J Krishi Vigyan 2018, 6(2) : 187-192 DOI : 10.5958/2349-4433.2018.00032.6

Physico-chemical Attributes of Brown Turkey Fig

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ABSTRACT

The Brown Turkey cultivar was introduced in 2013 for cultivation in Punjab, India. Study was undertaken to know about the effect of change in cultivation area on physico-chemical attributes. The fruit being a soft skinned, highly perishable needs packaging interventions to extend its shelf life to be consumed in its fresh state. Brown Turkey fig had an average weight of 25.97g, fruit length 38.31mm, thickness 31.87mm, breadth 36.18mm and geometric mean diameter 35.31mm. The fruit of Brown Turkey is spherical in shape with high antioxidant activity and a good source of macro and trace minerals.

Key Words: Brown Turkey, Ficus carica, Physical properties, Chemical properties, bioactive compounds.

INTRODUCTION

Fig (*Ficus carica* L.) is an ancient crop cultivated in the Mediterranean region and belongs to the mulberry family (Moraceae); which is one of the largest genera of angiosperms (Marpudi *et al,* 2013). *F. racemosa, F. elastic, F. carica* and *F. bengalensis* are the species of Ficus grown in India (Soni *et al,* 2014). Turkey is world's largest producer of figs with annual production of 274,535 MT followed by Egypt, Algeria, Morocco, Iran, Syrian Arab Republic, USA, Brazil, Albania and Tunisia (Anon, 2017).

In India, Fig is grown in Maharashtra, Gujarat, Uttar Pradesh, Karnataka, Punjab and Tamil Nadu as a minor fruit crop (Naikwadi *et al,* 2010). Twenty different types of fig varieties are grown worldwide. In India, "Poona Fig" variety is cultivated and is consumed in fresh form whereas a newly developed variety named "Dinkar" has been introduced for cultivation (Marpudi *et al,* 2013).

The fruits of ficus vary in size, with deep coloured ribs and a medium sized eye. The skin of the fruit shows a prominent purplish brown hue which goes lighter towards the stem. Flesh is pinkish brown with an excellent flavour. Maturation time ranges from last week of May to end June. Fruits are harvested by hand and a precaution should be taken during harvesting; pickers should wear gloves and protective clothing, as the latex oozing from the detached end of the fruit can cause skin irritation. Since fresh produce is very delicate, extra care is required in handling and transportation of fruits. Fruits should not be packed in the carton in more than two layers.

Figs are a great source of minerals, vitamins, amino acids, crude fibres, carotenoids, antioxidants, phenolic compounds and various other compounds like arabinose, b-amyrins, glycosides etc. Phenolic compounds are mainly of two types: phenolic acids and flavonoids (Kojic *et al,* 2011 and Soni *et al,* 2014). Darker variety of figs like Mission and the red Brown-Turkey varieties contain higher levels of flavonoids, anthocyanin and polyphenols, along with higher antioxidant activity as compared to lighter skin varieties (Altuki, 2013).

Brown Turkey, a new variety of fig, suitable for cultivation in sub-mountain and central zone of Punjab was introduced from Indian Institute of Horticultural Research, Banglore. Fruits have short neck, purple brown skin and pinkish brown flesh with excellent flavour. This study was to understand the shape and size dynamics of the fruit to evaluate

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physico-chemical attributes in order to design the suitable packaging material for minimizing losses during handling and transportation.

MATERIALS AND METHODS

Fruits of Brown Turkey cultivar were obtained from the Department of Fruit Science, Punjab Agricultural University, Ludhiana during the year 2016.

Physical Attributes

A total number of 50 fruits were analysed for the following parameters. Mass of the individual fruit was determined by using electronic weighing balance with 0.1g sensitivity.

Geometric properties: For each fig fruit Geometric properties were determined by using digital vernier calliper (Mitutoyo, model Absolute Digimatic, Japan) precision 0.01mm. Diameter (b), equatorial width (t) and perpendicular to diameter and equatorial width (l) were estimated (Fig1).

