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Expounding the influence of chemicals and processing techniques on the shelf life of Fig (*Ficus carica* L.)

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ABSTRACT: The quality of dried fig was compared by treating blanched figs with potassium metabisulfite, NaCl, ascorbic acid (AA) at various concentrations (2, 3, 4%) and sucrose solution (30, 40, 50%). In comparison of results for functional attributes, T_5 (blanching +4% AA dipped for 10 min) stood prominent in retaining higher ascorbic acid, phenolics and antioxidant activity followed by T_4 (blanching +3% AA dipped for 10 min) and T_3 (blanching +2% AA dipped for 10 min). However, higher fibers and total sugars were found in T_8 (blanching +50% sucrose dipped for 30 min) and T_7 (blanching +40% sucrose dipped for 30 min). Eventually, sensory evaluation of the stored samples demonstrated best scores for the osmotically dehydrated fig with 30 and 40% sucrose prior to cabinet drying. Overall, the results of present investigation have significant contribution to the food industry. Of note the shelf life and stability of fig could be enhanced upon bringing the result of this finding in practice.

KEYWORDS: dried fig, chemical pre-treatment, nutritional attributes, functional properties, sensory evaluation

INTRODUCTION

Fig (*Ficus carica* L.) is a commonly grown food crop in semi-arid climate of the eastern Mediterranean region and southwest Asia[1]. The annual production of fig is about one million metric tons in the world with a cultivated area of 419 000 ha[2]. It is a delicious fruit with highly nutritional and functional attributes. A serving of 100 g fig daily provides the mentioned nutritional information: 6.2% riboflavin, 7.1% thiamin, 30% iron, and 15.8% calcium[3]. Among all fruits, dried fig is a rich source of Cu, K, Mn, Mg, vitamins, dietary fibers and amino acids[4,5]. Dried fig contains the highest amount of crude fiber and phytochemicals. Different varieties of fig have numerous carotenoids like α-carotene, cryptoxanthin, lycopene and lutein, with the lycopene in larger quantity than lutein and α-carotene[6–8]. Keeping in view the compositional strength of fig, its extract is widely used for medicinal purposes[3,8,9]. Epidemiological studies have shown that consumption of fig can reduce heart disease, cancer and other degenerative diseases[6,10,11].

Unfortunately, the quality and characteristics of fig are mostly influenced by the high amount of sugars and organic acids. Fresh fruits of fig are perishable and have a very short postharvest life[10]. It deteriorates due to fermentation and other physical factors that reduce the marketing life and storage period. Better quality dehydrated products can be achieved by osmotic dehydration process and or its combination with other drying methods. Osmotic dehydration can be done by putting the food commodity in concentrated sugar solution and partially removing the moisture from the product. Chemicals which are generally recommended as safe (GRAS) such as SO_2 fumigation and use of potassium metabisulfite (KMS) and sodium carbonate are widely recommended worldwide to achieve a product of better sensory properties with increased shelf life[12,13]. Very few studies have been carried out to increase the shelf life of dried figs in Pakistan. Therefore, the present study was conducted to enhance the storage life and to assess the keeping quality of stored dried figs as affected by pretreatments during ambient storage.

MATERIALS AND METHODS

Collection of samples and treatments

The fully matured figs were harvested in District Ghizer, Gilgit Baltistan, Pakistan. Fruits were cleaned and washed to remove all adhering dirt and dust particles. The fresh fruits were divided into 9 groups to be treated with different chemicals as per following plan: The pretreatments were applied in the following scheme; all chemicals were prepared in % (w/v):

Treatment	Chemical
T_0:	control (without any treatment)
T_1:	0.15% KMS dip for 5 min
T_2:	blanching+2% NaCl dip for 60 min
T_3:	blanching+2% AA dip for 10 min
T_4:	blanching+3% AA dip for 10 min
T_5:	blanching+4% AA dip for 10 min
T_6:	blanching+30% sucrose dip for 30 min
T_7:	blanching+40% sucrose dip for 30 min
T_8:	blanching+50% sucrose dip for 30 min

Further, the fruits were dehydrated using solar drier facility available at the Agriculture Department, Gilgit. The dried fruits were sealed in plastic bags and brought to the Postharvest Lab of Food Technology, PMAS, Arid Agriculture University, Rawalpindi, stored at room temperature and analyzed for their shelf stability for a period of six months.

Storage and physicochemical analysis

Moisture content, crude fiber, titratable acidity and ascorbic acid were determined by following AOAC(2000) [14] procedures while total sugars were determined by Lane and Eynon method [15].

Moisture content

Moisture content was determined according to the official protocol of AOAC(2000) [14]. Pre-weight samples were subjected to hot air oven at 100–105 °C till constant weight. Then the moisture content was calculated by the following formula:

$$\text{Moisture}\,\% = \frac{\text{Sample weight} - \text{Weight after drying}}{\text{Sample weight}} \times 100$$

Crude fiber

Fat free samples were taken for estimation of crude fiber, the samples were treated with 1.25% (v/v) H_2SO_4 solution to digest the samples and then 1.25% (v/v) NaOH solution to neutralize the samples. The rest of filtrate was charred after drying. After that, samples were placed in muffle furnace at 550 °C to ignite the samples and the resulted materials were weighed (AOAC, 2000). By using the following formula, we can calculate the fiber content

$$\text{Fiber}\,\% = \frac{\text{Ash weight}}{\text{Sample weight}} \times 100$$

Titratable acidity

Five grams thoroughly mixed fig pulp samples were prepared and 100 ml volume was maintained by addition of distilled water. Thereafter, 10 ml of the filtrate was taken and 2–3 drops of phenolphthalein indicator was added and titrated against 0.1 N NaOH till light pink color appeared (AOAC, 2000). The acidity in percentage was calculated by following formula:

$$\text{Acidity}\,(\%) = \frac{\text{Acid weight} \times \text{Base normality} \times \text{Titer}}{\text{Sample weight} \times \text{Aliquot taken}} \times 100$$

Ascorbic acid content

Ascorbic acid was titrimetrically determined by using sodium 2,6-dichlorophenol indophenol dye (AOAC, 2000). Fig sample (10 g) was accurately weighed and grounded using mortar and pestle in 20 ml of metaphosphoric acid - acetic acid. The mixture was further grounded and strained through muslin and the extract was made up to 100 ml with the metaphosphoric-acetic acid mixture. Five ml of this acid-mixture solution was pipetted into 50 ml Erlenmeyer flask containing 2 ml of the extract. The samples were titrated separately with the indophenol dye until a light rose pink color was persisted for 5 seconds. The amount of dye used in the titration was determined and used for calculating vitamin C content present in the sample.

Total sugars

Amounts of total sugars present in fig were determined by using the methods adopted by Lane and Enyon [15]. The amounts of reducing and non-reducing sugars were measured (AOAC, 2000).

Total phenolic content and antioxidant activity

200 grams of fig sample were taken in 500 ml flask, then filled with methanol. The sample flask was placed in orbital shaker incubator for 48 h at ambient temperature. The resultant samples were filtered, thereafter, the extract was concentrated

by using rotary evaporator till the sample amount was reduced to 1 ml. The solvent was further removed by subjecting sample to the purified gentle stream of N_2 gas. The sample was stored at −4 °C till further analysis[16]. Total phenolic contents were measured using the Folin-Ciocalteu reagent in UV-Vis spectrophotometer[17]. Gallic acid was used as standard and the standard curve (obtained by running different concentrations of gallic acid) was used to calculate the total phenolic contents in the sample. The absorbance of the samples was measured at 765 nm. The results were expressed as mg GAE/100 g.

Antioxidant activity was measured by the method as described[18], that involves the use of the free radical 2,2-diphenyl-1-picrylhydrazyl (DPPH). The absorbance of the samples was spectrophotometrically measured at 517 nm. Antioxidant activity was calculated as % inhibition of DPPH radical by the following formula:

$$\%\,\text{Inhibition} = \frac{A_{\text{blank}} - A_{\text{sample}}}{A_{\text{blank}}} \times 100$$

Sensory evaluation

The sensory evaluation of the dried fig fruit (color, flavor, taste and overall acceptability) was carried out (at one month interval) by a panel of five trained judges using 9-point hedonic scale rating method following the method of Ref. 19.

Statistical analysis

Data obtained for each parameter was analyzed to check the level of significance ($p \leqslant 0.05$) and means were compared by Duncan Multiple Range Test (DMRT) according to Steel et al[20] using MSTAT-C software[21].

