Biological Forum – An International Journal **14(3): 532-537(2022)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Evaluation of Quality Attributes in Fresh Fig (*Ficus carica* L.) Fruits

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(Received 19 May 2022, Accepted 14 July, 2022)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: In the present study, the quality characteristics of fresh fig cultivars namely, Afghan, Brown Turkey and Deanna were evaluated for quality attributes. Physiological and physicochemical parameters were analysed for the fresh fruits and the findings were compared among the three varieties. The highest moisture content (82%), TSS (13. 5°Brix), protein (2.8 g/100g), titratable acidity (0.69%), vitamin C (8 mg/100g), antioxidant capacity (66%), total phenols (558 GAE mg/100g) and anthocyanin pigment (0.56 mg/100g) were observed in the cultivar Brown Turkey. Significant differences among fig cultivars were found in most of the parameters, in which Afghan cultivars recorded medium quality and Deanna recorded low quality attributes compared to Brown Turkey cultivar. The evaluation of high quality attributes in the fig fruit varieties indicated that it has to exploited by producing by-products or value-added products without draining any properties due to the effect of less shelf life of fig fruits.

Keywords: *Ficus carica,* Cultivars, quality attributes, physiological, physicochemical parameters.

INTRODUCTION

Fig (*Ficus carica* L.) belongs to Moraceae family, originated from Western Asia, and cultivated all over the world. Fig is a forbidden fruit and commonly known as Anjeer. The Genus *Ficus* includes more than 1000 species out of which about 65 species are found in India. The total area cultivated in India is around 5600 ha and production accounts for 13,802 thousand tonnes, *i.e*., cultivation of fig is about 12.32 tonnes per hectare. Fig is cultivated in Gujarat, Uttar Pradesh, Maharashtra, Karnataka and Tamil Nadu (Lokappa *et al.,* 2018).

Fig trees are normally deciduous and fruit is gynodioecious in nature. The type of fig is a multiple fruit, phytologically known as 'Syconium'. It consisting of fleshy receptacle with a narrow fenestration at the tip. Fig fruits are extremely perishable, contains sweet crunchy seeds (Stover *et al.,* 2007). Fruits are classified into four types namely Edible fig, Smyrna, San Pedro and Capri fig in which number of cultivars were botanically described in different shapes and colours. The edible fig is a parthenocarpic fruit which is consumed by the people in the world as common fig *e.g*., Poona fig, Brown Turkey, etc. (Stover *et al.,* 2007).

Brown Turkey fruits are medium to large pyriform in shape, without neck, copper coloured with few seeds. The cultivar is well adapted to warm climate (Hiwale *et al.,* 2015). Deanna cultivar is best suitable for preparing juice. It has bigger-size fruits compared to other cultivars. TSS is 22.8–25.0 %, acidity 0.11–0.16 %, skin 12.0%, pulp 82.0%, fruit weight 60–75 g, and calories 75 and golden yellow in colour (Hiwale *et al.,* 2015).

Fig is highly rich in phytonutrients, antioxidants, vitamins and minerals as a natural health benefit source (Ersoy *et al.,* 2015). It also has many medicinal properties such as treatment for skin infections, laxative property, reducing risk for chronic diseases, cancer prevention, regulates blood pressure and manages diabetes (Lansky *et al.,* 2008). Fig fruits can be consumed in both fresh and dried form. The edible portion of fig fruit is fleshy receptacle. The sugar content in fresh fig is 16% and in dried fig is 52% (Slatnar *et al.,* 2011).

There is a significant lack of research about the phytochemicals of fig in different cultivars and as a result, its use is still under investigation. It is necessary to study these nutritional contents to identify in different cultivars. The aim of this study was to determine differences in the physico chemical properties of the cultivars 'Afghan', 'Brown Turkey' and 'Deanna'.

MATERIALS AND METHODS

Fig (*Ficus carica* L.) fruits for the experiment were harvested from two year old trees grown in Arid Zone Fruit Block, TNAU, Coimbatore. Three fresh fig cultivars were harvested namely, Afghan, Brown Turkey and Deanna at proper maturity stage.