The geometric, arithmetic and harmonic mean diameters and spherecity were calculated (Mohsein, 1980) by using the following equations:

Geometric Mean Diameter, Dg= (btl)1/3……..(i)

Arithmetic Mean Diameter, Da= (b+t+l)/3……(ii)

Harmonic Mean Diameter, Dh= n/ (1/b+1/t+1/l). (iii)

Spherecity, φ= Dg/b……. (iv)

Surface Area: The surface area was calculated on the basis of geometric mean diameter of the fruit.

$S_f=\pi(Dg)^2$…..(v)

Where Dg is the geometric mean diameter

Specific surface area: Specific surface area was estimated by using the following equation given by Rich and Teixeira, 2005.

$S_{sf}=S_{f.\ b} / M_{uf}$….(vi)

Where, S_{sf} = Specific area of the unit fruit (mm^2/cm^3)

$M_{u,F,}$ = Mass of one unit of fruit(g)

$\rho_{b,F,}$ = Bulk density of fruits(g/cm^3)

Chemical Attributes and Bioactive Components

Chemical attributes were estimated from pulp of the fruit, which was obtained by macerating fruit so as to obtain a uniform sample followed by storing under refrigerated conditions. Moisture content, total soluble solids, titrable acidity, crude protein content, ash content, crude fiber, ascorbic acid content and fat content were estimated by standard AOAC (2000) methods.

Mineral content: Minerals in the sample were estimated by thermo electron inductively coupled plasma atomic emission spectrometry (ICP - AES), model ICAP – 630 (Arora and Bajwa, 1994).

Total carotenoids: Total carotenoids were estimated by grinding sample in pestle and mortar with acetone. Extract was filtered and transferred to separatory funnel containing 40 ml petroleum ether. Acetone was removed through slow addition of distilled water and aqueous phase was discarded and volume was made up by petroleum ether. Absorbance of the sample was noted at 450 nm (Carvalho *et al,* 2012). The total carotenoid content was calculated using the following formula:

$$\text{Total Carotenoid } (\mu g/g) = \frac{A \times V \times 10^4}{CE \times P}$$

Where, A = Absorbance

V = Total extract volume (ml)

P = sample weight (g)

CE =2592 (β-carotene Extinction Coefficient in petroleum ether).

Total anthocyanins: For the evaluation of total anthocyanin content 2 g of the sample was ground in pestle and mortar using ethanolic hydrochloric acid. Filtration of the extract was done followed by volume make up to 25 ml using ethanolic hydrochloric acid. Absorbance of the sample was read at 535 nm (Ranganna, 1986) using blank as ethanolic hydrochloric acid. Total anthocyanin content can be calculated by using the formula:

$$\text{Total absorbance per 100 g} = \frac{\text{Absorbance of sample x Volume made x 100}}{\text{Weight of sample}}$$

$$\text{Total anthocyanin (mg/100g)} = \frac{\text{Total absorbance per 100 g}}{98.2}$$

Total flavonoids content: Total flavonoids content was assessed by aluminium chloride calorimetric method (Sakhale *et al*., 2015). Methanolic extract of the sample was prepared. 0.5 ml of aluminium chloride solution was added to the sample along with 1M potassium acetate. Mixture was incubated at room temperature for 30 min and absorbance was measured at 415 nm (UV-VIS spectrophotometer). Quantification of flavonoids was done from standard quercitin curve and results were expressed as mg quercitin equivalent per 100 g.

Total phenols: A methanolic extract of the sample was prepared. Extract was taken along with folin ciocalteau reagent and 4 ml of saturated sodium carbonate solution. Mixture was incubated for 15 minutes and absorbance was read at 765 nm (Kojic *et al*., 2011) and results were expressed as gallic acid equivalent in mg/ 100 g. Formula used is given below:

$$\text{Total phenol (µg/100ml)} = \frac{\text{Concentration of phenol from graph x Final volume x 100}}{\text{Weight of sample x Volume of sample taken}}$$

Antioxidant activity: Antioxidant activity was evaluated by taking methanolic extract to which TRIS buffer and DPPH (1, 1 – diphenyl – 2 - picrylhydrazyl) reagent were added and absorbance of the sample was noted at 517 nm (Harzallah *et al*., 2016). The per cent inhibition activity was calculated using the following formula:

$$\text{Inhibition activity (\%) (Per 100 g sample)} = \frac{A_{control} - A_{sample} \times 100}{A \text{ control}}$$