RESULTS AND DISCUSSION

Physicochemical analysis

The mean values for moisture content of pretreated dried fig ranged from 11.41–16.03% (Table 1). Higher moisture content was observed in control sample (T_0, 16.03%), while lowest moisture content was observed in the sample treated with 40% sucrose solution (T_8, 11.71%). It was found that the moisture content of dried figs differed significantly ($p < 0.05$) among the treatments. A significant decrease in moisture was observed in the samples treated with sugar solution, when compared with other chemically treated figs. The samples treated with 2, 3, and 4% concentrations of ascorbic acid and KMS solution showed a non-significant difference among each other; however, differed significantly from other fig samples treated with sugar, NaCl and sucrose solution.There was a decreasing trend in the moisture content of pretreated dried fig samples during storage of six months. The mean values for moisture content during storage intervals ranged from 13.50–14.84%. Control samples carried highest moisture (16.03%) but the samples treated with 50% sucrose showed minimum moisture (11.41%) while the rest of samples responded variedly in between these values towards the end of storage. The fresh fig contained 75–80% moisture and after sun drying moisture reduced to 14–15%. However, during storage of six months at ambient temperature moisture also decreased and reached the level of 13.50%. The moisture content present in fig samples was less than that reported by earlier studies[8,22]. During the present study, moisture content of the pretreated dried fig remained in the lower limits which might be due to variation in storage conditions, drying technique, temperature and humidity during storage of the final product.

Crude fiber of pretreated dried fig samples ranged from 3.29 to 4.10% as can be seen in Table 2. Higher crude fiber was found in T_8 (4.10%) while the lowest was observed in control (3.29%). The increase in fiber content was observed due to increase in the pretreatment concentration. The data showed that there was a significant decreasing trend on crude fiber during storage of dried figs. Among all, fig fruits either in dried or fresh form contain large amount of fiber content which facilitate the digestive system and remove ingestion problems[9]. The conclusion of our recent observations is aligned with the results of Ramulu[23], who reported the same findings related to dietary fiber of fig fruit.

The data pertaining to total sugars shown in Table 3 indicated increasing trend of total sugars during storage against all treatments. The mean values for total sugar among different treatments ranged from 24.33–43.84 g/100 g. Significantly ($p < 0.05$), higher total sugar contents were observed in T_6, T_7, and T_8, respectively. Higher total sugar contents in T_8, T_7, and T_6 might be due to increase in the concentration of sucrose solution during pretreatment. Similarly, non-significant results were found for NaCl and ascorbic acid treated fruit along with control set. During storage of dried fruits, complex carbohydrates are converted into simple sugars and loss of moisture augments ultimate increase in soluble sugar concentration[10,24]. Naikwadi, Pawar, and Thota[10,25,26] also reported

Table 1 Effect of different treatments on moisture content in dried fig during ambient storage.

Treat	Storage period (days)							Mean ± SD
	0	30	60	90	120	150	180	
T_0	17.00 ± 0.60^{a}	16.50 ± 1.30^{ab}	16.00 ± 1.00^{abc}	15.90 ± 0.80^{abc}	$15.80 \pm 0.70^{a\text{-}d}$	$15.60 \pm 0.70^{b\text{-}f}$	$15.40 \pm 0.60^{b\text{-}g}$	16.03 ± 0.55^{a}
T_1	16.00 ± 0.50^{abc}	$15.80 \pm 0.90^{a\text{-}d}$	$15.60 \pm 1.20^{b\text{-}f}$	$15.67 \pm 0.76^{a\text{-}e}$	$15.10 \pm 0.60^{c\text{-}i}$	$14.80 \pm 0.80^{c\text{-}k}$	$14.40 \pm 0.90^{e\text{-}m}$	15.34 ± 0.59^{b}
T_2	$14.80 \pm 0.90^{c\text{-}k}$	$14.40 \pm 0.50^{e\text{-}m}$	$14.30 \pm 0.70^{f\text{-}n}$	$14.10 \pm 0.60^{g\text{-}o}$	$13.80 \pm 0.80^{i\text{-}q}$	$13.60 \pm 0.60^{k\text{-}q}$	$12.87 \pm 0.58^{o\text{-}t}$	13.98 ± 0.63^{c}
T_3	$15.60 \pm 0.80^{b\text{-}f}$	$15.67 \pm 0.76^{a\text{-}e}$	$15.30 \pm 0.80^{b\text{-}h}$	$15.10 \pm 0.60^{c\text{-}i}$	$14.90 \pm 0.90^{c\text{-}k}$	$14.70 \pm 1.20^{c\text{-}l}$	$14.50 \pm 0.50^{d\text{-}m}$	15.11 ± 0.44^{b}
T_4	$15.50 \pm 1.00^{b\text{-}f}$	$15.40 \pm 0.80^{b\text{-}g}$	$15.20 \pm 0.90^{b\text{-}h}$	15.00 ± 1.00^{cj}	$14.80 \pm 1.20^{c\text{-}k}$	$14.70 \pm 1.30^{c\text{-}l}$	$14.50 \pm 0.60^{d\text{-}m}$	15.01 ± 0.37^{b}
T_5	$15.37 \pm 0.42^{b\text{-}g}$	$15.50 \pm 1.10^{b\text{-}f}$	$15.30 \pm 1.30^{b\text{-}h}$	$15.10 \pm 0.80^{c\text{-}i}$	$14.90 \pm 1.30^{c\text{-}k}$	$14.80 \pm 0.90^{c\text{-}k}$	$14.27 \pm 0.42^{f\text{-}n}$	15.03 ± 0.42^{b}
T_6	$14.00 \pm 1.20^{h\text{-}p}$	$13.70 \pm 1.40^{j\text{-}q}$	$13.60 \pm 0.90^{k\text{-}q}$	$13.40 \pm 0.40^{l\text{-}q}$	$13.20 \pm 0.80^{m\text{-}r}$	$13.00 \pm 0.50^{n\text{-}s}$	$12.80 \pm 0.70^{o\text{-}t}$	13.39 ± 0.42^{d}
T_7	$13.30 \pm 0.80^{m\text{-}r}$	$13.20 \pm 0.70^{m\text{-}r}$	$13.00 \pm 0.60^{n\text{-}s}$	$12.90 \pm 0.90^{o\text{-}t}$	$12.70 \pm 0.90^{p\text{-}t}$	12.60 ± 0.40^{qrst}	$12.00 \pm 0.80^{r\text{-}u}$	12.81 ± 0.44^{e}
T_8	$12.00 \pm 0.90^{r\text{-}u}$	11.80 ± 0.90^{stu}	11.60 ± 0.80^{tu}	$13.60 \pm 0.70^{k\text{-}q}$	11.20 ± 0.80^{u}	11.00 ± 0.70^{u}	10.80 ± 0.40^{u}	11.71 ± 0.94^{f}
Mean	14.84 ± 1.52^{a}	14.66 ± 1.51^{a}	14.43 ± 1.44^{ab}	14.53 ± 1.06^{a}	14.04 ± 1.45^{bc}	13.87 ± 1.44^{cd}	13.50 ± 1.48^{d}	

LSD: T = 0.52, S = 0.45, TS = 1.36. Values are means of triplicate. The means within the row bearing same letter(s) are statistically significant at $p < 0.05$.

Table 2 Effect of different treatments on fiber in dried fig during ambient storage.