Sample preparation. Fig is a climacteric fruit and the shelf life of the fruits is very less. Hence, the fruits are harvested at early maturity stage. Maturity indices of fig is opening of ostiole and the disappearance of milky latex.The fruits which are still attached to the tree were handpicked and collected into a clean plastic bag. Each fig cultivar was evaluated for initial quality attributes of the harvested fresh fruits.The fresh fig fruits were cleaned and packed in a polyethylene film and stored in refrigerated condition at 4°C for conducting physical properties and physicochemical properties.

Quality evaluation. The quality evaluation of a sample is categorised into two *viz*., physiological parameters and physicochemical parameters. Physiological parameters included moisture content (%), fruit colour (L*,a*, b*, h* and C*), TSS (°Brix) and in physicochemical parameters included pH, acidity (%), total sugars (g/100g), protein (g/100g), vitamin C (mg/100g), antioxidant (%), total phenols (GAE mg/100g), anthocyanin (mg/100g).The parameters were determined in all the three varieties individually to assess the quality attributes of freshly harvested fruits.

Physiological parameters

Moisture content. Moisture content of the fruit is most important parameter, which affects the quality, value and freshness of the fruits. Moisture content of fig fruits was determined through dehydration process in dry basis method *i.e*., freshly harvested fruits were weighed and kept in a hot air oven at 105°C for 12hrs, the dried fruits were weighed and the moisture content is calculated. The percentage equivalent of the ratio of the weight of water (W_w) to the weight of the dry matter (W_d) described as dry basis moisture content (M_d). (Amer *et al.,* 2003)

Fruit colour. Fig fruits varies in pulp and skin colour based on different cultivars. The colour of fruit pulp and skin was measured using the instrument Tintometer. Colour of fruits was measured at four points, two opposite around the pedicel and two opposite around the ostiole, from the start to change during ripening. The colour development value was expressed as L*, a*, b* respectively and L* value represents lightness L* = 0 (black) to L* = 100 (white), a* value points range between green and red, which changes from –a (greenness) to + a (redness) and b* values point range between blue and yellow, which changes from -b(blueness) to +b(yellowness). Chroma (C*) means colour intensity or saturation. Hue angle (actual colour, being green, yellow-green, yellow–red, purple-black or red–black) (Karantzi *et al.,* 2021).

TSS. Total soluble solids (TSS) or Soluble solid contents (SSC) were determined by extracting and mixing the drops of juice from freshly harvested fruits into a digital refractometer or compensated handheld refractometer with a presence of refractive index accuracy of $\pm$ 0.1 and the range of 0 – 30 and values were expressed as percentage (%) or °Brix (Pereira *et al.,* 2017).

Physicochemical parameters

Protein. Protein content was determined according to Lowry's method. 0.5 g sample was dissolved in 10 ml of buffer/distilled water, then centrifuged at 5000 rpm for 15 mins, supernatant was collected and from that 0.2 ml of sample made up to 1 ml of distilled water. 5ml of Lowry's reagent in sample solution was added and allowed to stand it for 10 mins. 0.5 ml of Folin's ciocalteau reagent were added, mixed well and incubated at room temperature in dark for 30 mins. After the development of blue colour, the absorbance was measured at 660 nm in UV spectrophotometer (Mahesha *et al.,* 2012)

Titratable acidity. Titratable acidity was determined according to volumetric method (Paul *et al.,* 2010). The sample was ground and 5g of sample was dissolved and made up to 30ml with distilled water. The dissolved sample was filtered through cotton. In 5 ml of filtrate sample and 2 drops of phenolphthalein indicator solution was added. Titrated against 0.1 N NaOH. The end point of titratable acidity is the appearance of pink colour. The titratable acidity was expressed as %.

Ascorbic acid or Vitamin C. Vitamin C was determined according to volumetric method (Ismail *et al.,* 2014). 10g of sample was made up into 50 ml of oxalic acid. The sample was filtered through filter paper, from that 5 ml of filtrate solution made up to 10 ml of 4 % oxalic acid. The sample solution was titrated with dye (*i.e*., prepared by weighing 42mg of sodium bicarbonate into small volume of distilled water and 52 mg of 2 – 6 dichloro indophenol dissolved and made up to 200 ml of distilled water). The end point is the appearance of pink colour which disappears with 30 secs. The vitamin C was expressed as mg/100g.