RESULTS AND DISCUSSION

Physical attributes

The fresh Brown Turkey figs had an average weight of 25.97 g with a great variation in its maximum (39.635 g) and minimum (12.816 g) values (Table 1). Brown Turkey fig from an orchard in Madera County, CA, when harvested at commercial maturity stage exhibited an average weight of 44.3 g whereas at tree ripe stage it was found to be 52.2 g as reported by Crisosto *et al* (2010). An average weight of 35.43 g was reported for fig fruit for Siah Lorestan cultivar by Shahbazi and Rahmati (2012). The breba crops of Brown Turkey grown in Spain had mean mass values of 117.5 g (Pereira *et al,* 2017).

Shahbazi and Rahmati. (2012) recorded lower value for average length as 32.072 mm for the Siah Lorestan cultivar obtained from Lorestan province, Iran, as compared to Brown Turkey fig variety but the average width (43.086 mm) and thickness (40.179 mm) were greater than that of Brown turkey (36.18 mm and 31.87 mm) grown here. Chauhan *et al* (2015) reported average length of 15.46 mm and width of 18.14 mm for ripened figs grown in Bilaspur, HP, India.

Other parameters like geometric mean diameter, surface area, arithmetic mean, harmonic mean and specific area were recorded as 35.31 mm, 3944.52 cm2, 35.45 mm, 35.17 mm and 103.25 mm2. The sphericity of fig fruit varied between 82 to 99 per cent. These higher values of sphericity reveal that the Brown Turkey cultivar of fruit is most likely to roll than slide on flat surfaces. Sphericity value is essential in designing separation and sizing equipment. Geometric mean diameter is used for grading of fruit on the basis of size, sphericity helps in estimating the shape of the fruit and surface area deals with the amount of packaging material that would be required for wrapping the fruit.

Chemical attributes

The moisture content, total soluble solids and titrable acidity of Brown Turkey were found to be 80.70 per cent, 17° Brix and 0.29 per cent respectively (Table 2). Similar results were reported by Sakhale *et al*., 2015. The 'Poona cultivar' of fig exhibited TSS of 16° Brix and acidity of 0.25%

Table 1. Physical characteristics of Brown Turkey Fig. (N=50).

Sr. No.	Parameter	Average	Maximum	Minimum	Standard deviation
1.	Weight (g)	25.97	39.635	12.816	6.07
2.	Length (mm)	38.31	48.23	28.86	3.88
3.	Thickness (mm)	31.87	39.38	24.07	2.81
4.	Breadth (mm)	36.18	49.94	27.88	3.75
5.	GMD (mm)	35.31	41.29	30.55	3.00
6.	Sphericity	0.92	0.99	0.82	0.03
7.	Surface area (cm2)	3944.52	5355.06	2931.57	668.64
8.	Arithmetic mean (mm)	35.45	41.17	28.7	3.06
9.	Harmonic mean (mm)	35.17	41.04	28.68	2.96
10.	Specific area (mm2)	103.25	137.16	89.48	74.84

(Sakhale *et al,* 2012).

TSS: Acid ratio was found to be 58.6 which was at par with the Brown Turkey when harvested at their commercial maturity stage (Crisosto *et al,* 2010). The crude fibre was found to be 9.03 per cent which was higher than that reported by Pereira *et al,* 2017. Ascorbic acid content of 5.00 mg/100 g in Brown Turkey fig was found to be conformation with Sakhale *et al* (2015).

Antioxidant compounds are those which prevent oxidation of other molecules like fat present in food. Primary antioxidants mainly include phenolic compounds which further consist of flavonoids and carotenoids (Youssef, 2014). Antioxidants in terms of per cent inhibition activity per 100 g in Brown Turkey were calculated as 9444.44 whereas antioxidant capacity in Brown Turkey cultivar grown in Madera County, CA, was reported as 1.73

Table 2. Chemical composition and bioactive compounds of fresh Brown Turkey Fig.