Treat	Storage period (days)							Mean ± SD
	0	30	60	90	120	150	180	
T_0	$4.00 \pm 0.40^{a\text{-}d}$	$3.80 \pm 0.70^{a\text{-}e}$	$3.60 \pm 0.80^{b\text{-}f}$	$3.20 \pm 0.20^{d\text{-}g}$	3.00 ± 0.30^{efg}	2.80 ± 0.30^{fg}	2.60 ± 0.40^{g}	3.29 ± 0.53^{d}
T_1	$4.00 \pm 1.00^{a\text{-}d}$	$3.80 \pm 0.80^{a\text{-}e}$	$3.60 \pm 0.40^{b\text{-}f}$	$3.73 \pm 0.31^{a\text{-}e}$	$3.40 \pm 0.30^{c\text{-}g}$	$3.20 \pm 0.40^{d\text{-}g}$	3.00 ± 0.04^{efg}	3.53 ± 0.35^{bcd}
T_2	4.20 ± 0.30^{abc}	$4.00 \pm 0.70^{a\text{-}d}$	$3.80 \pm 0.80^{a\text{-}e}$	$3.60 \pm 0.60^{b\text{-}f}$	$3.40 \pm 0.50^{c\text{-}g}$	$3.40 \pm 0.50^{c\text{-}g}$	$3.20 \pm 0.20^{d\text{-}g}$	3.66 ± 0.36^{bc}
T_3	$4.00 \pm 0.40^{a\text{-}d}$	$3.70 \pm 0.46^{a\text{-}e}$	$3.60 \pm 0.40^{b\text{-}f}$	$3.40 \pm 0.25^{c\text{-}g}$	$3.40 \pm 0.60^{c\text{-}g}$	$3.20 \pm 0.60^{d\text{-}g}$	$3.20 \pm 0.10^{d\text{-}g}$	3.50 ± 0.29^{bcd}
T_4	4.20 ± 0.50^{abc}	$3.53 \pm 0.40^{c\text{-}f}$	4.08 ± 0.38^{abc}	$3.80 \pm 0.70^{a\text{-}e}$	$3.80 \pm 0.70^{a\text{-}e}$	$3.60 \pm 0.70^{b\text{-}f}$	3.07 ± 0.29^{efg}	3.73 ± 0.38^{bc}
T_5	$4.00 \pm 0.30^{a\text{-}d}$	$4.00 \pm 0.92^{a\text{-}d}$	$3.60 \pm 0.50^{b\text{-}f}$	$3.40 \pm 0.35^{c\text{-}g}$	$3.20 \pm 0.30^{d\text{-}g}$	3.00 ± 0.50^{efg}	3.00 ± 0.60^{efg}	3.46 ± 0.43^{cd}
T_6	$4.00 \pm 0.20^{a\text{-}d}$	$3.80 \pm 0.50^{a\text{-}e}$	$3.60 \pm 0.50^{b\text{-}f}$	$3.40 \pm 0.50^{c\text{-}g}$	$3.20 \pm 0.40^{d\text{-}g}$	3.00 ± 0.40^{efg}	3.00 ± 0.02^{efg}	3.43 ± 0.39^{cd}
T_7	4.20 ± 0.50^{abc}	$4.00 \pm 0.40^{a\text{-}d}$	$3.80 \pm 0.60^{a\text{-}e}$	$3.80 \pm 0.45^{a\text{-}e}$	$3.60 \pm 0.60^{b\text{-}f}$	$3.60 \pm 0.60^{b\text{-}f}$	$3.40 \pm 0.03^{c\text{-}g}$	3.77 ± 0.27^{b}
T_8	4.50 ± 0.50^{a}	4.40 ± 0.50^{ab}	4.20 ± 0.30^{abc}	4.20 ± 0.60^{abc}	$4.00 \pm 0.50^{a\text{-}d}$	$3.80 \pm 0.70^{a\text{-}e}$	$3.60 \pm 0.50^{b\text{-}f}$	4.10 ± 0.32^{a}
Mean	4.12 ± 0.17^{a}	3.89 ± 0.25^{ab}	3.76 ± 0.23^{bc}	3.61 ± 0.30^{cd}	3.44 ± 0.31^{de}	3.29 ± 0.33^{ef}	3.19 ± 0.28^{f}	

LSD: T = 0.16, S = 0.14, TS = 0.82. Values are means of triplicate. The means within the row bearing same letter(s) are statistically significant at $p < 0.05$.

the similar results related to our findings that during drying and storage the total sugar of fig fruit increased.

Titratable acidity of dried fig samples ranged from 0.08–0.152% and an overall increasing trend was witnessed in all treatments (Table 4). Significantly ($p < 0.05$) higher value was found in T_5 followed by T_4 and T_3, while the lowest values with non-significant pattern were found in other treatments and control sample. During extended storage, moisture losses and sugar fermentation occurs that resulted in increased concentration of organic acids. Similarly, the increase in titratable acidity was also related to increase in ascorbic acid concentration in the pretreatment. Our findings are in agreement with Naikwadi and Pawar[10,26], who found a gradual increase in titratable acidity of dried fig during storage.

Storage behavior of ascorbic acid (AA) in dried figs showed a declining trend in all treatments (Table 5). The mean values among different treatments ranged from 1.73–2.75 mg/100 g. The

Table 3 Effect of different treatments on total sugars in dried fig during ambient storage

Treat	Storage period (days)							Mean ± S.D.
	0	30	60	90	120	150	180	
T_0	22.60 ± 1.20^{u}	$23.80 \pm 0.90^{r\text{-}u}$	$24.00 \pm 1.00^{r\text{-}u}$	$24.80 \pm 0.80^{n\text{-}t}$	$24.50 \pm 0.70^{o\text{-}u}$	$24.40 \pm 0.90^{p\text{-}u}$	26.20 ± 0.80^{nop}	24.33 ± 1.09^{d}
T_1	3.40 ± 1.30^{tu}	$23.80 \pm 1.00^{r\text{-}u}$	$23.80 \pm 0.90^{r\text{-}u}$	$24.60 \pm 0.90^{o\text{-}t}$	$25.40 \pm 0.52^{n\text{-}s}$	$25.10 \pm 1.00^{n\text{-}t}$	26.40 ± 1.20^{no}	24.64 ± 1.07^{d}
T_2	23.40 ± 1.20^{tu}	$24.00 \pm 1.10^{r\text{-}u}$	$24.20 \pm 0.80^{q\text{-}u}$	$24.20 \pm 0.70^{q\text{-}u}$	$24.20 \pm 1.00^{q\text{-}u}$	$25.00 \pm 0.70^{n\text{-}t}$	26.40 ± 1.30^{no}	24.47 ± 0.97^{d}
T_3	23.60 ± 0.80^{stu}	$24.00 \pm 1.20^{r\text{-}u}$	$24.40 \pm 1.20^{p\text{-}u}$	$24.60 \pm 1.00^{o\text{-}t}$	$25.00 \pm 1.20^{n\text{-}t}$	$25.20 \pm 0.80^{n\text{-}t}$	$26.00 \pm 1.20^{n\text{-}q}$	24.69 ± 0.80^{d}
T_4	23.60 ± 0.90^{stu}	$23.80 \pm 1.30^{r\text{-}u}$	$24.60 \pm 1.30^{o\text{-}t}$	$25.20 \pm 1.30^{n\text{-}t}$	$25.40 \pm 0.90^{n\text{-}s}$	$25.30 \pm 1.10^{n\text{-}t}$	26.20 ± 0.85^{nop}	24.87 ± 0.93^{d}
T_5	$24.20 \pm 0.90^{q\text{-}u}$	$24.40 \pm 0.80^{p\text{-}u}$	$24.60 \pm 1.10^{o\text{-}t}$	$24.90 \pm 0.80^{n\text{-}t}$	$25.60 \pm 0.80^{n\text{-}r}$	26.60 ± 1.20^{n}	26.20 ± 1.00^{nop}	24.87 ± 0.92^{d}
T_6	32.00 ± 0.70^{m}	34.60 ± 1.40^{l}	37.80 ± 1.70^{jk}	41.00 ± 1.50^{hi}	43.60 ± 1.60^{fg}	47.00 ± 1.60^{cd}	50.00 ± 1.50^{ab}	40.86 ± 6.53^{c}
T_7	34.60 ± 1.40^{l}	36.60 ± 1.50^{jk}	40.60 ± 1.80^{i}	42.80 ± 1.40^{fgh}	45.80 ± 1.70^{de}	48.20 ± 1.40^{bc}	51.00 ± 1.60^{a}	42.80 ± 6.00^{b}
T_8	36.00 ± 1.50^{kl}	38.00 ± 1.40^{j}	41.80 ± 1.40^{ghi}	44.00 ± 1.30^{ef}	46.40 ± 1.30^{cd}	49.40 ± 1.50^{ab}	51.30 ± 1.40^{a}	43.84 ± 5.67^{a}
Mean	27.00 ± 5.50^{g}	28.09 ± 6.29^{f}	29.51 ± 7.99^{e}	30.64 ± 9.00^{d}	31.69 ± 10.22^{c}	32.80 ± 11.57^{b}	34.46 ± 12.24^{a}	

LSD: T = 0.72 S = 0.32, TS = 0.91. Values are means of triplicate. The means within the row bearing same letter(s) are statistically significant at $p < 0.05$.

Table 4 Effect of different treatments on titratable acidity in dried fig during ambient storage.