Total antioxidant. Total antioxidant was determined according to Brand Williams methods (Shehata, *et al.,* 2020). In 1g of fruit extract, 10 ml of 99% methanol was added and kept in centrifuge for 15 mins in 5000 rpm. 3 ml of supernatant solution was pipetted out, in that 1 ml of 1M DPPH (2,2-diphenyl-1-1-picrylhydrazyl) was added. The sample solution was made up to 10 ml of methanol and kept in dark for 30 mins. The absorbance of DPPH and the different sample solution were measured at 517 nm against a blank consisting of methanol and the control consist of DPPH and methanol. Total antioxidant was expressed as %.

Total phenols. Total phenols were determined according to Folin Ciocalteau method (Gundesli *et al.,* 2021). The sample extract 0.5 ml was taken and made up to 3ml of distilled water, 0.5 ml of Folin's-Ciocalteau reagent was added and incubated for 5 mins. 2 ml of 20% sodium carbonate solution was added in sample solution mixed thoroughly and kept in boiling water bath for 10 mins. The development of light blue or dark blue coloured sample solution were measured under the absorbance at 765nm in UV spectrophotometery. The Total phenols was calculated by graph value and the values were expressed as %.

Total anthocyanin. Total Anthocyanin was determined according to the modified pH differential method (Shehata *et al.,* 2020). 1g of sample was taken and made up to 25 ml of distilled water and kept in shaker for 2hrs. The sample extract was filtered through filter paper and made up to 25 ml of distilled water. 1ml of extract was pipetted out, in that 3 ml of 0.025M KCL buffer at pH 1.0 was added and another 1ml of extract was pipetted out, in that 3 ml of 0.4 M Sodium acetate at pH 4.5, HCl was added in buffer preparation to adjust the pH range. The absorbance was measured at 520 nm and 700 nm. The anthocyanin pigment concentration was calculated as per the formula AOAC.

RESULTS AND DISCUSSIONS

A. Physical properties of fresh fig fruits

Moisture content. Moisture content in fruit plays an important role in the growth of microorganism which determines the shelf life, fresh consumption and also product development. The moisture content of fruits on dry weight basis for three cultivars were Afghan (79.2%), Brown Turkey (82%) and Deanna (80.1%) (Fig. 1). Brown Turkey recorded the highest moisture content which is due to the biggest size of the fruit compared to other two fig cultivars. Similar results of moisture content in brown turkey was reported by Kaul, *et al.* 2018. The initial moisture content of the fig ranged from 78 to 80 % (Hiregoudar *et al.,* 2006).

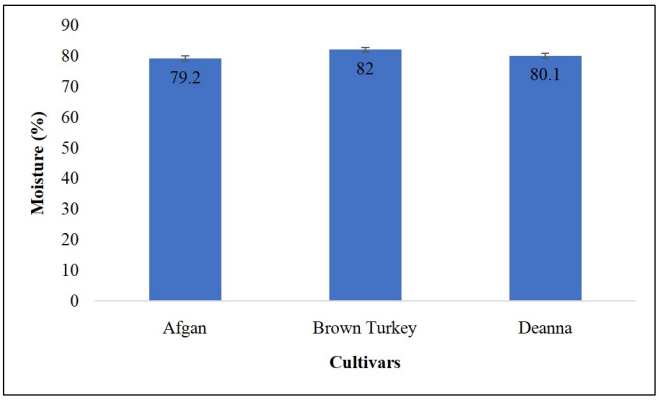
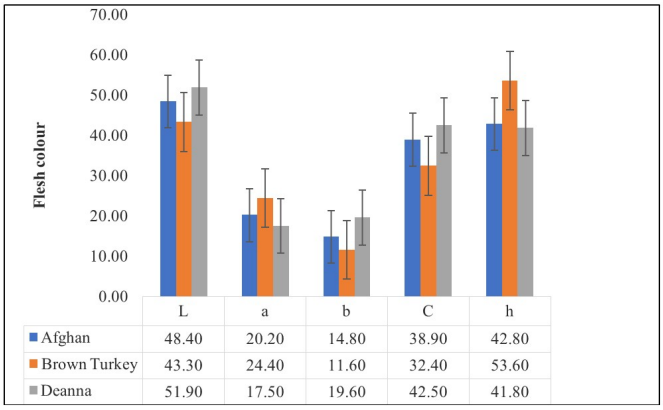


Fig. 1. Moisture content of Fig (*Ficus carica*) cultivars (%).

