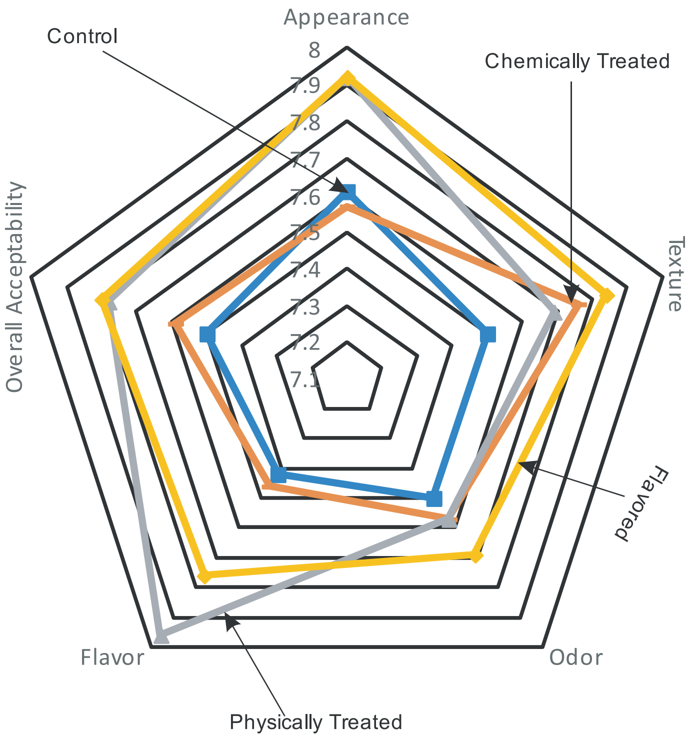

Fig. 1. Sensory score of pre-treated osmotically dried apple cubes

acceptability amongst all the treatments followed by physically treated apple cubes.

Pre-treatments prior to dehydration process considerably affected the final quality of produce. Highest lightness was observed in potassium sorbate treated apple cubes while yellowness was higher in steam treated apple cubes as observed from L* and b* values depicting that color comparable to fresh apple was maintained in the final product. It could be inferred from the present study that steaming process facilitated higher sugar intake with reduced dehydration time. With respect to textural characteristics, potassium sorbate treated apple cubes were quite hard as compared to control and other treatments. Minimum hardness and maximum cohesiveness were observed in steam treated apple cubes typically showing gel like structure. Based on the sensory properties, maximum overall acceptability was recorded for apple cubes treated with rose flavored syrup as osmotic solution alongwith optimum texture properties. Thus, flavored syrups could provide an edge over simple sucrose solution in creating variety of flavorful osmo-dried fruits. Future prospects could be to develop different flavored osmo-dried fruits with optimized texture and color properties from a single produce for wider acceptance among masses.

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Received: August, 2021; Revised: October, 2021; Accepted: October, 2021