Treat	Storage period (days)							Mean ± SD
	0	30	60	90	120	150	180	
T_0	$0.080 \pm 0.01^{k\text{-}p}$	$0.080 \pm 0.01^{k\text{-}p}$	0.067 ± 0.03^{nop}	$0.068 \pm 0.03^{m\text{-}p}$	$0.096 \pm 0.03^{g\text{-}o}$	$0.090 \pm 0.01^{h\text{-}p}$	$0.090 \pm 0.02^{h\text{-}p}$	0.082 ± 0.01^{e}
T_1	$0.090 \pm 0.01^{h\text{-}p}$	$0.074 \pm 0.03^{l\text{-}p}$	$0.074 \pm 0.03^{l\text{-}p}$	$0.090 \pm 0.04^{h\text{-}p}$	$0.105 \pm 0.05^{e\text{-}l}$	$0.100 \pm 0.05^{f\text{-}n}$	$0.100 \pm 0.01^{f\text{-}n}$	0.090 ± 0.01^{de}
T_2	$0.067 \pm 0.02^{l\text{-}p}$	0.067 ± 0.05^{nop}	$0.098 \pm 0.04^{g\text{-}o}$	$0.101 \pm 0.05^{f\text{-}n}$	$0.103 \pm 0.06^{f\text{-}m}$	0.063 ± 0.04^{op}	$0.080 \pm 0.04^{k\text{-}p}$	0.084 ± 0.01^{e}
T_3	$0.090 \pm 0.01^{h\text{-}p}$	$0.074 \pm 0.03^{l\text{-}p}$	$0.098 \pm 0.06^{f\text{-}o}$	$0.117 \pm 0.04^{d\text{-}j}$	$0.130 \pm 0.01^{c\text{-}g}$	0.150 ± 0.02^{cd}	0.140 ± 0.04^{cde}	0.114 ± 0.03^{c}
T_4	$0.085 \pm 0.02^{i\text{-}p}$	$0.100 \pm 0.01^{f\text{-}n}$	$0.130 \pm 0.02^{c\text{-}g}$	0.160 ± 0.05^{bc}	0.160 ± 0.02^{bc}	0.147 ± 0.04^{cd}	0.203 ± 0.03^{a}	0.141 ± 0.04^{ab}
T_5	$0.123 \pm 0.05^{d\text{-}h}$	$0.120 \pm 0.04^{d\text{-}i}$	0.140 ± 0.03^{cde}	$0.133 \pm 0.03^{c\text{-}f}$	0.160 ± 0.03^{bc}	0.190 ± 0.05^{ab}	0.200 ± 0.01^{a}	0.152 ± 0.04^{a}
T_6	$0.123 \pm 0.03^{d\text{-}h}$	$0.120 \pm 0.03^{d\text{-}i}$	0.140 ± 0.05^{cde}	$0.133 \pm 0.04^{c\text{-}f}$	0.160 ± 0.02^{bc}	0.190 ± 0.02^{ab}	0.200 ± 0.04^{a}	0.086 ± 0.17^{de}
T_7	$0.071 \pm 0.04^{l\text{-}p}$	$0.088 \pm 0.02^{i\text{-}p}$	$0.087 \pm 0.06^{i\text{-}p}$	$0.097 \pm 0.06^{g\text{-}o}$	$0.094 \pm 0.06^{h\text{-}o}$	$0.130 \pm 0.03^{c\text{-}g}$	$0.123 \pm 0.05^{d\text{-}h}$	0.099 ± 0.02^{d}
T_8	$0.084 \pm 0.04^{j\text{-}p}$	$0.109 \pm 0.05^{e\text{-}k}$	0.140 ± 0.04^{cde}	0.140 ± 0.04^{cde}	0.147 ± 0.04^{cd}	0.147 ± 0.41^{cd}	0.140 ± 0.03^{cde}	0.129 ± 0.20^{b}
Mean	0.084 ± 0.01^{e}	0.087 ± 0.02^{e}	0.103 ± 0.03^{d}	0.109 ± 0.14^{cd}	0.119 ± 0.04^{bc}	0.124 ± 0.18^{ab}	0.133 ± 0.05^{a}	

LSD: T = 0.05, S = 0.04, TS = 0.13. Values are means of triplicate. The means within the row bearing same letter(s) are statistically significant at $p < 0.05$.

Table 5 Effect of different treatments on ascorbic acid content in dried fig during ambient storage.

Treat	Storage period (days)							Mean ± SD
	0	30	60	90	120	150	180	
T_0	$2.40 \pm 0.40^{a\text{-}i}$	$2.40 \pm 0.30^{a\text{-}i}$	$2.20 \pm 0.20^{b\text{-}j}$	$2.00 \pm 0.20^{d\text{-}j}$	$1.50 \pm 0.40^{i\text{-}l}$	1.00 ± 0.05^{kl}	0.60 ± 0.30^{l}	1.73 ± 0.71^{d}
T_1	$2.77 \pm 0.70^{a\text{-}e}$	$2.60 \pm 0.36^{a\text{-}g}$	$2.30 \pm 0.23^{b\text{-}j}$	$2.17 \pm 0.58^{b\text{-}j}$	$1.97 \pm 0.58^{d\text{-}k}$	$1.67 \pm 0.35^{g\text{-}k}$	$1.67 \pm 0.29^{g\text{-}k}$	2.16 ± 0.43^{bc}
T_2	$2.60 \pm 0.69^{a\text{-}g}$	$2.20 \pm 0.60^{b\text{-}j}$	$2.20 \pm 0.24^{b\text{-}j}$	$2.00 \pm 0.30^{d\text{-}j}$	$1.70 \pm 0.75^{f\text{-}k}$	$1.60 \pm 0.30^{h\text{-}k}$	1.40 ± 0.05^{jkl}	1.96 ± 0.42^{cd}
T_3	3.07 ± 0.83^{abc}	$2.77 \pm 0.67^{a\text{-}e}$	$2.67 \pm 0.56^{a\text{-}f}$	$2.53 \pm 0.70^{a\text{-}h}$	$2.33 \pm 0.59^{b\text{-}j}$	$2.13 \pm 0.76^{c\text{-}j}$	$2.00 \pm 1.22^{d\text{-}j}$	2.50 ± 0.37^{ab}
T_4	3.13 ± 1.05^{ab}	$2.93 \pm 0.95^{a\text{-}d}$	$2.77 \pm 0.70^{a\text{-}e}$	$2.53 \pm 0.76^{a\text{-}h}$	$2.40 \pm 0.75^{a\text{-}i}$	$2.20 \pm 0.75^{b\text{-}j}$	$2.07 \pm 0.95^{d\text{-}j}$	2.58 ± 0.39^{a}
T_5	3.37 ± 1.06^{a}	3.13 ± 0.97^{ab}	$2.93 \pm 1.05^{a\text{-}d}$	$2.67 \pm 1.01^{a\text{-}f}$	$2.57 \pm 0.86^{a\text{-}h}$	$2.37 \pm 0.75^{b\text{-}j}$	$2.20 \pm 0.92^{b\text{-}j}$	2.75 ± 0.42^{a}
T_6	$2.73 \pm 0.55^{a\text{-}e}$	$2.47 \pm 0.42^{a\text{-}i}$	$2.30 \pm 0.44^{b\text{-}j}$	$2.00 \pm 0.50^{d\text{-}j}$	$1.83 \pm 0.40^{e\text{-}k}$	$1.63 \pm 0.50^{g\text{-}k}$	$1.50 \pm 0.40^{i\text{-}l}$	2.07 ± 0.45^{cd}
T_7	$2.60 \pm 0.40^{a\text{-}g}$	$2.40 \pm 0.30^{a\text{-}i}$	$2.20 \pm 0.20^{b\text{-}j}$	$2.00 \pm 0.30^{d\text{-}j}$	$1.80 \pm 0.50^{e\text{-}k}$	$1.50 \pm 0.30^{i\text{-}l}$	1.00 ± 0.02^{kl}	1.92 ± 0.55^{cd}
T_8	$2.60 \pm 0.50^{a\text{-}g}$	$2.40 \pm 0.40^{a\text{-}i}$	$2.20 \pm 0.60^{b\text{-}j}$	$2.20 \pm 0.60^{b\text{-}j}$	$2.00 \pm 0.25^{d\text{-}j}$	$1.80 \pm 0.60^{e\text{-}k}$	$1.60 \pm 0.30^{h\text{-}k}$	2.11 ± 0.34^{c}
Mean	2.87 ± 0.31^{a}	2.59 ± 0.30^{ab}	2.42 ± 0.29^{bc}	2.23 ± 0.27^{cd}	2.01 ± 0.35^{de}	1.77 ± 0.42^{ef}	1.56 ± 0.52^{f}	

LSD: T = 0.3, S = 0.33, TS = 0.98. Values are means of triplicate. The means within the row bearing same letter(s) are statistically significant at $p < 0.05$.

highest ascorbic acid content was observed in 4, 3, and 2% ascorbic acid treated fruits, respectively, followed by samples treated with KMS. A partially non-significant pattern with lower ascorbic acid values was found in sucrose treated fruit and control. It was revealed that increased ascorbic acid concentration in pretreatments resulted in the escalated ascorbic acid contents in the fig samples. The mean values for ascorbic acid during storage intervals of six month ranged from 2.87–1.56 mg/100 g and the losses were more than 50%. The sensitive nature of ascorbic acid prones it to oxidation which depends upon storage conditions, water activity and oxygen availability[27,28]. Although it depicts good antioxidant activity and protects the commodity from darkening and microbial growth during drying but most of the ascorbic acid content are lost during drying and storage[29,30]. Our results are also in agreement with the previous findings of Mir and Garcia[31,32] who reported losses of ascorbic acid in dried apricot during storage.

The present study revealed that total phenolic contents reduced during storage regardless of treatments (Table 6). Maximum total phenolic contents were found in T_5 (146.19 mg GAE/100 g) followed by T_6 (144.86 mg GAE/100 g), while the minimum was found in T_8 (138.38 mg GAE/100 g). There were significant differences among the storage means and average losses were 8.44% as compared to the initial values. Phenolics have protective act against coronary heart diseases[33] as well as play an important role in controlling the microbial contamination (FDA, 2019). Due to protective act of phenolic content against coronary heart diseases[33], fig fruit is considered the best health promoting fruit. Duenas[34] reported the similar result as shown in this study that total phenolic contents in fig fruit declined during drying as well as with the progression in storage.

