

Effect Of Osmode hydration On the Quality Attributes of Plum (*Prunus Domestica*) Emphasizing: Vitamin C, Total Anthocyanin and Total Phenolic Content

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Abstract

Plum (*Prunus domestica*) is seasonal nutraceutical fruit rich in many functional food nutrients such as vitamin C, antioxidants, total phenolic content and minerals. Now-a- days researchers are focusing on newer technologies for the retention of bioactive compounds during the processing of perishable fruits; plum is one of these fruits. This research work was carried out to investigate the effect of conventional drying and osmotic dehydration on moisture content (%), and acidity (%). Vitamin C (mg/100gm), total anthocyanin content (mg/100gm) and total phenolic content (mg Ga/100gm) of plum. For this work, conventional drying of fruit was carried out at (800C and 5-6 hr.) and whole fruit osmotic dehydration was carried out at different temperatures and (450C, 500C and 550C) and hypertonic solution concentrations (650B, 700B and 750B). It was observed that the osmotically treated fruit gives more nutrient retention than conventionally dried fruit. The TPC content of fruit significantly increased with the increase ($p < 0.05$ and CL 95%) in process temperature. However, vitamin C and total anthocyanin content of the fruit decreased significantly with process temperature and hypertonic solution concentration was observed.

Keywords: Antioxidants, Preservation, Anthocyanin, Osmotic dehydration, hypertonic solution.

1. INTRODUCTION

In India, there is a huge production of fruits. But the real challenges are starts after its harvesting because fruits are a highly perishable commodity. Preservation and processing are one of the arts to process fruits and increase their shelf life. There are lots of techniques available to preserve the fruits; dehydration is one of the best ways of all. Dehydration involves the simultaneous application of heat and removal of moisture from foods, resulting in the loss of heat-sensitive volatile components, like flavour, ascorbic acid and oxidation of pigments. Simultaneously changes to the texture of food are an

important undesirable cause of quality deterioration due to conventional drying methods. To minimize this dehydration loss osmotic dehydration is the most beneficial pre-treatment. Osmotic dehydration is the movement of hypertonic solution through the semipermeable membrane. Generally, sugar is used as a hypertonic solution for fruits. The osmotic dehydration process generally reduces 30-50% of the moisture content of the fruits (Josephine Selvi. N. et al., 2014). In India generally murabba (prepared from mango, and amala), pickles are commonly found in osmotically dehydrated products.

Plum is one of the most important nutritional fruit for the human diet. Near about 200 varieties of the plum are available but few are commercially important (Preeti Birwal, 35 Deshmukh G, Saurabh SP and Pragati S, 2017). Plum is an important source of bioactive 36 compounds influencing human health and work as a nutraceutical. Generally, plums are 37 consumed as fresh, processing of plum include drying, juice preparation and canning. Plum is a vital source of bioactive compounds such as phenolic acids, anthocyanins, carotenoids, minerals and pectin. Plum constitutes a valuable component of our diet, both in terms of their nutritive and dietary value. For many decades' plums have been used in Indian medicine as a component of natural drugs used in cases of leucorrhea, irregular menstruation and miscarriage (Preeti Birwal, Deshmukh G, Saurabh SP and Pragati S, 2017). Thus, this research aims to compare the moisture, acidity, vitamin C, anthocyanin and total phenolic content of conventional dried plum and osmodried plum (whole fruit osmosis) and drain sugar syrup. The objective of this study is to identify whether osmotic dehydration is the best way to preserve plums as compared to other preservation techniques and to understand the nutritional and other health benefits of dried plum and drain syrup. By treating whole fruit rather than cut fruits (size reduction) for retention of nutrients in high-moisture fruits like plums (87.63% moisture) by osmosis.