Fruit colour. Fig cultivars vary in fruit pulp colour namely, light green, light purple, purple, dark purple, yellow and light yellow. The fruit flesh colour of fig cultivars Afghan, Brown Turkey and Deanna, L*value (48.4, 43.3 and 51.9), a* value (20.2, 24.4 and17.5), b* value (14.8, 11.6 and 19.6), C* value (38.9, 32.4 and 42.5) and h* value (42.8, 53.6 and 41.8) respectively (Fig. 2). Brown Turkey recorded the highest L*, a* and h* values, Deanna recorded the highest b* value and Afghan recorded the highest C* values compared other two cultivars. Similar findings of C* (24.6), h* (44.7) and L* (51.7) in Brown Turkey was reported by Pereira *et al.* (2017). The colour of the fig flesh was due to relative concentrations of pigments such as anthocyanins and carotenoids (Wang *et al.,* 2019).



	L	a	b	C	h
Afghan	48.40	20.20	14.80	38.90	42.80
Brown Turkey	43.30	24.40	11.60	32.40	53.60
Deanna	51.90	17.50	19.60	42.50	41.80

Fig. 2. Flesh colour of fig (*Ficus carica*) cultivars.

Total Soluble Solids. The Total Soluble Solid content was reported in Afghan (12.3 °Brix), Brown Turkey (13.5 °Brix), Deanna (12.8 °Brix) respectively (Fig. 3). TSS was highest in Brown Turkey compared other two cultivars. Similar findings of TSS in Brown Turkey (17 °Brix) reported by Kaul *et al.* (2018) and in Deanna (9.9 °Brix) reported by Priyanka, *et al.* (2018). The increase in TSS of fig fruits might be due to the conversion of reserved starch and other insoluble carbohydrates into soluble sugars as fig is a climacteric fruit (Sable *et al.,* 2020).

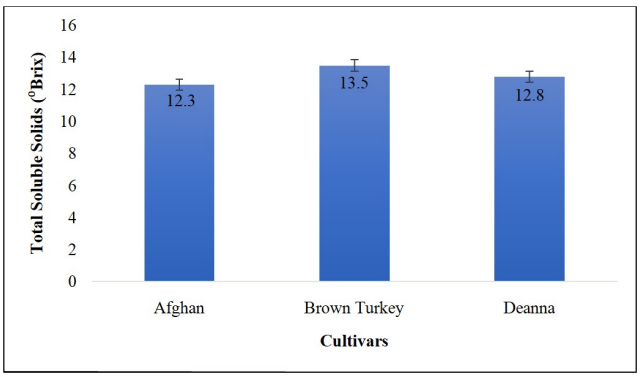


Fig. 3. TSS of Fig (*Ficus carica*) different cultivars (°Brix).

Table 1: Physicochemical properties of fresh fig fruits.

Cultivars	Protein (g/100g)	Titratable Acidity (%)	Vitamin C (mg/100g)	Total Antioxidant (%)	Total Phenols (mg/100g)	Total Anthocyanin (mg/L)
Afghan	1.96	0.18	14.50	47.00	378.00	0.40
Brown Turkey	2.80	0.29	8.00	66.00	558.00	0.37
Deanna	2.00	0.16	10.40	68.00	342.00	0.33
Mean	2.25	0.21	10.97	60.33	426.00	0.37
SD	0.47	0.07	3.29	11.59	115.72	0.03
SE	0.27	0.04	1.90	6.69	66.81	0.02

Protein. Proteins are one of the four main macromolecules which perform specialized functions inside the body. The total protein content of 1.96 g/100g, 2.8 g/100g and 2 g/100g in three cultivars Afghan, Brown Turkey and Deanna respectively (Table 1). Brown Turkey cultivar recorded the highest total protein content. Similarly, in Brown turkey total protein content was 2.48g/100g reported by Kaul *et al.* (2018). An increase in the total protein content might be due to the acceleration of ripening changes that initiate the array of enzyme activities. (Kulkarni *et al.,* 2005). The decrease in total protein content might be a consequence of a reduction in demand of endogenous enzymes associated with anabolic activities, which decreased with the fruit development and maturity (Frenkel *et al.,* 1968).