Antioxidant activity (in terms of DPPH free radical scavenging capacity of dried fig) revealed a declining trend in all treatments during storage (Table 7). The mean values among different treatments ranged from 27–38.57%. Higher antioxidant activity was observed in T_5, T_4, and T_3 that contained ascorbic acid 4, 3, and 2%, while, lower activity was observed in control followed by treatment with sucrose. The mean values for antioxidant activity during storage reduced from 30.83–35.33% at the end of the storage period. The results showed

Table 6 Effect of different treatments on total phenolic contents in dried fig during ambient storage.

Treat	Storage period (days)							Mean ± SD
	0	30	60	90	120	150	180	
T_0	150.2 ± 1.5^{abc}	$147.3 \pm 1.0^{d\text{-}g}$	$143.3 \pm 1.2^{i\text{-}l}$	141.0 ± 1.3^{lmn}	137.0 ± 1.4^{pqr}	135.0 ± 1.4^{rst}	133.0 ± 1.5^{t}	140.98 ± 6.41^{cd}
T_1	152.0 ± 2.0^{a}	$150.0 \pm 1.9^{a\text{-}d}$	147.0 ± 1.5^{efg}	143.0 ± 1.7^{jkl}	140.0 ± 1.8^{mno}	138.0 ± 1.7^{opq}	137.0 ± 1.6^{pqr}	143.86 ± 5.93^{b}
T_2	$148.1 \pm 1.8^{c\text{-}f}$	$146.0 \pm 1.8^{f\text{-}i}$	$144.0 \pm 1.6^{h\text{-}k}$	42.0 ± 1.8^{klm}	140.0 ± 1.7^{mno}	137.0 ± 1.8^{pqr}	135.0 ± 1.7^{rst}	141.73 ± 4.75^{c}
T_3	$150.0 \pm 1.4^{a\text{-}d}$	$148.0 \pm 1.7^{c\text{-}f}$	$146.0 \pm 1.4^{f\text{-}i}$	$144.0 \pm 1.9^{h\text{-}k}$	142.0 ± 1.2^{klm}	140.0 ± 1.5^{mno}	138.0 ± 1.8^{opq}	144.00 ± 4.32^{b}
T_4	151.0 ± 1.7^{ab}	$149.0 \pm 1.7^{b\text{-}e}$	$146.0 \pm 2.1^{f\text{-}i}$	$144.0 \pm 1.6^{h\text{-}k}$	$141.3 \pm 2.5^{k\text{-}n}$	141.0 ± 1.9^{lmn}	138.0 ± 1.9^{opq}	144.33 ± 4.64^{b}
T_5	152.0 ± 1.8^{a}	$150.0 \pm 1.6^{a\text{-}d}$	$148.0 \pm 2.2^{c\text{-}f}$	$146.3 \pm 2.2^{e\text{-}h}$	$144.0 \pm 1.5^{h\text{-}k}$	143.0 ± 1.6^{jkl}	140.0 ± 1.2^{mno}	146.19 ± 4.18^{a}
T_6	$150.0 \pm 1.9^{a\text{-}d}$	$149.0 \pm 1.5^{b\text{-}e}$	147.0 ± 1.6^{efg}	$145.0 \pm 1.5^{g\text{-}j}$	143.0 ± 2.0^{jkl}	141.0 ± 1.3^{lmn}	139.0 ± 1.3^{nop}	144.86 ± 4.10^{b}
T_7	$145.0 \pm 1.4^{g\text{-}j}$	$144.0 \pm 1.4^{h\text{-}k}$	142.0 ± 1.5^{klm}	$143.3 \pm 4.2^{i\text{-}l}$	138.0 ± 1.3^{opq}	136.0 ± 1.4^{qrs}	135.0 ± 1.0^{rst}	140.48 ± 4.07^{d}
T_8	$144.0 \pm 1.3^{h\text{-}k}$	142.0 ± 1.3^{klm}	140.0 ± 1.8^{mno}	$137.7 \pm 1.4^{o\text{-}r}$	136.0 ± 1.2^{qrs}	135.0 ± 1.0^{rst}	134.0 ± 1.5^{st}	138.38 ± 3.74^{e}
Mean	149.15 ± 2.89^{a}	147.26 ± 2.77^{b}	144.81 ± 2.66^{c}	142.93 ± 2.52^{d}	140.15 ± 2.73^{e}	138.44 ± 2.92^{f}	136.56 ± 2.40^{g}	

LSD: T = 1.03, S = 0.91, TS = 2.37. Values are means of triplicate. The means within the row bearing same letter(s) are statistically significant at $p < 0.05$.

Table 7 Effect of different treatments on antioxidant activity in dried fig during ambient storage.

Treat	Storage period (days)							Mean ± SD
	0	30	60	90	120	150	180	
T_0	30.03 ± 1.25^{nop}	29.00 ± 1.40^{opq}	28.00 ± 1.80^{pqr}	27.00 ± 1.30^{qrs}	26.00 ± 1.20^{rst}	25.00 ± 1.30^{st}	24.00 ± 1.90^{t}	27.00 ± 2.17^{g}
T_1	$37.00 \pm 2.00^{c\text{-}g}$	$35.50 \pm 1.50^{f\text{-}j}$	$35.00 \pm 1.20^{g\text{-}k}$	$34.00 \pm 1.40^{i\text{-}l}$	33.00 ± 1.30^{klm}	32.50 ± 1.50^{lm}	32.00 ± 1.40^{lmn}	34.14 ± 1.80^{c}
T_2	$34.00 \pm 1.50^{i\text{-}l}$	$34.33 \pm 0.72^{h\text{-}l}$	33.00 ± 1.30^{klm}	32.00 ± 1.50^{lmn}	31.00 ± 1.40^{mno}	30.00 ± 1.40^{nop}	29.00 ± 1.50^{opq}	31.91 ± 2.02^{e}
T_3	$36.00 \pm 1.60^{e\text{-}i}$	$35.50 \pm 1.40^{f\text{-}j}$	$35.00 \pm 1.50^{g\text{-}k}$	$34.33 \pm 1.36^{h\text{-}l}$	$34.00 \pm 1.50^{i\text{-}l}$	33.50 ± 1.60^{jkl}	33.00 ± 1.60^{klm}	34.46 ± 1.08^{c}
T_4	39.00 ± 1.70^{abc}	$38.50 \pm 1.50^{a\text{-}d}$	$38.00 \pm 1.60^{a\text{-}e}$	$37.50 \pm 1.00^{b\text{-}f}$	$37.00 \pm 1.60^{c\text{-}g}$	$36.50 \pm 1.00^{d\text{-}h}$	$36.00 \pm 1.60^{e\text{-}i}$	37.50 ± 1.08^{b}
T_5	40.00 ± 1.80^{a}	39.50 ± 1.60^{ab}	39.00 ± 1.70^{abc}	$38.50 \pm 0.50^{a\text{-}d}$	$38.00 \pm 1.80^{a\text{-}e}$	$37.50 \pm 0.50^{b\text{-}f}$	$37.50 \pm 0.87^{b\text{-}f}$	38.57 ± 0.98^{a}
T_6	33.00 ± 1.90^{klm}	32.50 ± 1.40^{lm}	32.00 ± 1.10^{lmn}	31.00 ± 1.60^{mno}	30.00 ± 1.50^{nop}	28.00 ± 1.60^{pqr}	27.00 ± 1.40^{qrs}	30.50 ± 2.29^{f}
T_7	$34.00 \pm 1.20^{i\text{-}l}$	33.00 ± 1.60^{klm}	32.00 ± 1.20^{lmn}	31.00 ± 1.70^{mno}	30.00 ± 1.80^{nop}	29.00 ± 1.70^{opq}	28.00 ± 1.80^{pqr}	31.00 ± 2.16^{ef}
T_8	$35.00 \pm 1.30^{g\text{-}k}$	$34.00 \pm 1.70^{i\text{-}l}$	33.50 ± 1.00^{jkl}	33.00 ± 1.80^{klm}	32.50 ± 1.00^{lm}	32.00 ± 1.80^{lmn}	31.00 ± 1.90^{mno}	33.00 ± 1.32^{d}
Mean	35.34 ± 3.08^{a}	34.65 ± 3.15^{ab}	33.95 ± 3.32^{bc}	33.15 ± 3.50^{cd}	32.39 ± 3.71^{d}	31.56 ± 4.02^{e}	30.83 ± 4.33^{e}	

LSD: T = 0.90, S = 0.80, TS = 2.24. Values are means of triplicate. The means within the row bearing same letter(s) are statistically significant at $p < 0.05$.

a coincidence of antioxidant activity with the reducing trend of phenolic compounds and ascorbic acid during storage. It has been found that antioxidant concentration decreases during storage[6]. The results of present study also agreed with the findings of Patthamakanokporn and Nadheesha[35,36] who reported that during storage of dried fruits the antioxidant activity decreased gradually[37].