2. MATERIALS AND METHODS

2.1 Sample preparation

Fresh fully ripened plums (*Prunus domestica*) with outer dark red skin were procured from the market. The fruits were washed with chlorinated water to ensure

the removal of surface adherents. Further blanching (1000C) was carried out for the removal of tissue gases, inactivation of enzymes, softening of tissue and the facilitation of osmosis by rupturing the cell wall. The retention of colour was done by the addition of 1% citric acid and 0.5% salt (NaCl) in combination during blanching.

2.2 Osmotic Dehydration

Osmosis of whole blanched fruit was done with variant process conditions as temperature (450C, 500C and 550C) and hypertonic solution (sucrose) concentration (650, 700 and 750 B) respectively at a constant contact time of 24 hours. The whole blanched fruit with initial moisture content (87.63%) and TSS (140 B) was immersed into a hypertonic solution of sucrose maintaining fruit to hypertonic solution ratio (1:6). After every treatment fruit was removed from the solution and kept at a constant temperature for 15 min to drain the syrup, and then fruits were gently blotted with tissue paper. Washing with water after osmosis may lead to a fall in the total TSS of fruit, thus be avoided.

2.3 Conventional Drying of fruit

Conventional drying of whole fruit was carried out under control conditions (800C) for 7-8 hours by using a hot air oven.

2.4 Physiochemical Analysis

Physiochemical Analysis of each batch includes moisture, total acidity measurement, vitamin C, total anthocyanin and total phenolic content. All readings are in triplicates.

2.4.1 Moisture content

The moisture content of all the samples was determined according to the standard methods of AOAC, (AOAC, 2000). The sample (5 gm) of the sample was oven

dried at 1100 C and the moisture content of the sample was calculated.

2.4.2. Total Acidity

Total acidity was determined by the procedure stated in Ranganna (2012). Standardization of NaOH (0.1N) was done by using an aliquot (10ml) of oxalic acid (0.1N) and phenolphthalein as an indicator. Osmotically dehydrated plum was crushed in a mortar and homogenised with sterile distilled water. The extract was filtered using Whatman filter paper no. 1. Further volume was made up to 100 ml with distilled water. Aliquot (5 ml) was titrated with (0.1N) NaOH. The persistence of the pink colour for at least 15 sec indicates the completion of titration. Each determination was in triplicate.

2.4.3 Ascorbic Acid (Vitamin C)

Ascorbic acid of the osmotically dehydrated plum was determined by 2, 6-Dichlorophenol-Indophenol visual titration method (Johnson, 1948; Methods of Vitamin Assay, 1948) with modifications. Standard ascorbic acid (0.1mgml⁻¹) was standardized by 2, 6-Dichlorophenol-Indophenol. Osmotically dehydrated plum was crushed in a mortar and homogenised with HPO₃. The extract was filtered using Whatman filter paper no. 1. Further volume was made up to 100 ml with HPO₃. Aliquot was titrated with 2, 6-Dichlorophenol- Indophenol. Endpoint was noted when the pink colour persisted for at least 15 sec. All measure was in triplicate.

2.4.4. Total Anthocyanin content

The total anthocyanin content of the osmotically dehydrated plum was determined by using the method described by Fuleki, T. and F. J. Francis, (1968) with modification. Osmotically dehydrated plum (15gm) was crushed in a mortar and homogenised with ethanolic HCl (15ml)

(85 (95%):15 (1.5 N HCl)). Transfer in a glass-stoppered bottle and stored overnight under controlled refrigeration (40C) conditions. Further filter on a Whatman filter paper no. 1 using a Buchner funnel. Wash the residue repeatedly with ethanolic HCl until 90 ml extract was collected and the final volume was made up to 100 ml by ethanolic HCl in the same volumetric flask. For spectrophotometric (Labman Scientific Instrument) measurement aliquot (6.24 ml) was taken and made up the volume 25 ml with ethanolic HCl. Stored in a dark for 2 hours and measure the absorbance at 535 nm. Ethanolic HCl is used as a blank solution for UV visible spectrophotometric (Labman Scientific Instrument) measurement. Each determination was in triplicate.

