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STUDIES ON NUTRITIONAL VALUE OF FUNCTIONAL PRODUCTS OF FIG (*FICUS CARICA* L.)

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ABSTRACT

Fig (*Ficus carica* L.) and its functional products are rich source of ascorbic acid, iron, calcium and antioxidant properties. TSS (16.3°Brix), titratable acidity (0.27 %), ascorbic acid (12.84 mg/100 g), total sugars (16.54 %), protein (9.76 %), ash (4.76 %) and total antioxidant activity (72.34 %) were estimated in fresh fig fruits. The fresh fig fruits are an excellent source of calcium (220.56 mg/100 g), potassium (814.75 mg/100 g) and iron (15.70 mg/100 g). The fig fruits were dried in a cabinet drier at 60 ± 5°C for 48 hours. The fig powder showed TSS (48.7°Brix), titratable acidity (0.79 %), ascorbic acid (8.32 mg/100 g), total sugars (61.52 %), reducing sugars (55.41 %), protein (5.26 %), ash (3.80 %) and total antioxidant activity (52.48 %). The fig powder was used for preparing fig chocolate, fig jujube and fig ice cream. Among fig functional products, total sugars was higher in fig ice cream (38.73 %) compared to other fig products. Reducing sugars was higher in fig jujube (28.42 %) compared to fig chocolate (17.53 %) and fig ice cream (16.30 %). The highest iron content of 18.33 mg/100 g was recorded in fig chocolate followed by fig jujube (13.40 mg/100 g). The significantly higher amount of potassium was recorded in fig chocolate (301.17 mg/100 g) followed by fig ice cream (232.11 mg/100 g). Fig jujube scored higher sensory score than other functional products of fig. There is a tremendous potential for fresh fig to be processed into high quality products.
Keywords **:** *Ficus carica* L., fig chocolate, fig jujube, fig ice cream, total sugars, calcium, iron, po

Introduction

Fig, *Ficus carica* L. is one of the nutritious fruit crops. It was originated in Middle East and Western Asia. It is a deciduous and subtropical crop. It grows well in arid and semi-arid regions with high temperature, plenty of sunshine and moderate winter. Being a gynodioecious crop with long styled pistillate flowers, it produces parthenocarpic fruits. Botanically, the fig fruit is called as 'Syconium' a type of multiple fruit which consists of number of flowers inside the fruits and fleshy receptacles. It is largely cultivated in Algeria, Egypt, Spain and Turkey. It is mainly grown in Gujarat, Uttar Pradesh Maharashtra, Karnataka and Tamil Nadu in an area of around 5,803 hectares with the production of 14,646 thousand tonnes (FAO, 2020). It is grouped into four types based on pollination behaviour and sex form of the flower. The commonly grown fig varieties are Poona, Brown Turkey and Mission.

Fig is a source of food during ancient period (Barolo *et al.*, 2014). The fruits are highly valued for their nutraceutical properties and health benefits. The fig fruits help in alleviating various diseases *viz.,* chronic diseases, anti-diabetic, gastrointestinal, anti-tumour, lipid lowering, anti-fungal and anti-ulcer activities. Fresh fruits contain carbohydrates (20 g/100 g), proteins (1.02 g/100 g), calcium (104.2 mg/100 g), iron (0.73 mg/100 g) and fibre (2.10 g/100 g) (Vora *et al.,* 2017). Besides these minerals, figs are also rich source of sugars predominantly fructose and glucose (Genna *et al.,* 2008). The fresh fruits have limited shelf life and usually consumed within three to four days in ambient storage condition. The quality of fruits is affected by microorganisms resulting in huge economic loss (Jusoh *et al.,* 2020). About 70% of fig is consumed as dried fig. The higher nutrient composition is recorded in the dried figs. The dried fig had higher sugar content of 52% (Slatnar *et al.,* 2011) and higher antioxidant capacity compared to fresh fig (Arvaniti *et al.,* 2019). The fig powder prepared from cabinet dried fig is rich in fibre, protein and mineral composition (Khapre *et al.,* 2015). The present research work was conducted to study the nutritional profile of different functional products.