Sensory evaluation

The maximum color scores were assigned to the fruit treated with 4% ascorbic acid solution followed by those treated with KMS solution and 3% ascorbic acid, while control set got minimum score (Table S1). The storage also has a considerable impact on the color attribute of dried fig, the initial score of 8.30 decreased to 4.93 at the termination of the experiment. A similar significant ($p < 0.05$) trend in case of flavor was also observed among different treatments (Table S2). Maximum scores were assigned to the samples treated with higher sucrose and ascorbic acid concentrations, followed by NaCl and KMS treated samples. The storage intervals also significantly affected the flavor score and the initial scores decreased towards the end of storage. The score for taste was maximum in sucrose treated figs followed by ascorbic acid treatment and a partially significant trend was found among all treatments (Table S3). The scores for taste also decreased significantly ($p < 0.05$) during storage. The scores for overall acceptability presented in Table 8, demonstrated a partially significant differences among all treatments. The maximum acceptability was retained by 4% ascorbic acid followed by 30% sucrose treated samples, while the minimum score was obtained by a set of the control. Overall acceptability was significantly affected towards the extended storage. Sensory attributes, i.e., color, flavor and taste play a significant role in determining consumer acceptability[38]. These characteristics are affected by different factors, i.e, final moisture content and storage environment. Studies have shown that consumer acceptance decreases with increased storage period as a result of color, flavor and taste deterioration. Among various treatments, ascorbic acid concentrations retained higher acceptability scores, while the remaining treatments showed partially similar results. It was also obvious that the extended storage resulted in poor score for the commodity. Previous research has suggested that

Table 8 Effect of different treatments on overall acceptability (sensory properties) of dried fig during ambient storage.

Treat	Storage period (days)							Mean ± SD
	0	30	60	90	120	150	180	
T_0	8.53 ± 0.50^{a}	$8.00 \pm 0.60^{a\text{-}d}$	$7.00 \pm 0.50^{d\text{-}h}$	$6.00 \pm 0.70^{h\text{-}l}$	5.00 ± 0.60^{lm}	4.00 ± 0.60^{mn}	3.00 ± 0.20^{n}	6.00 ± 2.16^{d}
T_1	8.20 ± 0.40^{abc}	$7.40 \pm 0.40^{b\text{-}f}$	$7.00 \pm 0.40^{d\text{-}h}$	$6.80 \pm 0.80^{e\text{-}i}$	$6.40 \pm 0.70^{f\text{-}j}$	$6.20 \pm 0.80^{g\text{-}k}$	5.40 ± 0.40^{jkl}	6.77 ± 0.90^{bc}
T_2	8.20 ± 0.40^{abc}	$7.60 \pm 0.40^{b\text{-}e}$	$7.00 \pm 0.80^{d\text{-}h}$	$6.80 \pm 0.60^{e\text{-}i}$	5.60 ± 0.60^{jkl}	5.20 ± 0.60^{kl}	5.00 ± 0.80^{lm}	6.49 ± 1.24^{c}
T_3	8.40 ± 1.00^{ab}	$7.60 \pm 0.70^{b\text{-}e}$	$6.80 \pm 0.70^{e\text{-}i}$	$6.20 \pm 0.50^{g\text{-}k}$	$6.00 \pm 0.80^{h\text{-}l}$	$5.80 \pm 0.40^{i\text{-}l}$	5.40 ± 0.60^{jkl}	6.60 ± 1.07^{bc}
T_4	8.40 ± 1.40^{ab}	$8.00 \pm 0.80^{a\text{-}d}$	$7.00 \pm 0.60^{d\text{-}h}$	$6.80 \pm 0.40^{e\text{-}i}$	$6.40 \pm 0.30^{f\text{-}j}$	$6.00 \pm 0.50^{h\text{-}l}$	5.40 ± 0.70^{jkl}	6.86 ± 1.06^{abc}
T_5	8.20 ± 0.40^{abc}	$8.00 \pm 0.60^{a\text{-}d}$	$7.60 \pm 0.50^{b\text{-}e}$	$7.20 \pm 0.50^{c\text{-}g}$	$7.00 \pm 0.70^{d\text{-}h}$	$6.40 \pm 0.50^{f\text{-}j}$	$6.00 \pm 0.60^{h\text{-}l}$	7.20 ± 0.81^{a}
T_6	8.40 ± 0.40^{ab}	$7.60 \pm 0.70^{b\text{-}e}$	$7.20 \pm 0.40^{c\text{-}g}$	$6.80 \pm 0.40^{e\text{-}i}$	$6.40 \pm 0.40^{f\text{-}j}$	$6.20 \pm 0.70^{g\text{-}k}$	$6.00 \pm 0.70^{h\text{-}l}$	6.94 ± 0.85^{ab}
T_7	8.20 ± 1.20^{abc}	$7.20 \pm 0.90^{c\text{-}g}$	$7.00 \pm 0.70^{d\text{-}h}$	$6.40 \pm 0.80^{f\text{-}j}$	$6.20 \pm 0.50^{g\text{-}k}$	5.20 ± 0.40^{kl}	$6.00 \pm 0.90^{h\text{-}l}$	6.60 ± 0.97^{bc}
T_8	8.40 ± 1.30^{ab}	$7.00 \pm 0.60^{d\text{-}h}$	$6.80 \pm 0.60^{e\text{-}i}$	$6.40 \pm 0.60^{f\text{-}j}$	$6.00 \pm 0.40^{h\text{-}l}$	$6.00 \pm 0.60^{h\text{-}l}$	5.00 ± 0.50^{lm}	6.51 ± 1.06^{c}
Mean	8.38 ± 0.25^{a}	7.60 ± 0.36^{b}	7.04 ± 0.24^{c}	6.60 ± 0.37^{d}	6.11 ± 0.70^{e}	5.67 ± 0.75^{f}	5.24 ± 0.93^{g}	

LSD: T = 0.41, S = 0.36, TS = 1.08. Values are means of triplicate. The means within the row bearing same letter(s) are statistically significant at $p < 0.05$.

pretreatment of antioxidant chemicals and additives improves storage life of dried fruits. Our results are also in agreement with Ehabe[39] who established that dipping fruits prior to drying in NaCl and sugar solution improved quality of derived banana figs[39].

CONCLUSION

The study showed a strong potential to increase the shelf life of fig by osmotic dehydration in combination with chemical treatments and drying technique. The results for sensory evaluation of the stored samples revealed that the osmotically dehydrated figs with 30–40% sucrose prior to cabinet drying were given higher scores by panelist. The results of this study can be used at industrial level to enhance shelf life stability of fig. The study results in high quality products and may also lead to substantial energy savings. Postharvest losses can also be reduced by osmotic dehydration. Initial fruit characteristics, i.e., texture, color, aroma and nutritional composition are well retained via this technique. For the development of home-scale industries and self-entrepreneurs, this technology has wider applications. The present study will provide an updated standing on osmotic dehydration and its research breach which is useful for processing industries, research purpose and academia.

Appendix A. Supplementary data

Supplementary data associated with this article can be found at http://dx.doi.org/10.2306/scienceasia1513-1874.2019.45.547.

REFERENCES

1. Stover E, Aradhya M, Ferguson L, Crisosto CH (2007) The fig: overview of an ancient fruit. *HortScience* **42**, 71083–71087.
2. FAO (2015) *Faostat, Agriculture Database*, FAO, available at www.fao.org/faostat/en/.
3. Vinson JA, Zubik L, Bose P, Samman N, Proch J (2005) Dried fruits: excellent in vitro and in vivo antioxidants. *J Am Coll Nutr* **24**, 44–50.
4. Veberic R, Colaric M, Stampar F (2008) Phenolic acids and flavonoids of fig fruit (*Ficus carica* L.) in the northern Mediterranean region. *Food Chem*b**106**, 153–157.
5. Kurubar AR (2007) Studies on integrated nutrient and post harvest management of fig (*Ficus carica* L.), PhD thesis, UAS Dharwad, India.
6. Vinson JA, Proch J, Zubik L (1999) Phenol antioxidant quantity and quality in foods: Cocoa, dark chocolate, and milk chocolate. *J Agric Food Chem* **47**, 4821–4824.
7. Su Q, Rowley KG, Itsiopoulos C, O'Dea K (2002) Identification and quantitation of major carotenoids in selected components of the Mediterranean diet: green leafy vegetables, figs and olive oil. *Eur J Clin Nutr* **56**, 1149–1154.
8. Solomon A, Golubowicz S, Yablowicz Z, Grossman S, Bergman M, Gottlieb HE, Altman A, Kerem Z, et al (2006) Antioxidant activities and anthocyanin content of fresh fruits of common fig (*Ficus carica* L.). *J Agric Food Chem* **54**, 7717–7723.
9. Lianju W, Weibin J, Kai M, Zhifeng L, Yelin W (2003) The production and research of fig (*Ficus carica* L.) in China. In: Corrales ML, Garcia MJB (eds) *ISHS Acta Horticulturae 605: II International Symposium on Fig*, Caceres, Spain, pp 191–196.
10. Naikwadi PM, Chavan UD, Pawar VD, Amarowicz R (2010) Studies on dehydration of figs using different sugar syrup treatments. *J Food Sci Technol* **47**, 442–445.
11. Karabulut OA, Ilhan K, Arslan U, Vardar C (2009) Evaluation of the use of chlorine dioxide by fogging for decreasing postharvest decay of fig. *Postharvest Biol Technol* **52**, 313–315.
12. Hiregoudar S, Nidoni U, Meda V, Gadade S, Patil BV (2006) A study of different drying methods for fig (*Ficus carica* Linn) fruit. In: *ASABE/CSBE North Central Intersectional Meeting*, ASABE, Michigan.