2.4.5. Total Phenolic Content

The total phenolic content of the sample was calculated by using Folin Ciocalteu's method described in Chuah et al. (2008) with some modifications. Osmotically dehydrated plums (5gm) were crushed in a mortar with 80% ethanol and then the sample was stored for 2 hours under controlled refrigeration conditions (at 40C). Then the sample was centrifuged at 3000 rpm for 20 min and filtered on a Whatman filter paper no. 1. The clean extract was stored at 40C for further analysis. 0.4 ml of osmotically dehydrated plum extract and gallic acid (GA) (20, 40, 60 and 80µl) solution was transferred to the test tube; 5 ml water was added. Followed by this 0.5 ml Folin Ciocalteu's (FC) (10 fold) reagent was added. After 3 min 20%, Na₂CO₃ was added to make up the volume of 10ml and shaken. The sample was then put into the water bath (1000C) for 1min. After cooling at room temperature absorbance was measured on a UV visible spectrophotometer (Labman

Scientific Instrument) at 640 nm. The gallic acid (GA) calibration curve was plotted to compare the spectrophotometric absorbance. Results were expressed as mg GA 100g⁻¹ osmotically dehydrated plum. All measures were done in triplicates.

2.4.6 Statistical analysis

The effect of temperature and sugar syrup concentration on each quality parameter was analysed using GraphPad Prism 5.00.288 applying an analysis of variance (ANOVA). Differences in the mean values were analysed using the least significant difference (LSD) test with a significance level of 0.05 and a confidence interval of 95% ($P < 0.05$). In addition, the Bonferroni test included in the statistical

program was used to compare the entire column with each other.

3 RESULTS AND DISCUSSION

Table no.1 and figure present the mean values and standard deviation of the moisture content (%), acidity (%), vitamin C (mg/100gm), total anthocyanin (mg/100gm) and total phenolic content (mg GA/100gm) of conventional dried fruit and osmotically dehydrated fruit (fruit and drain syrup) with respect to different level operating parameters $p < 0.05$ and (confidence level 95%) temperature (450, 500 and 550C) and hypertonic solution concentration (650, 700 and 750 B) respectively.

Sample Parameters	Raw Fruit Analysis		Conventional Dried Fruit Analysis	
	Dry Basis	Wet Basis	Dry Basis	Wet Basis
Moisture Content (%)	295.6 ± 0.52 ^b	85.22 ± 0.52 ^b	155.4 ± 0.122 ^b	7.77 ± 0.012 ^a
Acidity(%)	8.18 ± 0.45 ^b	1.21 ± 0.05 ^a	1.40 ± 0.102 ^b	1.30 ± 0.102 ^b
Vitamin C(mg/100gm)	339.78 ± 0.55 ^b	50.22 ± 0.26 ^b	8.72 ± 0.05 ^a	8.05 ± 0.05 ^a
Anthocyanin (mg/100gm)	759.13 ± 0.51 ^b	112.2 ± 0.005 ^a	43.02 ± 0.05 ^a	39.68 ± 0.025 ^a
TPC (mg GA/100g)	835.59 ± 0.49 ^b	123.5 ± 0.087 ^a	1952.94 ± 0.002 ^a	1801.20 ± 0.002 ^a

Table no. 1: Raw and Conventional dried fruit analysis. The table represents the mean ± standard deviation of triplicates (n=3) and values followed by the same letter in the same column are not significantly different ($P < 0.05$).

From table no.1 it was observed that the acidity of the conventional dried fruit is not that much affected as compared to raw fruit. Vitamin C and anthocyanin content of the fruit was significantly decreased (Djendoubi Mrad Nadia et al., 2013; S. Oancea, M. Stoia, D. Coman, (2012). The

total phenolic content of the fruit increased with an increase in the temperature of the drying (Nazmi IZLI, Gökçen IZLI, Onur TASKIN, 2017). From this observation, it was found that the conventional drying process produces more losses as compared to other drying technology. Thus osmotic

dehydration process is preferred for dehydration.