Materials and Methods

Fig fruits were harvested from two-year-old plants grown in fruit block of Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India. The fully matured fig fruits were selected, washed thoroughly by removing dirt and debris present on the fruits. Then, the pedicel of the fruit was removed. The cleaned fruits were pre-treated by dipping in 1 per cent of potassium metabisulphite (KMS) and 1 per cent of citric acid for 30 minutes. The pre-treated fruits were spread in a tray uniformly and dried in a cabinet drier at 60 ± 5 °C for 48 hours. During drying, moisture content was reduced to 20 per cent. The dried fig was ground into fig powder and the same powder was used for preparing different fig functional products namely, fig chocolate, fig jujube and fig ice cream. The experiment was conducted in a completely randomized design.

The fig chocolate was prepared from finely ground fig powder. 10 g of fig powder was mixed with 100 g sugar, 5 g cocoa powder, 30 g milk powder and 10 g butter. The sugar syrup was prepared by mixing sugar in 63 ml of water and boiled at temperature of 115°C for 15-20 minutes. Finally, the chocolate mix was added into the sugar syrup and then it was transferred into chocolate moulds and stored under refrigerated condition.

The fig jujube was prepared from finely ground fig powder. 10 g of fig powder was mixed with 75 g sugar. The sugar syrup was prepared by mixing sugar in 75 ml of water and boiled at a temperature of 112°C for 10-15 minutes. The remaining ingredients such as gelatin (15 g), liquid glucose (5 g), fig powder (10 g) and a pinch of citric acid were added into sugar syrup. The mixture was transfer into chocolate moulds and stored under refrigerated condition.

The fig ice cream was prepared from finely ground fig powder. 50 g of fig powder was mixed with 120 g sugar. The remaining ingredients such as corn flour (12.5 g), gelatin (2.5 g), GMS-Glycerol monosterate (2.5 g), CMC-Carboxy Methyl Cellulose (2.5 g), milk powder (63 g) was added and boiled for 5-7 minutes. This ice cream mix was mixed with liquid glucose (5 g), condensed milk (40 g) and fresh cream (50 g). The mixture was then homogenized and stored under freezer.

Titratable acidity was determined by titrating sample against 0.1N NaOH. Ascorbic acid content was determined by volumetric method. The sample solution was prepared by addition of oxalic acid and starch indicator solution and titrated against the iodine solution till the appearance of dark blue-black colour. The sugar content was determined by Shaffer-Somogyi method (Pickett, 1940). To estimate total sugars, the sample was hydrolyzed by hydrochloric acid, neutralized against sodium hydroxide using phenolphthalein indicator. To estimate reducing sugars, the sample was boiled in clarified water with the addition of lead acetate. The highest amount of lead precipitate was filtered and diluted using potassium oxalate. The protein content was determined by colorimetric technique given in Lowry's method (Ansari *et al.,* 2021). Using a UV spectrophotometer, the absorbance was recorded at 660 nm. The calibration curve approach was used to figure out the unknown sample concentration. Total antioxidant activity was measured by following Brand Williams method (Shehata *et al.,* 2020). 1 M DPPH (2,2-diphenyl 1-1-picryl hydrazyl) was added into the sample and the final volume was made up with methanol and placed in darkness at room temperature for 30 minutes. The absorbance was measured at 517 nm. The ash content was estimated by following AOAC method. In a muffle furnace, the sample was ignited at a temperature around 500-600°C.