13. Molinu MG, Venditti T, Dore A, D'Hallewin G, Serusi A, Del AC, Agabbio M (2006) Postharvest decay reduction of fig fruit (*Ficus carica*) by hot water sodium carbonate solutions dip. *Commun Agric Appl Biol Sci* **71**, 923–928.
14. AOAC (2000) *Official Methods of Analysis*, 17th edn, The Association of Official Analytical Chemists, Gaithersburg, MD, USA. [Methods 925.10, 65.17, 974.24, 992.16].
15. Lane JH, Eynon L (1923) Methods for determination of reducing and nonreducing sugars. *J Sci* **42**, 32–37.
16. Javed MS, Randhawa MA, Butt MS, Nawaz H (2016) Effect of calcium lactate and modified atmosphere storage on biochemical characteristics of guava fruit. *J Food Process Preserv* **40**, 657–666.
17. Sun T, Xu Z, Wu CT, Janes M, Prinyawiwatkul W, No HK (2007) Antioxidant activities of different colored sweet bell peppers (*Capsicum annuum* L.). *J Food Sci* **72**, 98–102.
18. Brand-Williams W, Cuvelier M-E, Berset C (1995) Use of a free radical method to evaluate antioxidant activity. *LWT-Food Sci Technol* **28**, 25–30.
19. Rousseau B (2004) Sensory evaluation techniques. In: *Handbook of Food Analysis: Physical Characterization and Nutrient Analysis*, 2nd edn, CRC Press, pp 21–37.
20. Steel RGD, Torrie JH, Others (1980) *Principles and Procedures of Statistics, a Biometrical Approach*, McGraw-Hill Kogakusha.
21. Freed R, Eisensmith SP, Goetz S, Reicosky D, Smail VW, Wolberg P (1991) User's guide to MSTAT-C: A software program for the design, management, and analysis of agronomic research experiments. Michigan State Univ East Lancing, MI.
22. Del Caro A, Piga A (2008) Polyphenol composition of peel and pulp of two Italian fresh fig fruits cultivars (*Ficus carica* L.). *Eur Food Res Technol* **226**, 715–719.
23. Ramulu P, Rao PU (2003) Total, insoluble and soluble dietary fiber contents of Indian fruits. *J Food Compos Anal* **16**, 677–685.
24. Slatnar A, Klancar U, Stampar F, Veberic R (2011) Effect of drying of figs (*Ficus carica* L.) on the contents of sugars, organic acids, and phenolic compounds. *J Agric Food Chem* **59**, 11696–11702.
25. Thonta GT, Patil VK (1988) Studies on drying of fig fruits. *Indian Food Pack* **42**, 94–99.
26. Pawar SG, Kulkarni DN, Shere DM, Kulkarni KD, Patil VK (1992) Effect of pretreatments on chemical composition and drying rates of solar dried figs. *Indian Food Pack* **46**, 39–44.
27. Dennison DB, Kirk JR (1982) Effect of trace mineral fortification on the storage stability of ascorbic acid in a dehydrated model food system. *J Food Sci* **47**, 1198–1200.
28. Eison-Perchonok MH, Downes TW (1982) Kinetics of ascorbic acid autoxidation as a function of dissolved oxygen concentration and temperature. *J Food Sci* **47**, 765–767.
29. Lund D (1988) Effects of heat processing on nutrients. In: Karmas E, Harris RS (eds) *Nutritional Evaluation of Food Processing*, Springer, Dordrecht, pp 319–354.
30. Ryley J, Kajda P (1994) Vitamins in thermal processing. *Food Chem* **49**, 119–129.
31. Mir MA, Hussain PR, Fouzia S, Rather AH (2009) Effect of sulphiting and drying methods on physicochemical and sensorial quality of dried apricots during ambient storage. *Int J Food Sci Technol* **44**, 1157–1166.
32. García-Martínez E, Igual M, Martín-Esparza ME, Martínez-Navarrete N (2013) Assessment of the bioactive compounds, color, and mechanical properties of apricots as affected by drying treatment. *Food Bioprocess Technol* **6**, 3247–3255.
33. Hollman PCH, Hertog MGL, Katan MB (1996) Analysis and health effects of flavonoids. *Food Chem* **57**, 43–46.
34. Dueñas M, Pérez-Alonso JJ, Santos-Buelga C, Escribano-Bailón T (2008) Anthocyanin composition in fig (*Ficus carica* L.). *J Food Compos Anal* **21**, 107–115.
35. Patthamakanokporn O, Puwastien P, Nitithamyong A, Sirichakwal PP (2008) Changes of antioxidant activity and total phenolic compounds during storage of selected fruits. *J Food Compos Anal* **21**, 241–248.
36. Nadheesha MKF, Bamunuarachchi A, Edirisinghe E, Weerasinghe W (2007) Studies on antioxidant activity of Indian gooseberry fruit and seed. *J Sci Univ Kelaniya* **3**, 83–92.
37. Puoci F, Iemma F, Spizzirri UG, Restuccia D, Pezzi V, Sirianni R, Manganaro L, Curcio M, et al (2011) Antioxidant activity of a Mediterranean food product: fig syrup. *Nutrients* **3**, 317–329.
38. Ishaq S, Rathore HA, Masud T, Ali S (2009) Influence of post harvest calcium chloride application, ethylene absorbent and modified atmosphere on quality characteristics and shelf life of apricot (*Prunus armeniaca* L.) fruit during storage. *Pakistan J Nutr* **8**, 861–865.
39. Ehabe EE, Eyabi GDE, Numfor FA (2006) Effect of sugar and NaCl soaking treatments on the quality of sweet banana figs. *J Food Eng* **76**, 573–578.

Appendix A. Supplementary data

Table S1 Effect of different treatments on color (sensory properties) of dried fig during ambient storage.

Treat	Storage period (days)							Mean ± SD
	0	30	60	90	120	150	180	
T_0	8.20 ± 0.60^{a}	6.20 ± 0.50^{c-f}	5.40 ± 0.90^{f-j}	4.60 ± 0.20^{jk}	2.80 ± 0.10^{l}	1.60 ± 0.20^{m}	1.20 ± 0.20^{m}	4.29 ± 2.56^{e}
T_1	8.20 ± 0.70^{a}	6.80 ± 0.70^{bcd}	7.20 ± 0.40^{b}	6.80 ± 0.30^{bcd}	6.40 ± 0.35^{b-e}	6.20 ± 0.40^{c-f}	6.00 ± 0.40^{d-g}	6.80 ± 0.74^{a}
T_2	8.40 ± 0.40^{a}	5.40 ± 0.40^{f-j}	5.40 ± 0.60^{f-j}	5.60 ± 0.40^{e-i}	5.60 ± 0.40^{e-i}	5.00 ± 0.50^{h-k}	4.40 ± 0.50^{k}	5.69 ± 1.27^{d}
T_3	8.40 ± 1.10^{a}	6.40 ± 0.60^{b-e}	6.40 ± 0.70^{b-e}	6.20 ± 0.50^{c-f}	6.20 ± 0.70^{c-f}	5.80 ± 0.60^{e-h}	5.40 ± 0.70^{f-j}	6.40 ± 0.95^{b}
T_4	8.40 ± 1.20^{a}	7.00 ± 0.70^{bc}	6.80 ± 0.80^{bcd}	6.80 ± 0.70^{bcd}	6.20 ± 0.17^{c-f}	6.20 ± 0.70^{c-f}	6.00 ± 0.60^{d-g}	6.77 ± 0.81^{a}
T_5	8.20 ± 0.30^{a}	7.20 ± 0.80^{b}	6.80 ± 0.70^{bcd}	7.00 ± 0.80^{bc}	6.80 ± 0.50^{bcd}	6.40 ± 0.40^{b-e}	6.00 ± 0.80^{d-g}	6.91 ± 0.69^{a}
T_6	8.40 ± 0.80^{a}	5.40 ± 0.20^{f-j}	5.60 ± 0.40^{e-i}	6.00 ± 0.40^{d-g}	5.93 ± 0.42^{d-h}	5.20 ± 0.30^{g-k}	5.00 ± 0.40^{h-k}	5.93 ± 1.15^{cd}
T_7	8.20 ± 0.90^{a}	6.00 ± 0.30^{d-g}	5.80 ± 0.50^{e-h}	5.40 ± 0.50^{f-j}	5.60 ± 0.60^{e-i}	5.20 ± 0.40^{g-k}	4.80 ± 0.80^{ijk}	5.86 ± 1.11^{cd}
T_8	8.33 ± 1.50^{a}	5.40 ± 0.50^{f-j}	6.40 ± 0.60^{b-e}	6.00 ± 0.60^{d-g}	5.80 ± 0.40^{e-h}	5.60 ± 0.60^{e-i}	5.60 ± 0.40^{e-i}	6.16 ± 1.01^{bc}
Mean	8.30 ± 0.10^{a}	6.20 ± 0.71^{b}	6.20 ± 0.67^{b}	6.04 ± 0.77^{b}	5.70 ± 1.16^{c}	5.24 ± 1.46^{d}	4.93 ± 1.51^{d}	