3.1 Moisture Content

The initial moisture content of raw fruit was presented in table no. 1 and osmotically dehydrated fruit moisture content was presented in figure no. 1. A significant decrease in moisture content was observed for osmotically dehydrated

plum (figure no. 1) with respect to different operating parameters temperature (450, 500 and 550C) and sugar syrup concentration (650, 700 and 750B) at the level of $p < 0.005$ and 95% CL. Similar results for moisture content was reported by Yissleen Nunez-Mancilla et al., (2013) for osmotically dehydrated strawberry (*Fragaria vesca*).

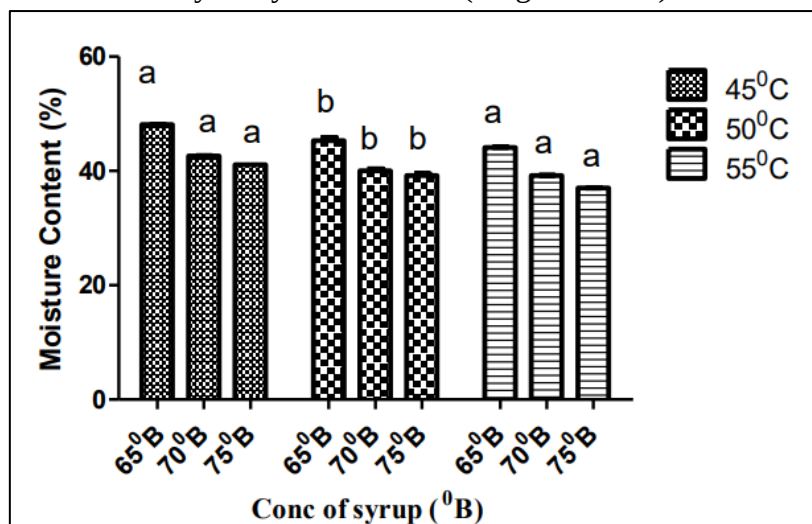


Figure No. 1: Changes in Moisture Content of Osmodried Fruit with respect to temperature and sugar syrup concentration. Combined Bars represent the mean $\pm$ standard deviation of triplicates ($n=3$). Identical letters above the bars indicate no significant differences ($P < 0.05$).

3.2 Acidity

Figures no. 2a and 2b present the combined bar graph for acidity content (%) of both osmotically dehydrated plum and drain syrup. From this, it was observed that there is no significant change in the acidity of osmotically dehydrated plum

(figure no. 2a). It was also observed that there is a significant increase (0.1-0.15%) in the acid content of drain syrup due to addition of citric acid during syrup preparation for colour retention (figure no. 2b).