The mineral components of fig functional products were determined using inductively coupled plasma–optical emission spectrometer (ICP-OES) at Food quality testing laboratory, Centre for Post-Harvest Technology, Tamil Nadu Agricultural University, Coimbatore. A microwave-assisted digestion process was followed to reduce the digesting time. A mixture of strong nitric acid and hydrogen peroxide (70 % : 30 %) were added into sample. The digestion conditions were followed at 1000 W at 80^{o}C for 5 minutes, 1000 W at 50^{o}C for 5 minutes, 1000 W at 190^{o}C for 20 minutes and 0 W for 30 minutes to cool. After cooling, 70 per cent of concentrated nitric acid made up to 7 ml and dilution was made up with ultrapure deionized water used for analysis of mineral compositions by ICP-OES (Hong *et al.,* 2019).

The fig powder incorporated products were evaluated by a panel of 25 persons on a sensory rating of 9 hedonic scores for the attributes of appearance, colour, texture, flavor and overall acceptability. A score of 5.5 or above was recognized as acceptable (Jain and Khurdiya, 11). The data were statistically analysed for analysis of variance (ANOVA) suggested by Snedecor and Cochran, (1994).

Results and Discussion

The dehydrated fig showed 5 pH, 0.69 % titratable acidity, 48^{o}Brix TSS, 8.34 mg/100 g ascorbic acid, 45.38 % total sugars, 40.17 % reducing sugars, 78.13 % total antioxidant activity, 9.76 per cent protein content and 2.43 per cent ash content. The functional products of fig (Fig.1.) showed high nutritional value. pH, total soluble solids, titratable acidity and ascorbic acid of fresh fig and functional products are given in Table 1. Among functional products of fig, higher TSS was recorded in fig ice cream (51.2^{o}Brix) whereas lower TSS (35.48^{o}Brix) was recorded in fig jujube. The addition of sugar increased TSS in ice cream (Caliskan and Polat, 2008). The titratable acidity was higher in fig powder (0.79 %) and lower in dried fig (0.69 %). The titratable acidity of 1.40 % in fig powder was reported by Khapre *et al.,* (2015). The loss of ascorbic acid occurs during dehydration (Piga *et al.,* 2004). Among products tested, the ascorbic acid was higher in fig ice cream (9.34 mg/100 g) compared to other fig products.