LSD: T = 0.37, S = 0.33, TS = 0.98. Values are means of triplicate. The means within the row bearing same letter(s) are statistically significant at $p < 0.05$.

Table S2 Effect of different treatments on flavor (sensory properties) of dried fig during ambient storage.

Treat	Storage period (days)							Mean ± SD
	0	30	60	90	120	150	180	
T_0	8.40 ± 0.70^{a}	7.60 ± 0.50^{ab}	6.13 ± 0.31^{d-i}	4.60 ± 0.40^{kl}	2.80 ± 0.20^{m}	1.60 ± 0.10^{n}	1.20 ± 0.20^{n}	4.62 ± 2.87^{d}
T_1	8.40 ± 0.60^{a}	7.20 ± 0.60^{bc}	6.40 ± 0.60^{c-g}	6.20 ± 0.40^{d-h}	5.80 ± 0.30^{f-j}	5.60 ± 0.40^{g-j}	5.40 ± 0.40^{h-k}	6.43 ± 1.05^{c}
T_2	8.40 ± 0.30^{a}	8.20 ± 0.70^{a}	7.20 ± 0.70^{bc}	6.80 ± 0.60^{b-e}	6.40 ± 0.40^{c-g}	5.00 ± 0.60^{jkl}	4.40 ± 0.50^{l}	6.63 ± 1.51^{bc}
T_3	8.20 ± 0.30^{a}	7.60 ± 0.90^{ab}	7.20 ± 0.40^{bc}	7.00 ± 0.50^{bcd}	6.00 ± 0.70^{e-i}	5.60 ± 0.70^{g-j}	5.20 ± 0.60^{i-l}	6.69 ± 1.11^{bc}
T_4	8.20 ± 0.80^{a}	7.60 ± 0.40^{ab}	7.20 ± 0.50^{bc}	6.60 ± 0.70^{c-f}	6.20 ± 0.80^{d-h}	6.00 ± 0.80^{e-i}	5.40 ± 0.40^{h-k}	6.74 ± 0.98^{abc}
T_5	8.40 ± 0.60^{a}	8.20 ± 0.50^{a}	7.60 ± 0.60^{ab}	7.00 ± 0.60^{bcd}	6.80 ± 0.90^{b-e}	6.00 ± 0.50^{e-i}	5.60 ± 0.70^{g-j}	7.09 ± 1.06^{a}
T_6	8.40 ± 0.70^{a}	7.60 ± 0.60^{ab}	7.00 ± 0.80^{bcd}	6.80 ± 0.40^{b-e}	5.60 ± 0.60^{g-j}	5.20 ± 0.40^{i-l}	5.00 ± 0.30^{jkl}	6.51 ± 1.29^{c}
T_7	8.40 ± 1.00^{a}	7.60 ± 0.70^{ab}	7.00 ± 0.50^{bcd}	6.80 ± 0.70^{b-e}	6.40 ± 0.40^{c-g}	6.20 ± 0.40^{d-h}	6.00 ± 0.60^{e-i}	6.91 ± 0.85^{ab}
T_8	8.40 ± 1.50^{a}	8.20 ± 0.30^{a}	7.60 ± 0.40^{ab}	7.20 ± 0.60^{bc}	6.40 ± 0.50^{c-g}	6.20 ± 0.70^{d-h}	5.60 ± 0.40^{g-j}	7.09 ± 1.06^{a}
Mean	8.36 ± 0.09^{a}	7.76 ± 0.36^{b}	7.04 ± 0.49^{c}	6.56 ± 0.79^{d}	5.82 ± 1.19^{e}	5.27 ± 1.44^{f}	4.87 ± 1.45^{g}	

LSD: T = 0.36, S = 0.32, TS = 0.96. Values are means of triplicate. The means within the row bearing same letter(s) are statistically significant at $p < 0.05$.

Table S3 Effect of different treatments on taste (sensory properties) of dried fig during ambient storage.

Treat	Storage period (days)							Mean ± SD
	0	30	60	90	120	150	180	
T_0	9.00 ± 0.80^{a}	8.40 ± 0.40^{ab}	7.00 ± 0.60^{d-h}	6.80 ± 0.60^{e-h}	6.40 ± 0.70^{f-j}	6.00 ± 0.70^{h-k}	5.60 ± 0.70^{ijk}	7.03 ± 1.25^{ab}
T_1	8.20 ± 0.60^{abc}	7.40 ± 0.50^{b-f}	7.20 ± 0.40^{c-g}	6.80 ± 0.70^{e-h}	6.80 ± 0.80^{e-h}	5.60 ± 0.90^{ijk}	5.00 ± 0.50^{k}	6.71 ± 1.09^{b}
T_2	8.40 ± 0.50^{ab}	8.20 ± 0.40^{abc}	7.00 ± 0.80^{h}	7.00 ± 0.80^{d-h}	6.80 ± 0.90^{e-h}	6.20 ± 0.70^{g-j}	6.00 ± 0.90^{h-k}	7.09 ± 0.92^{ab}
T_3	8.40 ± 0.80^{ab}	7.60 ± 0.60^{b-e}	7.60 ± 0.60^{b-e}	7.20 ± 0.90^{c-g}	6.80 ± 0.60^{e-h}	6.40 ± 0.80^{f-j}	5.40 ± 0.70^{jk}	7.05 ± 0.97^{ab}
T_4	8.40 ± 1.30^{ab}	8.20 ± 0.70^{abc}	7.20 ± 0.40^{c-g}	7.20 ± 0.60^{c-g}	6.60 ± 0.50^{e-i}	6.20 ± 0.40^{g-j}	6.00 ± 0.60^{h-k}	7.11 ± 0.93^{ab}
T_5	8.20 ± 0.80^{abc}	8.00 ± 0.80^{a-d}	7.60 ± 0.50^{b-e}	7.20 ± 0.50^{c-g}	6.80 ± 0.40^{e-h}	6.20 ± 0.30^{g-j}	6.00 ± 0.70^{h-k}	7.14 ± 0.85^{a}
T_6	8.40 ± 0.60^{ab}	8.20 ± 0.70^{abc}	7.60 ± 0.35^{b-e}	7.20 ± 0.40^{c-g}	7.00 ± 0.60^{d-h}	6.80 ± 0.40^{e-h}	6.20 ± 0.60^{g-j}	7.34 ± 0.78^{a}
T_7	8.40 ± 1.10^{ab}	7.60 ± 0.80^{b-e}	7.60 ± 0.45^{be}	7.20 ± 0.60^{c-g}	7.00 ± 0.50^{d-h}	6.80 ± 0.50^{e-h}	6.20 ± 0.80^{g-j}	7.26 ± 0.70^{a}
T_8	8.40 ± 1.40^{ab}	8.00 ± 0.90^{a-d}	7.60 ± 0.40^{b-e}	7.20 ± 0.70^{c-g}	7.00 ± 0.80^{d-h}	6.40 ± 0.60^{f-j}	6.00 ± 0.50^{h-k}	7.23 ± 0.85^{a}
Mean	8.42 ± 0.23^{a}	7.96 ± 0.34^{b}	7.38 ± 0.27^{c}	7.09 ± 0.18^{cd}	6.80 ± 0.20^{d}	6.29 ± 0.38^{e}	5.82 ± 0.41^{f}	

LSD: T = 0.41, S = 0.37, TS = 1.10. Values are means of triplicate. The means within the row bearing same letter(s) are statistically significant at $p < 0.05$.