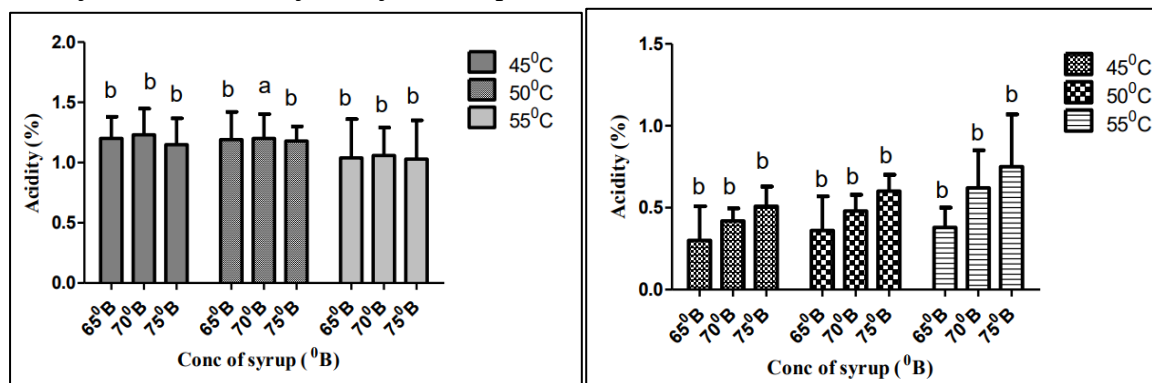


Figure No.2 (2a and 2b): Changes in Acidity of Osmodried Fruit and drain syrup with respect to temperature and sugar syrup concentration respectively. Combined Bars represent the mean $\pm$ standard deviation of triplicates (n=3). Identical letters above the bars indicate no significant differences ($P < 0.05$).

3

3.3 Vitamin C

Figures no.3a and 3b present the combined bar graph of sugar syrup concentration (0B) versus ascorbic acid content (mg/100gm) at different temperatures (450, 500 and 550C) for the different samples of osmotically dehydrated fruit and drain syrup. A significant decrease in vitamin C content was observed for osmotically dehydrated plum and drain syrup with respect to different operating parameters temperature (450, 500 and 550C) and sugar syrup concentration (650, 700 and 750B) at the level of $p < 0.005$ and 95% CL. The sample treated at 450C gives

better vitamin C retention than samples treated at 500C and 550C. It was found that there is a 12% reduction in ascorbic acid content in the case of osmotically dehydrated plums and a 40% ascorbic acid reduction in the case of conventionally dehydrated plums. Ascorbic acid concentration decreases with processing temperature and hypertonic solution concentration (Djendoubi Mrad Nadia et al., 2013). Leaching is also one of the most important factors to consider in the decrease in ascorbic acid concentration in osmotically dehydrated fruit.

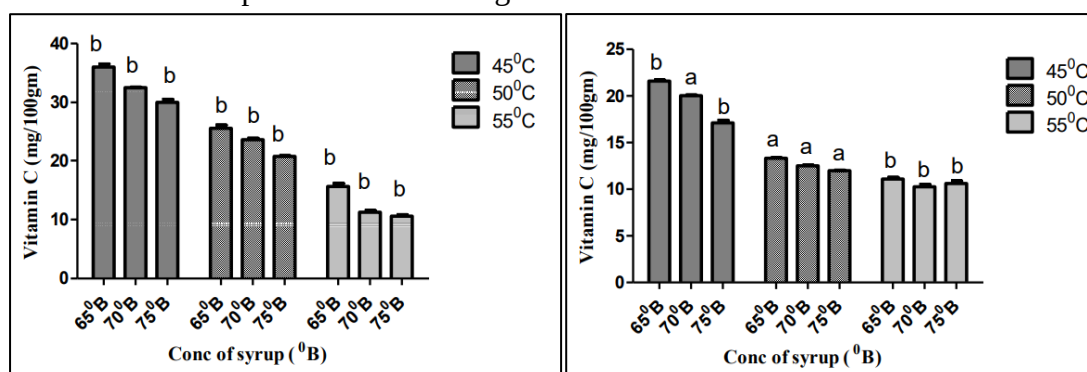


Figure No. 3 (3a and 3b): Changes in Vitamin C content of Osmodried Fruit and drain syrup with respect to temperature and sugar syrup concentration respectively. Combined Bars represent the mean $\pm$ standard deviation of triplicates (n=3). Identical letters above the bars indicate no significant differences ($P < 0.05$).

Vitamin C is highly heat sensitive, is easily destroyed during processing (Wolbang, C. M., Fitos, J. L., & Treeby, M. T., 2008). The decrease in ascorbic acid concentration with the increase in osmosis temperature shows its instability to the higher temperature (Solanke and Awonorin, 2002; Osundahunsi, 2008).