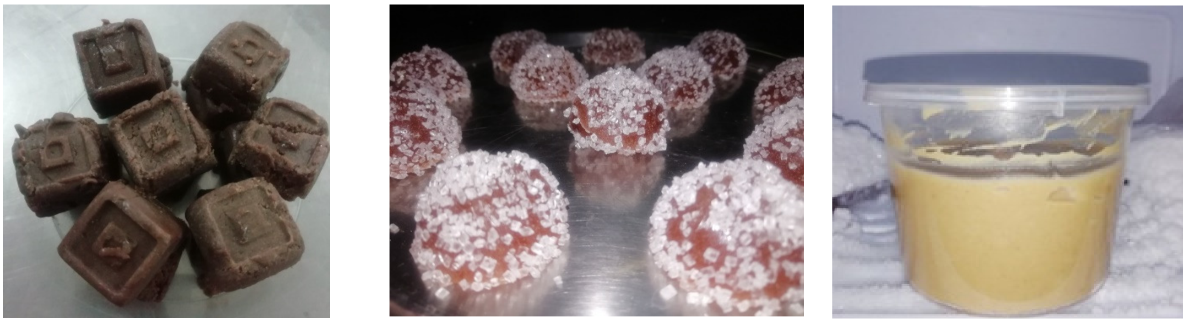

Fig chocolate **Fig jujube** **Fig ice cream**

Fig. 1 : Function products of fig

The highest total sugar content was recorded in fig powder (61.69 %). The high sugar content in dried fig was also reported by Khairuddin *et al.* (2017). Among functional products of fig, higher total sugars were recorded in fig ice cream (48.73 %) compared to other fig products (Fig.2). Total sugars, invert sugars, acidity and melting of ice cream was positively affected by addition of pekmez (Temiz and Yeşilsu, 2010). The antioxidant activity was higher in dried fig (78.13 %) than fig jujube (38.45 %) (Fig.3). The higher total antioxidant activity of dried fig (75.83 %) was reported by Abul-Fadl *et al.* (2015) and might be due to the accumulation of phenolic compounds and flavonoids during dehydration. The highest protein content was recorded in the dried fig (9.76 %) followed by fig chocolate (7.78 %) (Fig.4). Andreou *et al.* (2021) reported that protein content of dehydrated fig (9.33 %) might be due to protein rich seeds of fig. The highest ash content was recorded in fig powder (3.80 %) followed by dried fig (2.43 %) (Fig. 5).

Table 1 : pH, TSS (^{o}Brix), titratable acidity (%) and ascorbic acid (mg/100 g) in fresh and functional products of fig

S.No.	Products	PH	TSS (^{o}Brix)	Titratable acidity (%)	Ascorbic acid (mg/100 g)
1.	Fresh fig	4.60	16.3	0.27	12.84
2.	Dried Fig	5.00	48.0	0.69	3.84
3.	Fig powder	5.05	48.7	0.79	8.32
4.	Fig chocolate	5.18	38.3	0.57	8.61
5.	Fig jujube	5.07	35.5	0.59	7.49
6.	Fig ice cream	6.14	51.2	0.63	9.34
	Mean	5.17	39.7	0.59	8.41
	CD (0.05)	0.29	3.44	0.04	0.63

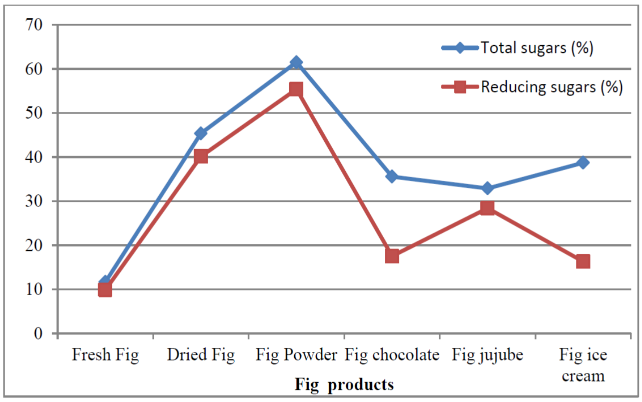

Fig. 2 : Total sugars (%) and reducing sugars (%) of fresh and functional products of fig