Titratable acidity. The dominant organic acid in fig fruits are citric acid. Titratable acidity of 0.61%, 0.69% and 0.38% was recorded in three cultivars Afghan, Brown Turkey and Deanna respectively (Table 1). Brown Turkey cultivar recorded the highest titratable acidity content compared to other two cultivars. Similar findings of titratable acidity in Brown Turkey (0.29%) was reported by Kaul *et al.* (2018) and in Deanna (0.14%) were reported by Priyanka *et al.* (2018). Organic acids are the main contributor to acidity in fruits and vegetables and present in higher levels, which is required for metabolic pathways. Loss of acidity occurs during maturation and ripening and it is often because of the fact that these acids act as substrate for respiration and get converted into sugars (Paul *et al.,* 2010).

Vitamin C. Ascorbic acid or vitamin C was abundantly present in all plant cells and performs many biological functions. Vitamin C content of 14.5 mg/100g, 8 mg/100g, 10.4 mg/100g was recorded in three cultivars Afghan, Brown Turkey and Deanna respectively (Table 1.) and Afghan recorded the highest ascorbic acid content. Similar values of vitamin Cin Brown Turkey cultivars (8 mg/100g) reported by Hiwale, (2015). At fruit matured stage, the highest accumulation rate of ascorbic acid accumulated during late fruit development and continued to accumulate during ripening (Huang *et al.,* 2014).

Total antioxidant. Brand Williams method with some modifications was used to determine the antioxidant activity of the different extracts. Total Antioxidant content of 47%, 66% and 68% of three cultivars namely Afghan, Brown Turkey and Deanna respectively (Table 1). Deanna recorded the highest antioxidant activity. Similar values of antioxidant capacity in fig var. Azenjar (68.48%) reported by Meziant *et al.* (2014). The antioxidant activity was highly availablein fruits and vegetables due to the presence of polyphenol and flavonoid compounds (Solomon *et al.,* 2006).

Total phenols. Total phenolic content of 378 (GAE mg/100g), 558 (GAE mg/100g)and 342(GAE mg/100g) was recorded in three cultivars namely Afghan, Brown Turkey and Deanna respectively (Table 1). Brown Turkey cultivar recorded the highest total phenolcontents. Similar findings of total phenolic content in Brown Turkey cultivar (577 GAEmg/100g) was reported by Kaul *et al.* (2018). The quantity of the phenol contents influence in fruits due to the ripeness (Gougoulias *et al.,* 2018).

Total anthocyanin. Total anthocyanin content of0.40 mg/100g, 0.56 mg/100g and 0.33 mg/100gwas recorded in three cultivars namely Afghan, Brown Turkey and Deanna respectively (Table 1). Brown Turkey recorded the highest anthocyanin content. Similar findings of total anthocyanin in Brown turkey (1.3 mg/100g) reported by Solomon *et al.* (2006). Total anthocyanin level increased as the fruit ripens. Anthocyanins possess antioxidant activity which contains different pharmacological properties (Shehata *et al.,* 2020).

CONCLUSION

From the present investigation, it was concluded that there is a prominent difference among the fig cultivars Afghan, Brown Turkey and Deanna on the basis of physiological and physicochemical properties. Fig fruit is an excellent source of a quality attributes *i.e*., TSS (12.86%), colour (L* 43.3, a* 24.40 and b* 11.6), vitamin C (10.97mg/100g), protein (2.25 g/100g), antioxidant activity (60.33%), total phenols (558.00mg/100g) and anthocyanin (0.56 mg/100g). Figs are important dietary source of natural antioxidants and phenolic compound can be considered as foods with remarkable benefits for human health. The knowledge gained from this study will be useful for further research and application of the resource for the preparation of value added products such as dried fig, jam, squash, gummies, chocolates, etc., without any alteration in quality attributes.

FUTURE SCOPE

On the basis of present study, the protocol evaluated the highest nutritional profile in the fig cultivar 'Brown Turkey'. Furthermore, future studies requirement to carried out with the development of high value functional foods.

Acknowledgement. The authors are grateful to Tamil Nadu Agricultural University, Coimbatore for facility and materials. Special thanks to the Department of Fruit Science, HC& RI, Coimbatore, TNAU to conduct the research work by providing a laboratory facility.
Conflict of Interest. None.

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How to cite this article: D. Swetha, C. Indu Rani, G. Gurumeenakshi, M.S. Aneesa Rani, G. Amuthaselvi and R. Neelavathi (2022). Evaluation of Quality attributes in fresh fig (*Ficus carica* L.) fruits. *Biological Forum – An International Journal*, *14*(3): 532-537.