However, some enzymes like cytochrome oxidase, ascorbic acid oxidase and peroxidase found in fruits are also responsible for ascorbic acid degradation (Yissleen Nuñez-Mancilla et al., 2013) and Karim, O.R. and Adebawale A.A. (2009) for peach.

3.4 Anthocyanin content

From figure 4a it was observed that a significant decrease in anthocyanin content of osmotically dehydrated plums with respect to different operating parameters temperature (450, 500 and 550C) and sugar syrup concentration (650, 700 and 750B) at the level of $p < 0.005$ and 95% CL. The sample processed at 450C and 650B gives more anthocyanin content

(90.32 mg/100gm) than the sample processed at 500C and 550C for osmotically dehydrated fruit. It was found that in the case of osmotically dehydrated plums 20-22% anthocyanin content losses and in the case of conventionally dehydrated plums more than 50% losses as compared to fresh plum fruit.

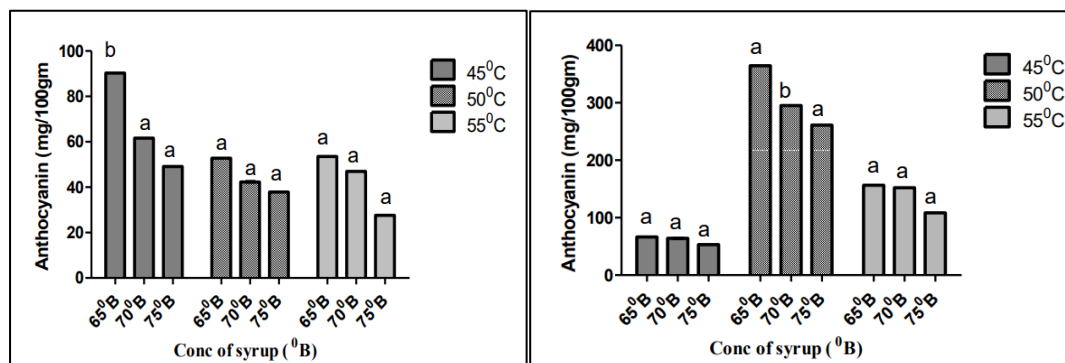


Figure No. 4 (4a and 4b): Changes in Anthocyanin content of Osmodried Fruit and drain syrup with respect to temperature and sugar syrup concentration respectively. Combined Bars represent the mean $\pm$ standard deviation of triplicates ($n=3$). Identical letters above the bars indicate no significant differences ($P < 0.05$).

No significant change in the al anthocyanin content of drain syrup was observed (presented in figure 4b) with respect to temperature (450, 500 and 55°C) and sugar syrup concentration (650, 700 and 750B). The anthocyanin content of drain syrup was depending upon the amount of anthocyanin leaching out from fruit during 24-hour osmosis.

Sugar is one of the critical factors for anthocyanin stability (Ngo T., Wrolstad RE. and Zhao Y, 2007) reported that total anthocyanin in strawberries canned at 200B at room temperature. Similarly, the temperature and duration of blanching strongly at the anthocyanin. In the study of Brownmiller C., Howard J. R. and Prior R. L., (2008) observed that a higher temperature of blanching (950C for 3 min)

resulted in 43% anthocyanin losses compared to the original level found in fresh fruit. Numbers of factors are responsible for anthocyanin degradation during processing such as heat, pH, light, oxygen and duration of exposure of these factors to the product (Ramesh C. Khanal, 2010). Anthocyanin pigment is a heat-sensitivesdescribed by S. Oancea, M. Stoia, and D. Coman, (2012) for the effect of extraction conditions on total anthocyanin content from *Vaccinium corymbosum*. Pericles markakis, gideon e. Livingston, and carl r. Fellers, (1956) reported anthocyanin degradation with respect to temperature.