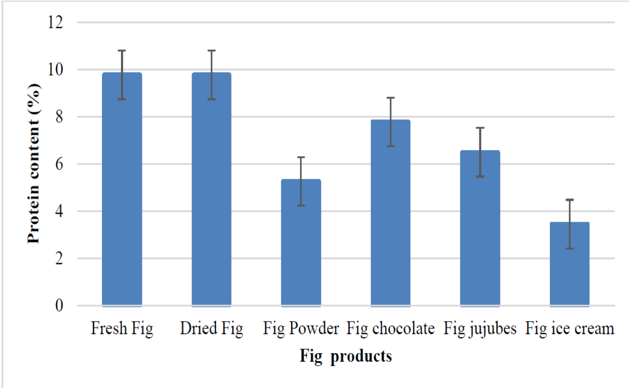

Fig. 4 : Protein content (%) of fresh and functional products of fig

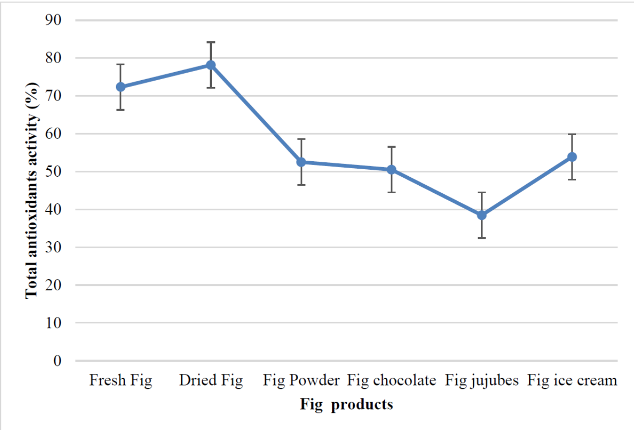

Fig. 3 : Total antioxidant activity (%) of fresh and functional products of fig

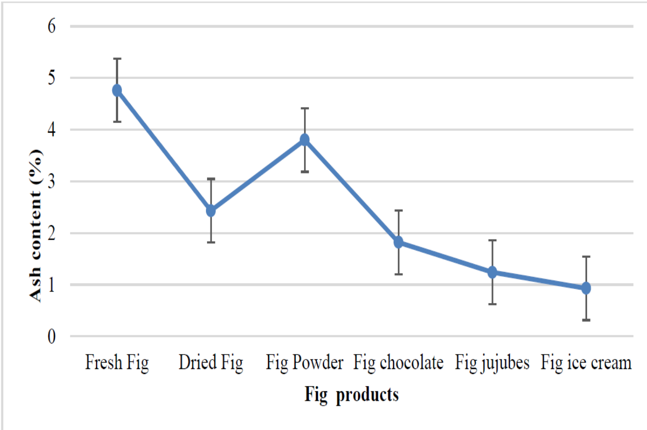

Fig. 5 : Ash content (%) of fresh and functional products of fig

The dried fig powder incorporated fig products showed significant differences in nutrients (Table 2). The highest calcium content was recorded in dried fig (147.72 mg/100 g) followed by fig chocolate (131.03 mg/100 g). The calcium content was lower in fig jujube (35.55 mg/100 g). The dried fig contained significantly higher amount of potassium (697.19 mg/100 g) followed by fig chocolate (301.17 mg/100 g) and fig ice cream (232.11 mg/100 g). The highest iron content of 18.33 mg/100 g was recorded in the fig chocolate followed by dried fig (14.83 mg/100 g). Dark chocolates containing 90% cocoa powder are excellent source of magnesium, iron, zinc and selenium (Cinquanta *et al.,* 2016).

Table 2 : Nutritional profile of fig functional products

S.No.	Products	Calcium (mg/100g)	Potassium (mg/100g)	Iron (mg/100g)
1.	Fresh Fig	220.56	814.75	15.70
2.	Dried Fig	147.72	697.19	14.83
3.	Fig chocolate	131.03	301.17	18.33
4.	Fig jujube	35.55	85.86	13.40
5.	Fig ice cream	119.45	232.11	4.42
	Mean	108.43	329.08	12.74
	SEd	2.85	6.08	0.26
	CD (0.05)	6.58	14.03	0.60

The sensory evaluation of functional products prepared from fig powder (Table 2). Among functional products, fig jujube was superior with the highest overall acceptability 7.89 out of 9 sensory score followed by fig chocolate (6.85).

Table 3 : Sensory evaluation of functional products of fig fruits

S.No.	Fig products	Colour and appearance	Texture	Taste	Flavour	Overall acceptability
1.	Fig chocolate	7.50	6.60	6.20	7.10	6.85
2.	Fig jujube	8.30	7.40	7.60	8.20	7.87
3.	Fig ice cream	6.00	6.10	5.30	6.50	5.97
	Mean	7.26	6.70	6.36	7.26	6.89
	SEd	0.09	0.18	0.14	0.11	0.08
	CD (0.05)	0.22	0.44	0.34	0.28	0.21

Conclusion

The high nutritional value and antioxidant of fig functional products hold an important component in making confectionery. There is a tremendous potential for fresh fig to be processed into high quality products such as dried fig, fig chocolate, fig jujube and fig ice cream retaining a lot of the nutritional and antioxidant benefits. The production of functional products of fig is predicted to increase globally, demanding new markets for introducing fig into various dietary food products.

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