Sr. No.	Parameter	Amount
1.	Anthocyanin content (mg/100g)	9.651
2.	Antioxidant activity (per cent inhibition activity/100g)	9444.44
3.	Ascorbic acid (mg/100g)	5.00
4.	Ash content (%)	4.16
5.	Crude fiber (%)	9.03
6.	Fat content (%)	0.62
7.	Moisture content (%)	80.70
8.	Protein content (%)	2.48
9.	Titrable acidity (%)	0.29
10.	Total carotenoids (mg/100g)	0.237
11.	Total flavonoids (mg/100g)	25.41
12.	Total phenols (GAE mg/100g)	577.61
13.	Total soluble solids (°Brix)	17°
14.	TSS:Acid	58.6

µmol TE/g by Crisosto *et al* (2010). Total phenolic content of fresh Brown Turkey fig in terms of gallic acid equivalent was found to be 577.61 GAE mg/100 g. Anthocyanins are the flavonoids which are present as coloring matter in the horticultural produce, Kumar and Pandey (2013). Anthocyanins and total flavonoids content in Brown Turkey were estimated as 9.651 mg/100 g and 25.41 mg/100 g. Harzallah *et al* (2016) reported total anthocyanin content of 162 mg cyanidin-3-glucoside/100g in pulp of Hamri variety and 344.89 mg cyanidin-3-glucoside/100g in pulp of Bidhi variety grown in Tunisia.

Mineral Composition: On comparing mineral composition of Brown Turkey cultivar to other tropical fruits it could be derived that fig contains all the essential minerals in appreciable amounts than other fruits (Table 3). Calcium content (213.7 mg/100g) of fig was much higher than Pineapple (15mg/100g), Mango (18.2mg/100g), Pomegranate (30 mg/100g) and Plum (20mg/100g). Calcium intake is important for prevention of osteoporosis, bone growth during adolescence stage and in post-menopausal women (Hess *et al,* 2016). Similarly Magnesium (116.7 mg/100g) was found to be on higher side when compared to other fruits like Pineapple (42 mg/100g), Mango (25.5 mg/100g), Pomegranate (12 mg/100g) and Plum (9.8 mg/100g) (Paul and Shaha, 2004). Magnesium is considered to be beneficial in treating various diseases like Alzheimer, dementia, migraine, stroke, blood pressure and diabetes (Volpe, 2013). Similar trend in potassium concentration could be observed, where higher amount was found in Brown Turkey fig that is 615.4 mg/100g and other tropical fruits like Pineapple, Mango, Pomegranate, Orange and Plum contain 228 mg/100g, 200 mg/100g, 171 mg/100g, 99.4 mg / 100g and 129 mg /100g (Paul and Shaha, 2004). High Sodium diet has an adverse effect on the blood pressure levels and cardiovascular health and is not considered good in diet (Ha, 2014). The sodium content of Brown Turkey found to be 14.46 mg/100g which was less than the other tropical fruits (Jahan *et al,* 2011). Apart from these minerals fig is a good source of trace minerals like Zinc (1310 µg/100 g), Manganese (631 µg/100 g) and Copper (444.5 µg/100 g). Soni *et al* (2014) reported that dried fig is a good source of minerals like Strontium (saturated), Calcium (1545.46 ppm), Magnesium (679.04 ppm), Phosphorus (365.75 ppm) and Iron (29.49 ppm).

CONCLUSION

Brown Turkey cultivar has average weight 25.97 g, average length 38.31 mm, geometric mean diameter 35.31 mm and sphericity 0.9. The chemical composition of Brown Turkey cultivar showed that it is good source of crude fibre, and ascorbic acid and contains lower amount of fat. It contains appreciable amounts of bioactive compounds like anthocyanins, antioxidants, phenolic compounds and flavonoids and is a mineral rich fruit containing many macro and micro minerals like Calcium, Potassium, Magnesium, Iron, Copper, and Manganese etc. in appreciable amounts.

Table 3: Mineral composition of Brown Turkey fig (on dry basis)

Macro Minerals	Amount (per 100 g)	Trace Minerals	Amount (per 100 g)
Calcium (mg)	213.7	Zinc (µg)	1310
Potassium (mg)	615.5	Copper (µg)	444.5
Magnesium (mg)	116.7	Manganese (µg)	631
Iron (mg)	16.09	Boron (µg)	1415
Phosphorus (mg)	131.6	Chromium (µg)	46.5
Sodium (mg)	14.46	Nickel (µg)	74.5

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Received on 06/11/17 *Accepted on 15/12/17*