3.5 Total phenolic content (TPC)

The Effect of processing temperature and hypertonic solution concentration on the

total phenolic content of fruit was reported in figures no 5a and 5b. This figure shows a combined bar graph for change in the total phenolic content of the fruit and syrup. From it was observed that a significant increase in TPC content with an increase in processing temperature and sugar syrup concentration. Similar results

were reported by Nazmi IZLI, Gökçen IZLI, Onur TASKIN, (2017) for osmotically dehydrated mango, SEOK-MOON JEONG and et al., (2004) for citrus peels. The sample processed at 55°C shows higher TPC content than the sampling process at 45°C and 50°C.

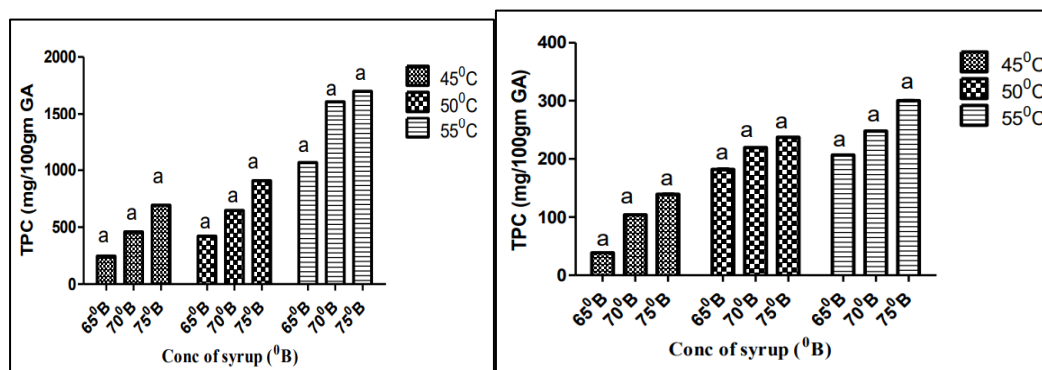


Figure No. 5 (5a and 5b): Changes in the Total phenolic content of Osmodried Fruit and drain syrup with respect to temperature and sugar syrup concentration respectively. Combined Bars represent the mean $\pm$ standard deviation of triplicates ($n=3$). Identical letters above the bars indicate no significant differences ($P < 0.05$).

Various factors are responsible for TPC change like temperature, pH, sugar syrup concentration, enzymes, organic acids and many more. Polyphenol oxidase and other enzymes are responsible for TPC degradation during drying but higher processing temperatures and longer exposure result in the inactivation of these enzymes (Nadia Djendoubi Mrad, 2012). Que et al., (2008) reported that the formation of phenolic compounds occurs during drying because the precursor of phenolic compounds present in the fruits is converted into phenolic compounds with the help of non-enzymatic interconversion. The phenolic content of osmotically (NaCl as a hypertonic solution) pretreated grapes was increased on drying as reported by, J. Carranza-Concha et al., (2012). This might

be due to structural changes in drying and skin damage due to pre-treatment.

Besides, some researchers reported phenolic compounds are decreased during the thermal processing of food products and some reported there is no significant change in the TPC. The TPC content of dried pears decreased significantly with an increase in temperature reported by, Nadia Djendoubi Mrad, (2012). Similar results for TPC decrease were reported by, Santos et al., (2014) for pear and Vega-Gálvez et al., (2012) for apple and Michalczyk, M., Macura, R., Matuszak, (2009).

4. CONCLUSION

A comparison between osmotically dehydrated fruit (at different temperatures and hypertonic solution concentration) and conventionally dehydrated fruit (800C for

5-6 hours) and drain syrup was represented in this research work. Vitamin C content and anthocyanin content of the fruit were significantly decreased with an increase in processing temperature. The total phenolic content of the fruit increased as the processing temperature increased. The osmotically treated fruit shows more vitamin, anthocyanin, and acidity content retention than conventionally dried fruit. Thus osmotic dehydration is the best process for the preservation of fruits.

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